University of Belgrade
Faculty of Organizational Sciences

XVII INTERNATIONAL SYMPOSIUM

September 07 - 09, 2020

online

SERBIA

UNIVERSITY OF BELGRADE
FACULTY OF ORGANIZATIONAL SCIENCES

symorg 2020

BUSINESS
AND
ARTIFICIAL INTELLIGENCE

SYMORG 2020

Belgrade, September 7-9, 2020
(Online)

XVII INTERNATIONAL SYMPOSIUM

BUSINESS AND ARTIFICIAL INTELLIGENCE

SYMPOSIUM PROCEEDINGS

Editors:
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Belgrade, 2020

Publisher
University of Belgrade – Faculty of Organizational Sciences
Jove Ilića 154, Belgrade, Serbia
www.fon.bg.ac.rs

Dean of Faculty of Organizational Sciences
Milija Suknović, Ph.D.

Designed by
Marina Dobrota, Ph.D., Minja Marinović

Printing
SAJNOS DOO NOVI SAD.
Momčila Tapavice 2, Novi Sad, SERBIA

Year
2020

Conference Organizer
University of Belgrade - Faculty of Organizational Sciences, Serbia

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CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

005:004(082)(0.034.2)
005.6(082)(0.034.2)
005.8(082)(0.034.2)
658:004(082)(0.034.2)
004.738.5:658(082)(0.034.2)

INTERNATIONAL symposium business and artificial intelligence (17 ; 2020 ; Beograd)
Symposium proceedings [Elektronski izvor] / XVII International Symposium Business and Artificial Intelligence , SYMORG Belgrade, September 7-9, 2020 ; editors Dušan Starčević, Sanja Marinković ; [conference organizer Faculty of organizational sciences]. - Belgrade : Faculty of organizational sciences, 2020 (Novi Sad : Sajnos). - 1 elektronski optički disk (CD-ROM) : tekst ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovnog ekrana. - Tiraž 100. - Bibliografija uz svaki rad.

ISBN 978-86-7680-385-9

а) Бизнис -- Информациона технологија -- Зборници
б) Електронско пословање -- Зборници
в) Пројектни менаџмент -- Зборници
г) Менаџмент људских ресурса -- Зборници
д) Предузећа -- Пословање -- Информациона технологија -- Зборници

COBISS.SR-ID 22734345

FOREWORD

We are very pleased to present the Proceedings of the XVII International Symposium of Organizational Sciences – SymOrg 2020.

Ever since 1989, the Faculty of Organizational Sciences, University of Belgrade, has been the host of SymOrg, an event that promotes scientific disciplines of organizing and managing a business. Traditionally, the Symposium has been an opportunity for its participants to share and exchange both academic and practical knowledge and experience in a pleasant and creative atmosphere. This time, however, due the challenging situation regarding the COVID-19 pandemic, we have decided that all the essential activities planned for the International Symposium SymOrg 2020 should be carried out online between the 7th and the 9th of September 2020.

We are very pleased that the topic of SymOrg 2020, "Business and Artificial Intelligence", attracted researchers from different institutions, both in Serbia and abroad. Why is artificial intelligence a disruptive technology? Simply because "it significantly alters the way consumers, industries, or businesses operate." According to the European Commission document titled Artificial Intelligence for Europe 2018, AI is a key disruptive technology that has just begun to reshape the world. The Government of the Republic of Serbia has also recognized the importance of AI for the further development of its economy and society and has prepared an AI Development Strategy for the period between 2020 and 2025. The first step has already been made: the Science Fund of the Republic of Serbia, after a public call, has selected and financed twelve AI projects.
This year, more than 200 scholars and practitioners authored and co-authored the 94 scientific and research papers that had been accepted for publication in the Proceedings. All the contributions to the Proceedings are classified into the following 11 sections:

Information Systems and Technologies in the Era of Digital Transformation
Smart Business Models and Processes
Entrepreneurship, Innovation and Sustainable Development
Smart Environment for Marketing and Communications
Digital Human Resource Management
Smart E-Business
Quality 4.0 and International Standards
Application of Artificial Intelligence in Project Management
Digital and Lean Operations Management
Transformation of Financial Services
Methods and Applications of Data Science in Business and Society

We are very grateful to our distinguished keynote speakers: Prof. Moshe Vardi, Rice University, USA, Prof. Blaž Zupan, University of Ljubljana, Slovenia, Prof. Vladan Devedžić, University of Belgrade, Serbia, Milica Đurić-Jovičić, PhD, Director, Science Fund of the Republic of Serbia, and Harri Ketamo, PhD, Founder & Chairman of HeadAI ltd., Finland. Also, special thanks to Prof. Dragan Vukmirović, University of Belgrade, Serbia and Prof. Zoran Ševarac, University of Belgrade, Serbia for organizing workshops in fields of Data Science and Machine Learning and to Prof. Rade Matić, Belgrade Business and Arts Academy of Applied Studies and Milan Dobrota, PhD, CEO at Agremo, Serbia, for their valuable contribution in presenting Serbian experiences in the field of AI.

The Faculty of Organizational Sciences would to express its gratitude to the Ministry of Education, Science and Technological Development and all the individuals who have supported and contributed to the organization of the Symposium. We are particularly grateful to the contributors and reviewers who made this issue possible. But above all, we are especially thankful to the authors and presenters for making the SymOrg 2020 a success!

Belgrade, September 9, 2020

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INVITED PAPERS

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QUO VADIS, AI?

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Abstract: *AI has become a key technology in many areas – from business and services, to science engineering and engineering, natural language processing and news, publishing and writing, human resource management and education, medicine and healthcare, transportation and aviation, government, military and agriculture. As the field advances and expands at an unprecedented pace, it becomes more and more difficult to distinguish between AI and other fields.*
Moreover, just like any other technology, AI has both its bright and its dark sides. There is a number of expectations, hopes and promises of AI that still remain to be fulfilled, yet new avenues for further development open day after day. This talk attempts to put AI developments in different contexts and shed different lights on AI applications in general, AI applications in business in particular, and current limitations, trends and challenges in the field.

Keywords*: Artificial intelligence*, *machine learning*, *neural networks*, *business*, *applications*.

1. INTRODUCTION

It is very difficult, if not impossible, to define Artificial Intelligence (AI). The field is huge and also overlaps with other fields and uses approaches and techniques from other fields. AI focuses on mimicking parts of human intelligent behavior in machines, and human intelligence itself is also not possible to define – it is simply much too complex to allow for capturing in a single definition. As R.J. Sternberg (1987) has put it, “viewed narrowly, there seem to be almost as many definitions of intelligence as there were experts asked to define it”. All of the aspects of human intelligence – thinking, reasoning, abstracting, generalizing, planning, and many more – are also extremely complex; there is currently no scientific understanding of the nature of these processes.

For the purpose of further discussion, a characterization of intelligence offered by Henrik H. Lund from the University of Southern Denmark is adopted here: intelligence is human “capability of creating a variety of behaviors, while complying with the givens of the system/environment.”

2. EXAMPLES OF AI

One of the best-known examples of AI is that of personal assistants, such as Amazon Alexa and Google Assistant. These devices provide intelligent personal assistance, in terms of helping human users find the information they are looking for, add/retrieve events to/from their calendars, or gives directions when the users ask for them. The communication between the users and such devices is conducted in (a limited form of) natural language.

Self-driving vehicles collect relevant information from the environment and are capable of taking passengers and goods around without being driven by human drivers.

When consumers want to watch a movie on Netflix, Netflix uses its predictive, AI-based technology to analyze the user’s previous choices and recommend other films to watch. Similarly, Amazon predicts what the users are interested to purchase based on their online behaviors.

Email services like Gmail successfully filter spam and suggest the users how to create replies to messages, nudging which emails they haven’t answered or have ignored. Navigating with Google Maps is easy, since Google Maps intelligently calculates the route taking into account the traffic conditions and road construction in order to recommend a faster route.

Automated image analysis and object detection/recognition has become popular as well, and there are more and more services that the users can read their images into and the services will recognize the scene, parts of the scene and details on the images. Likewise, speech-to-text services enable voice-based input of search queries when using search engines, as spoken input gets automatically converted to text (the search string).

Applications and services that are called AI today are typically based on training the system with large volumes of data in order to build a model that then accurately classifies input and predicts output when presented with new data from the same category. The accuracy is never 100%, but has already got impressive.

At the time of giving this talk (Sep 2020), the technology that enables many of these applications is deep learning (Goodfellow et al., 2016). It uses neural networks with complex topography in order to successfully recognize different features of sound, images and other forms of input data and integrate them into accurate higher-level descriptions that allow the network to produce correct output (such as classification, prediction, and the like).

3. GARTNER HYPE CYCLE FOR AI

The well-known Gartner Hype Cycle curve, Figure 1, provides a view of how a certain technology or application will evolve over time. Gartner Inc. publishes such curves each year, for different technologies, based on their complex methodology of analyzing technological trends.

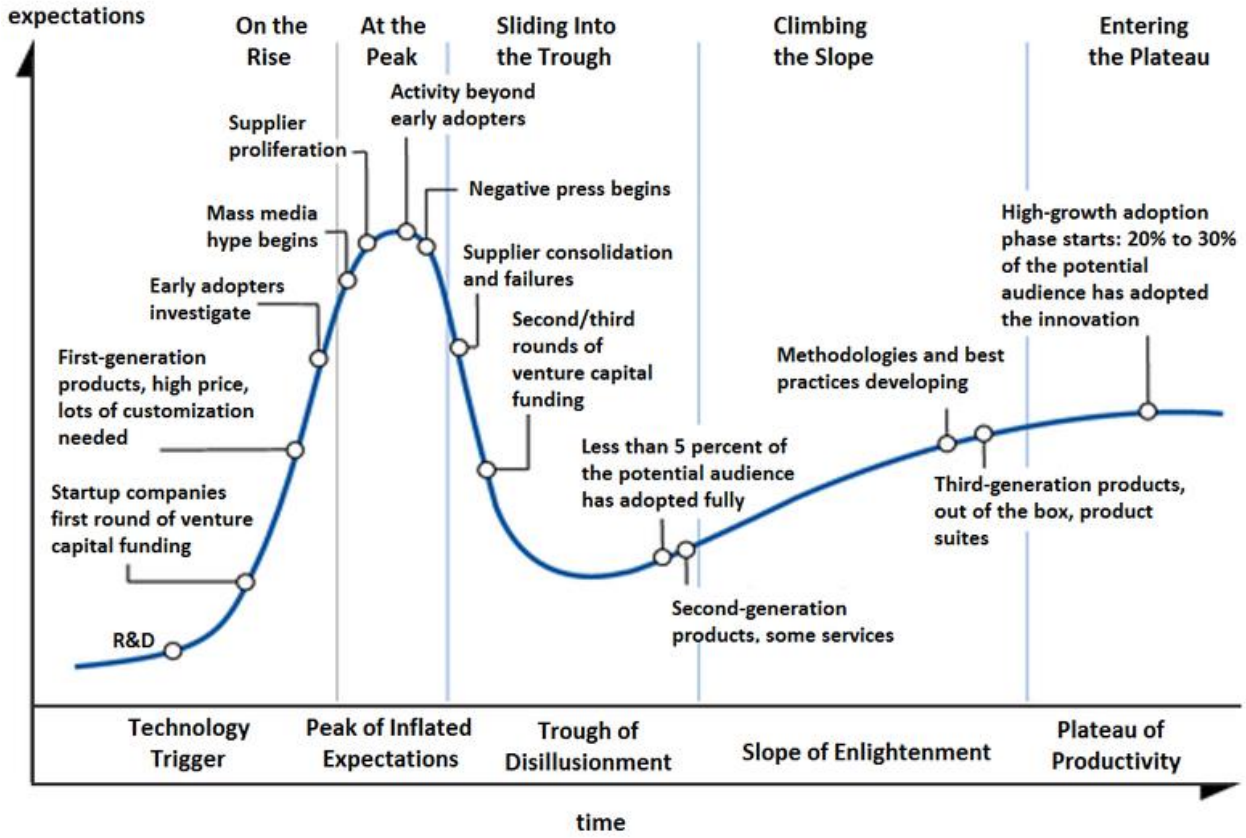

Figure 1: Gartner Hype Cycle curve, general (source: https://commons.wikimedia.org/wiki/File:Hype-Cycle-General.png, marked for reuse under Creative Commons license)

If one follows Gartner Hype Cycle curves for AI in recent years (tip: Google search for "Gartner Hype Cycle AI", and see Google Images for the results), some trends emerge there:

- deep learning is at the peek of inflated expectations for at least three years; it has started to slightly decline in 2020, but it's still there
- traditional machine learning is declining and is now sliding into the Trough of Disillusionment
- even Natural Language Processing (NLP), in spite of the recent breakthroughs, seems to be slightly declining

- Artificial General Intelligence (AGI) is on the rise; it's been there for quite some time, but the 2020 trend shows some ascension
- AI cloud services, or AI PaaS (platform as a service) has been on the rise for a couple of recent years, and has entered the peak of popularity in 2020; AI PaaS is about putting a number of AI services (such as deep learning and natural language translation) in the cloud, making them run on powerful hardware that speeds up the training processes, and enabling end users to access them through the Internet
- Edge AI – delegating AI processing to peripheral (edge) devices, rather than centralizing them on cloud services – is also getting popular
- Small Data movement is on the rise – instead of using massive data volumes to train machine learning (typically deep learning) models, how about learning from just a handful of data, as humans typically do?

4. AI, BUSINESS AND MANAGERS

Managers and business should be aware of some important facts when it comes to AI today:

- the AI hype is evident everywhere; it's undeniable
- still, it is not clear whether AI can live up to the hype – there have always been promises coming from AI researchers, early adopters of AI technology and general press, many of which have failed to deliver
- what is often labeled 'AI' today is essentially not much more than brilliantly applied statistics; no true intelligence or true learning in the human-like sense is evident in today's AI applications
- one of the reasons why many deny any intelligence in AI systems is that they are still human-driven, and not autonomous; likewise, there is a lot of (human-generated) bias in AI systems as they are designed by humans who are inherently biased
- yet, when surveyed for their opinion on whether AI can replace managers in companies or not (Schawbel, 2019), many respondents in different countries provided an affirmative answer; they only believed that AI is still inferior to humans when it comes to soft-skill management (showing empathy, coaching, promoting work culture and the like – for most other typical managerial roles, like financial and human resource management, the respondents believed that AI-powered robots can do better than humans
- AI has become an important *marketing* term – in many businesses and services it has become for companies "a matter of survival" on the market to advertise themselves as AI companies, or at least as companies that use AI in their business; however, a 2019 survey conducted by a UK-based investment firm has shown that about 40% of Europe's "AI companies" don't use AI in any way essential to their business (Knight, 2019)
- when hiring AI specialists to work for a company today, it is essential to realize that the set of skills needed includes a lot of database analysis and administration, a good command of SQL, experience in programming, and a thorough understanding of data security; it is estimated that these activities consume 90% of AI specialists at workplaces, whereas for only 10% of their time they work on building and evaluating AI models
- model democratization is an important factor to take into account – with the rise of AI PaaS, such as AutoML from Google, everyone can build and evaluate their models online, running cloud-based services that perform great (compared to human analysts) and companies do not have to care about providing and maintaining expensive hardware for model building and running

4. CONCLUSION

So, Quo Vadis, AI?

It is very hard to say. On the one hand, the hype is still on and it is a fact that no previous AI hype has lived this long (it is since more than a decade that the last AI hype has started). One has to admit that the results achieved during this last period of AI development have been more impressive than ever before (see section 2). Many AI systems are now trained on large volumes of data, and today data is available in tons – in companies, in government institutions, all over the Internet. Advances in hardware development have contributed to the acceleration of processing these large volumes of data.

On the other hand, critics say that no AI system today is capable of exhibiting true, human-like intelligence, and that what most people label 'AI' is actually just technology that is powerful and impressive, but not smart. Thus, many predict that the AI bubble will burst soon, and that the AI community might even experience another AI winter – the term referring to ceasing of funding for AI research and development, due to the disillusionment and disappointment in technology that has been promising much, but has eventually failed to deliver.

As guidelines in trying to decide where AI is heading today and how to drive business decisions to this end, it might be helpful to:

- watch for trends; Gartner Hype Cycle curves for AI are good source of information for businesses and managers, but keeping an eye on well-reputed AI community Websites like AI Topics (https://aitopics.org/search), Figure 2, is probably even better for spotting emerging trends early

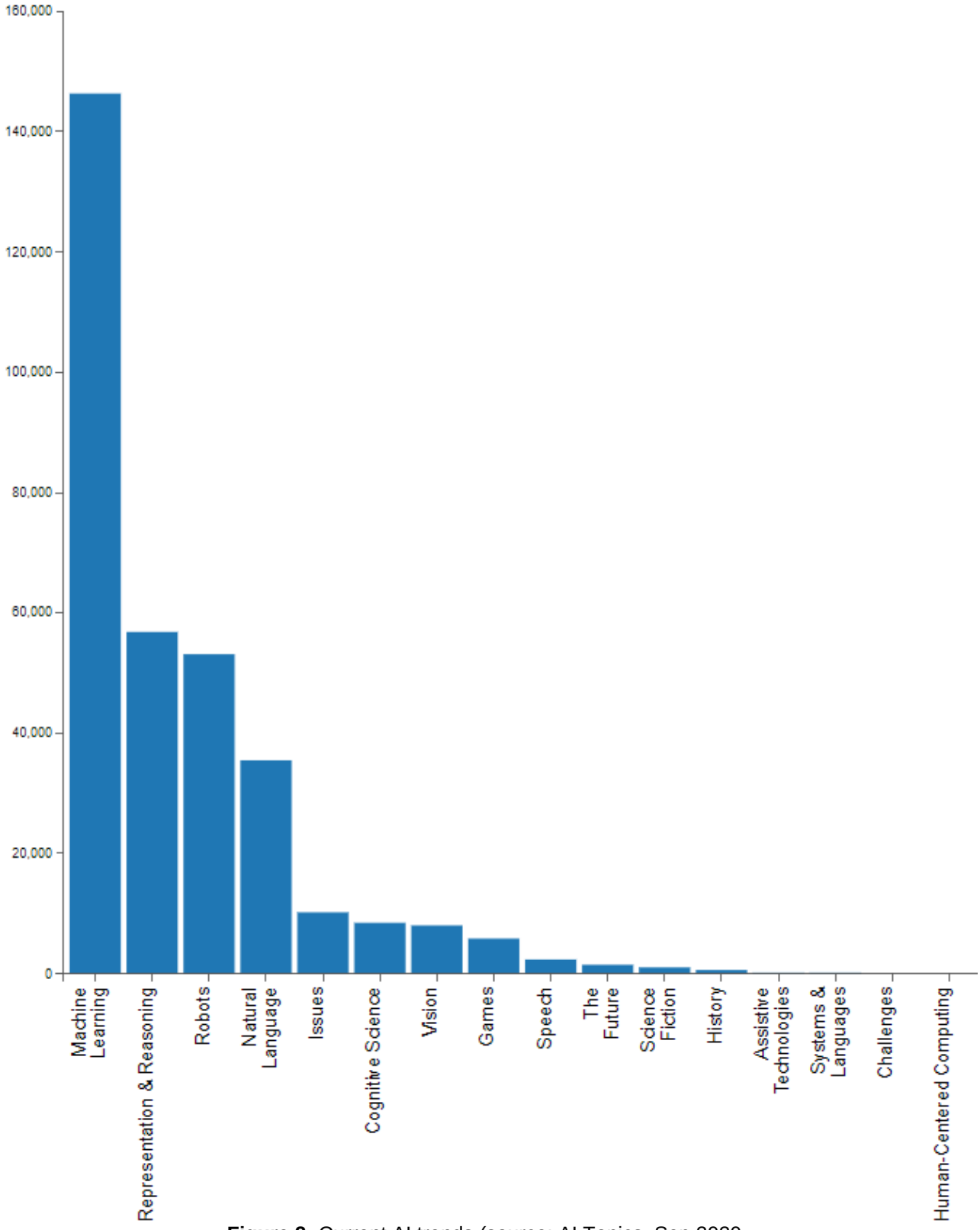

Figure 2: Current AI trends (source: AI Topics, Sep 2020, https://aitopics.org/explore/classifications?filters=taxnodes:Technology%7CInformation%20Technology%7CArtificial%20Intelligence&from-taxnode=Technology%7CInformation%20Technology%7CArtificial%20Intelligence)

- remember the context; Figure 3 shows a non-exhaustive list of traditional AI topics, almost always discussed in books on AI – according to many *all these* topics constitute AI as a field, not only a handful of those exposed on the AI Topics Website (Figure 2)
- bear in mind that, although it is not clear from Figures 2 and 3, human intelligence (capabilities like search, knowledge representation, reasoning, problem solving etc.) is largely based on heuristics, which current AI systems largely lack

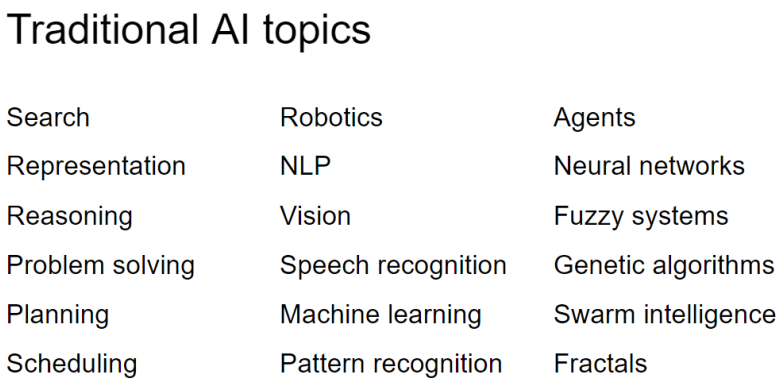

Figure 3: Topics studied in AI since its early days

- be aware of the (sad?) fact that the term 'AI' is often abused; in his famous tweet, Quincy Larson mockingly notes (https://twitter.com/ossia/status/1097804721295773696?lang=en):

> When you're fundraising, it's AI.
> When you're hiring, it's ML.
> When you're implementing, it's logistic regression.

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DATA SCIENCE FOR EVERYONE!?

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Data science, and in particular, machine learning methods, are drivers of change in sciences, engineering, and technologies that affect our every day's life. The computational approaches that can sip through vast collections of data, extract interesting patterns, and devise predictive models are becoming omnipresent. But only a few professionals understand the basics of data science, and even fewer engage in building models using their data. In the era when AI is almost silently shaping our world, everybody needs to be at least aware of its capabilities, benefits, and dangers. We must devise means to communicate and teach concepts of data science to anyone. Data science is shaping today's world, and its means and ways should become a common knowledge.

Our group at the University of Ljubljana has been building a tool that can assist both traineers and trainees in data science training. Orange (https://orange.biolab.si) is a general-purpose data science toolbox that features a combination of data visualization, machine learning, interactive workflows, and visual programming to construct them. We have been crafting courses with Orange that, at least by design, can explain the essential mechanics behind data mining to anyone who can spare a few hours for learning. After a short training, the course attendees can gain enough intuition about data science to recognize opportunities that this field can offer and actively engage in data science projects.

The key to simplicity required in the training and versatility to cover most of the core topics and adapt to various application areas is a Lego brick-like construction of analytical pipelines and interactivity of all the components (see Fig. 1). To further support the teaching and focus on concepts rather than on underlying mechanics, Orange implements easy access to data, reproducibility through the saving of workflows with all the various user-based settings and choices, and easy customization through the design of new components. Essential to the training are means of storytelling through inspection of the workflow, and specialized components for experimentation, like drawing of the experimental data sets or learning about overfitting of polynomial linear regression.

Orange is released in open-source and accompanied by short training videos (http://youtube.com/orangedatamining).

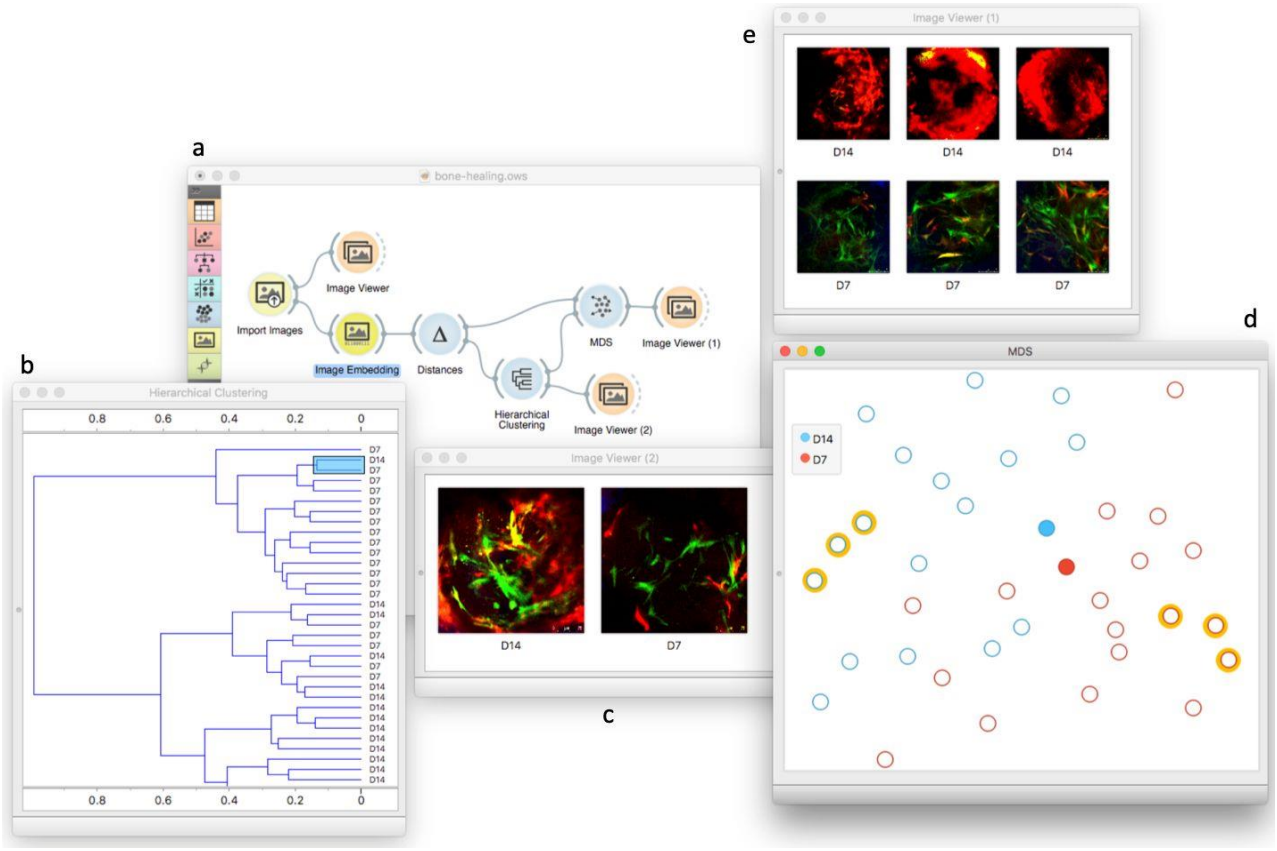

Figure 1: | Orange data mining platform (from Godec et al., Nature Communications)

Fig. 1 | Orange data mining platform, with an example of image analytics workflow for analysis of bone healing images after a week (D7) or two weeks of healing (D14) (from Godec et al., Nature Communications). The workflow (a) imports images from a local folder, embeds them in vector space and performs hierarchical clustering (b) and places images in multi-dimensional scaling visualization (d). Any change in user selection in Orange is propagated to the downstream workflow components. For instance, a change in selection in the dendrogram (b) triggers an update of display of selected images (c) and changes highlighted image points in MDS (d). Any change in user selection of data points in MDS (d) triggers changes in the display of selected images (e). This figure illustrates how a domain expert, in this case molecular biologist, may explore the data after clustering – first focusing on the misclassified samples and looking at the images and then selecting some of the best-classified images as a point of reference for further exploration. Notice, though, that the workflow is general, and we can use it for analysis of any other set of images.

CONTENT

APPLICATION OF ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT

CONTENT

AGILE PROJECT VALUES AND YOUTH ENGAGEMENT IN THE POST COVID TRANSITION

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Abstract: *The paper deals with basic agile principles and values in project management. Special emphasis was placed on the challenges that await young people in the post-covid period and their involvement in agile projects. Agile approaches include frequent iterations, changing requirements, user involvement and servant leadership. The new modality of education has contributed to the fact that graduates have acquired their project management competences in a different way than usual. On the other hand, during the Covid-19, they were denied participation in student projects. All this has contributed to the fact that the current labor market has different requirements in terms of labor, as well as that future project leaders may not have had enough opportunities to be adequately prepared for the labor market. The paper also presents the parallel perception among young people in terms of project areas between traditional and agile approach.*

Keywords*: Agile, Project, Covid, Changes, Youth*

1. INTRODUCTION

Agile methodology is widespread in IT project management. Since the beginning of 2000, agile methodology has slowly begun to take precedence as a methodology that is increasingly used in the IT project management. The question then arises as to whether agile methodologies can play an equally important role in project management among youth, just as they play a role in software projects. The large number of projects that could be managed using agile methodologies is a sufficient basis to reconsider the way of applying agile methodology and possibly supplement it with its new possibilities. Even the PMBOK Guide in the revised edition has dedicated one chapter to the application of agile methodology, it is certain that many teams within IT companies are working on important projects that certainly affect the IT teams and their way. Currently, the situation on the labor market is such that a growing number of young people who do not have an internship are graduating from college and want to get involved in projects, which are mostly of a virtual nature. The paper will present the basic values and principles in the post covid period.

The agility of an organization can be defined as the capability to respond rapidly to fluctuations in the business environment, which is very dynamic. Prerequisite for successful planning and introduction of agile methodology in organizations are flexible processes and competence of employees. Multi-functional teams work on the projects, working through iterations on product development. Each iteration is focused on delivering a high-quality product, that is, the part of the product that is planned and planned for that iteration. Individual competencies of team members are drivers of agile practices and adequate implementation of agile principles among team members (Gren et al., 2018).

2. AGILE BASIC VALUES

The agile manifesto is the basis for setting values and principles for the application of agile methodology. It was created by experts in the field of software engineering in 2001 in Seattle. They emphasize four values:

- The first of the values focuses on increasing the interaction among project participants, and less on the tools they use. Although this first value emphasized interaction, in the post-covid period, the tools through which teams communicate and work are gaining in importance.
- The reduction of unnecessary documentation highlights the product itself, which is created for the end user.
- Frequent communication with stakeholders also contributes to reducing the error in the delivery of the final product; Strict adherence to the contract does not contribute to a greater degree of collaboration.
- Rigorous application of the plan is immanent in traditional approaches. In agile approaches, the focus is on the integrated aspects of change that permeate the entire project management system.

The competencies of graduates are gaining more and more influence in response to the growing needs of the market in various spheres. Therefore, in addition to technical knowledge, knowledge related to cooperation with others is also desirable. By interacting with others on the project, they certainly gain competencies that they were not able to acquire during their education. Namely, some of these competencies also concern the tools they apply, which, above all, are not primary in their field.

One of the most important requirements that is set for development teams and that is most valued are the expectations of end users. Frequent meetings with customers help them to express their opinions regarding their needs as well as shortcomings in product development. In this way development teams can deliver valuable product through shorter iterations and continuous feedback.

Contractual constraints can often undermine collaborative aspects on projects. Certainly, contracts affect stakeholders, but the application of agile principles and values affects their flexibility. Such a system sometimes contributes to the contracting parties accepting the earlier delivery of results with the realization of 80% of the project that brings the greatest value to the project. As a result, the user received the best of the products, and the supplier realized the project earlier than planned.

In project initiations, customers (end users) do not have a clear idea of what exactly they want. Through the progressive elaboration of the project, ie. through the development of the idea in sprints or stages, a final solution is reached. The functionalities that are added during the project certainly represent the results of frequent meetings with clients and feedback. In this way, the team must accept changes, both in the way it is organized and in the creation of the product itself.

The core values that the agile methodology propagates allow for software development processes to be iterative and incremental, as well as for the coded and tested piece of software to be delivered at the end of each iteration. This is possible if:

- Works as a team
- Works in smaller iterations
- Delivers a specific part at the end of each iteration
- Focuses on business priorities
- Team adjustment (Highsmith, 2010)

3. RESPONSE TO CHANGE

Opposite to traditional methodologies, with detailed processes and extensive documentation agile methodology try to avoid dependence on project participants, agile methodologies consider that people, regardless of the process, are the essential factors of success or failure. Accordingly, agile methodologies try to help team members give their full contribution, by insisting on direct communication, friendliness, teamwork, ceremony reduction and a creative approach to problem solving. Regarding to their principles and values, agile methodologies have gained popularity in a relatively short time. Collocated teams might be valuable in terms of osmotic communication (Papadopoulos, 2015). The concept of co-teams was significantly reduced during the corona virus.

Online education has also brought novelties on the Serbian market in terms of preparing young people for the labor market, because such a system has not been widely applied so far. Young people are increasingly recognizing the activities that bring value during covid-19, while on the other hand the faculties direct the activities towards the necessary ones in order to realize the curricula. The youth participation in projects implies involvement through the research centers of the faculties and connection with the economy, in the context of the necessary products and services according to market demands. This type of focus has a number of advantages:

- Faster and more efficient solution delivery;
- Progressive elaboration provides the desired information about the needs of the market and thus the way of employing youth on projects;
- Through frequent feedback from the market, the project team and youth involved often have the impression that they are working on project items that really mean something, ie. they do not feel that the time spent is unnecessary (Douglass, 2013).

4. ADAPTIBILITY

Traditional project management approaches often lead to the situation of delivering a product that is not fully needed. Therefore, through the application of agile concepts, we accept the concept of progressive elaboration of the project and adaptability of the project in accordance with the market requirements. Instead of such an approach, agile accepts that more information will be revealed as the project develops. It may happen that a

certain technical solution does not meet the needs of customers or a completely different problem is revealed below the mentioned problem. The application of agile principles enables the acceptance of the unknown and the priority of discovery and experimentation in order to remove uncertainty before we fully decide on a solution. Agile methodologies are more adaptable than predictable (Mishra & Mishra, 2011).

Students often prefer a structured way of learning and problem-solving approaches. However, as they enter the labor market, they encounter a different situation, where clients or the organizations they work for impose variable requirements on day to day basis. The post-covid period raises the question of the skills they will need and the education for the jobs that will be offered in the market. Some occupations will certainly gain in importance, while others will have less impact on the labor market.

5. FREQUENT ITERATIONS

Most scrum practices have shown that work divided into iterations contributes to greater efficiency of project work. (Shef & Lemétayer, 2013). Therefore, participation in iterations is not fixed and it is based on the functionality that is delivered. This way of organizing allows young people to learn about the processes of the organization and projects, because they are involved in several projects within different work packages. It is extremely important to point out that young people are also engaged in socially responsible projects, which have wider social benefits.

Most agile practices have been developed over the years for small organizations. Although corporations also use agile approaches, we can often come across hybrid approaches to project management. The question that arises for larger organizations concerns the way of leading smaller teams in organizations with over 1000 employees. Although not all of them are agile, only the appropriate sectors have applied this way of organization. Such teams also include participation in joint product creation with end users. (Khalid et al., 2020; Paasivaara & Lassenius, 2014). To achieve this kind of participation, frequent deliveries of smaller parts of the project are desirable, as well as the inclusion of feedback in product development. Through this system, youth have the opportunity to learn quickly, but not only from employees in the, but also from the market for which the product is intended.

6. CONSTRAINTS OF AGILE APPROACH APPLICATION

Opponents believe that agile methodologies are actually a call for ad-hoc development without discipline, order and plan, without modeling, without working on architecture. The authors of agile methodologies answer that due to the emphasis on testing, visibility of results and constant improvement of program code (refactoring), it is definitely not true that there is no discipline, and modeling and realization of architecture are continuous activities that take place during the entire project. It is widely believed that agile methodologies without additional extensions are not scalable to large projects. The most noticeable success factor are categorized according to management support, choosing and customizing the agile model, training and coaching, and mindset and alignment (Dikert et al., 2016).

The problem that both proponents and opponents of agile methodologies have is that there is still not a sufficient number of really detailed and rigorously conducted studies to support their views. It is especially difficult to find data in the ranks of the agile community at all that some of the proposed techniques do not work in practice. If a failure is reported, it is mostly not the agile methodologies used that are to blame, but the project team that did not adhere to some of the recommended techniques. However, the opus of available works is already sufficient to identify some weak points:

- Most agile methodologies provide more guidance than specific guidance for project implementation; a team that is new to this field often has difficulties if it does not have at least one member with experience in the chosen methodology;
- Significantly more quality team members are needed than with classical methodologies;
- Too much burden and responsibility has been shifted to the user; an inappropriate user leads to the failure of the project;
- For more complex projects, minimizing the initial phase envisaged for requirements analysis and the lack of more detailed architecture design can lead to a percentage of program code changes that the team cannot make;
- Insisting on simple solutions at all costs until there is a need for more complex ones, as well as avoiding the development of libraries, templates and everything that is not directly visible to the user), can also lead to too many changes in later stages and slowing down the project
- Agile methodologies advocate incremental development, but do not insist on incremental introduction. Although the increments are accepted by the user, in our opinion, reliable information can be obtained only when the actual use in a real environment begins.

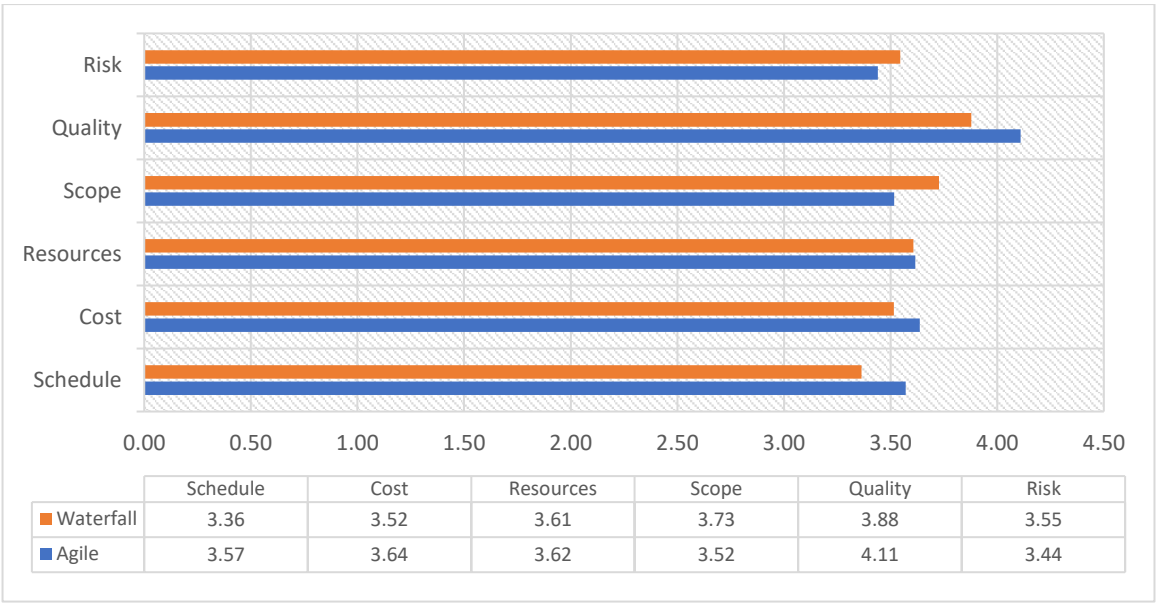
- Insisting on automated tests at any cost, and in situations where their implementation is very difficult or even impossible (database transactions that take too long, user interface testing, etc.)
- Too much reliance on direct communication and default knowledge (lack of documentation) (Dingsøyr et al., 2012; Drury-Grogan, 2014; Gligor et al., 2014; Racheva et al., 2009; Torrecilla-Salinas et al., 2016).

7. YOUTH ENGAGEMENT ASPECTS IN POSTCOVID PERIOD

Leadership, social engagement and communication are the three most important factors among young people exposed to the labor market (Mohamad, 2020). It will also influence the access of young people to projects and their desire to get involved. Many young people are not ready to embark on an agile environment, with an uncertain project environment, preferring the traditional way of working on projects. Three important aspects should be emphasized:

- Young people involved in projects should understand necessary requirements, and the whole story and epic definition (before and after the sprint), as well as agile principles and values,
- Team members must not rely so much on requirements that are based on a predefined roadmap,
- Management and managers must understand that the Agile priority-driven model is the pull method, not the the push method.

According to the mentioned aspects, we prepared research with 120 respondents in recent months. They are mostly graduates (BSc, MSc) as well as young people who have just started their career, with project management experience up to 5 years. Most of their engagement is mainly related to internships and student projects. In the analysis, project parameters were taken into consideration and compared in relation to the traditional and agile approach. It is noticeable that the respondents value quality the most, which indicates that the users are also in the foreground. It is also noticeable that the agile approach is more dominant in considering costs and schedules, while the traditional approach emphasizes scope, because functionalities must be planned in more detail if they do not include frequent iterations (Figure 1).



	Schedule	Cost	Resources	Scope	Quality	Risk
Waterfall	3.36	3.52	3.61	3.73	3.88	3.55
Agile	3.57	3.64	3.62	3.52	4.11	3.44

Figure 1. Comparative project management areas analysis between agile and waterfall methodology

8. CONCLUSION

Involving young people in agile projects contributes to greater employability and an impact on the development of entrepreneurship in Serbia in post covid period. The labor market is becoming oversaturated, so graduates exhibiting on the labor market must consider additional forms of education, in order to be competitive on agile projects. The paper presents parallel comparisons of traditional and agile methodologies through the evaluation of basic project parameters, such as risk, resources, costs, schedules, quality and scope. There are two aspects in the application of agility to projects. The first of them includes the type of project, and the second analyzes the achieved level of maturity of the organization. Flexibility of organization is related with maturity concepts, as well as with value delivery concepts (Shukla & Sushil, 2020). There is also a group of young people who do not prefer project fluctuations and frequent changes. Also, the size of the organization affects the modality of agile approach application, ie these approaches often take the form of hybrids.

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DIGITAL AND LEAN OPERATIONS MANAGEMENT

CONTENT

TIME-SERIES ANALYSIS APPLICATION IN DEMAND FORECASTING: A CASE STUDY OF FMCG

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Abstract: *This paper presents the application of time-series analysis in demand forecasting on the example of a product category from the Fast-moving consumer goods (FMCG) industry. The market of the FMCG is affected by seasonality and trends and is very sensitive to competitors and marketing activities as well as consumer opinions. Due to that, in the process of demand management, there is continuous intention/tendency to monitor and anticipate future demand with a quantitative model. The numerous methods of time series analysis are an excellent approach for application on demand forecasting. In this paper, the demand level of three different types of products from category of breakfast cereals is analysed using the next time-series forecasting methods: naive, average and seasonal naive methods as benchmarks, and simple, double and Holt-Winters exponential smoothing, as well as ARIMA modelling. The main purpose of research analysis is to discover the forecasting method that best fits overall demand for observed product category.*

Keywords*: Demand forecasting, Time-series analysis, Exponential smoothing, ARIMA, FMCG*

1. INTRODUCTION

Every market is affected by seasonality and trends to some extent. This, in turn, causes a plethora of problems surrounding resources, costs, demand etc., putting an emphasis on right operation timing and optimization (Tirkeş et al., 2017). Abolghasemi et al (2019) state that “a volatile market causes a volatile demand”, and so it is of great importance to predict possible uncertainties in order to avoid the negative aspects a volatile demand brings with it.

For these reasons, in demand management, the first and crucial step is to find out what the customer demand might be. With this knowledge, managers can plan all the activities ranging from production to distribution (Rakićević & Vujošević, 2015; Kerkkänen et al. 2009).

According to Fildes et al. (2009), demand forecasting is the crucial aspect of planning in supply-chain companies. It is one of the most important activities, and it could be said that all other activities of SCM are dependent on it, since it plays a crucial role in the decision making process. Most, if not all firms are dependent on these forecasts that impact decisions such as resource allocation, integration, etc. (Adhikari et al., 2017). Kerkkänen et al. (2009) considered that with adequate demand forecasts, managers can better plan the volumes and variety in business activities: production, marketing, purchasing, distribution, transportation and warehousing. Adhikari et al. (2017), also state that “the objective of demand planning is to make reliable demand plans as a base for the S&OP process.” Adequate demand forecasting can mitigate or even eliminate the bullwhip effect!

Importance of forecasting in relation to demand management also stems from a fact that It provides better customer experience and service level, reducing the possibility of an item being out of stock. Consequently, a good forecast can theoretically reduce the price of the item itself due to lower overall costs, avoiding excess inventory levels and transportation costs, while simultaneously meeting customer demand (Bose et al., 2017; Akyuz et al., 2017).

The purpose of this paper is to analyse effective demand forecasting models for the product category demand in the case of the company from the FMCG industry. This paper is structured as follows: After the introduction, section 2 is used to introduce the basics of different forecasting methods. In the third section, there is a quick word about the difficulty of forecasting in this type of environment accompanied by the methodology used to analyze the data. Section 4 discusses basic time series decomposition, as well as Autocorrelation function

(ACF) and Partial autocorrelation function (PACF) results. Section 5 presents the results pertaining to the model fits. Section 6 concludes the paper and presents implications and future research directions.

2. FORECASTING METHODS

All forecasting methods can essentially be separated into two groups, qualitative and quantitative. Qualitative forecasting methods rely on expert's previous knowledge and experience, to make what can be referred to as a judgements call (Rakićević & Vujošević, 2015). Quantitative forecasting techniques, on the other hand, rely on historical data and a forecasting model that "discovers" patterns in the data and uses those patterns to predict future values of the observed variable (Montgomery et al., 2015; Rakićević & Vujošević, 2015).

It's important to mention that there is no single best model that adequately forecasts all time series well and that often a statistical model is used in conjunction with expert's knowledge to produce an adequate forecast (Abolghasemi et al., 2019).

Most people think of a forecast value as a single number or a point forecast. It is worth mentioning that a prediction will almost always be wrong, and a forecast error will occur. Hence, it is good practice to accompany the results of a forecasting model with an error value estimate that can then be used to evaluate the models' performance. This most often means using different models to predict future values that weren't used to construct it, and evaluating errors it produces in this "new" environment (Montgomery et al., 2015). Produced errors could then be used to conclude which of the observed models is the best.

Different statistical models will produce different forecasts. Some of the most commonly used models are (Adhikari et al., 2017):

- Moving Average: The model calculates the average of n previous values, with all values having equal weight;
- Croston Model: this model can be used when forecasting items with intermittent demand, since it takes not only the amount, but also the timing between orders into account (Levén & Segerstedt, 2004);
- Seasonal Linear Regression: the dependent variable is expressed as a function of one or more independent variables (for example price, elements of marketing mix and so on);
- Simple Exponential Smoothing (SES): exponentially decreasing weights are given to past observations, which are used to predict a future value;
- Double exponential smoothing: Uses the same technique as the single exponential smoothing, but will also apply a trend. The alpha remains the same. The beta will determine how quickly the forecast picks up a trend in history.

The Moving average is more often used as a basic smoothing model that helps provide insight into overall trend of a time series (Montgomery et al., 2015), and will not be used as a forecasting method.

Exponential smoothing is used the most of all the available techniques since it is easy to comprehend and requires very little computational power (Ostertagova & Ostertag, 2011). Exponential smoothing was originated by RG Brown, working as an operations research analyst for the US navy (Syntetos et al., 2009). Simple exponential smoothing method assigns exponentially decreasing weights to the observations, which means that older observations are given relatively less weight than more recent observations (Rakićević & Vujošević, 2015). This can be seen in the formula (1) of simple exponential smoothing:

$$X_{T+1|T} = \alpha X_T + \alpha(1-\alpha) X_{T-1} + \alpha(1-\alpha)^2 X_{T-2} + \ldots \quad (1)$$

Simple exponential smoothing, however, doesn't do well when data has a trend, which is why double exponential smoothing is useful. This method contains two smoothing equations, that results in two corresponding parameters α and β. Formulas for forecasted value h terms into the future (2), level (3) and trend (4) are shown below (Hyndman & Athanasopoulos, 2018):

$$F_{t+h|t} = l_t + hb_t \quad (2)$$

$$l_t = \alpha y_t + (1-\alpha)(\ell_{t-1} + b_{t-1}) \quad (3)$$

$$b_t = \beta * (l_t - l_{t-1}) + (1-\beta) b_{t-1} \quad (4)$$

The Holt-Winters method, in addition to the formula used to forecast values h terms into the future (5), contains three equations, one for the level (6), one for the trend (7), and a third one (8) pertaining to the seasonal factor. This, in turn, results in a three parameters α, β and γ (Hyndman & Athanasopoulos, 2018). Although the Holt-

Winters model is one of the simpler ones, it can still give forecasting results similar to the results of more advanced techniques, hence it is often used, due to its simplicity (Tirkeş et al., 2017). Formulas for forecasted value h terms into the future, level, trend and seasonality are shown below, respectively (Hyndman & Athanasopoulos, 2018):

$$F_{t+h|t} = l_t + hb_t + s_{t+h-m(k+1)} \tag{5}$$

$$l_t = \alpha(y_t - s_{t-m}) + (1-\alpha)(l_{t-1} + b_{t-1}) \tag{6}$$

$$b_t = \beta(l_t - l_{t-1}) + (1-\beta)b_{t-1} \tag{7}$$

$$s_t = \gamma(y_t - l_{t-1} - b_{t-1}) + (1-\gamma)s_{t-m} \tag{8}$$

Apart from the models previously mentioned, one of the most common types of advanced forecasting is Autoregressive Integrated Moving Average (ARIMA) modelling (NHS, n.d.). ARIMA models are different from ES models because they also incorporate autocorrelations into the modelling process, which gives insight into the effects past values have on the observed variable. This is particularly important for forecasting demand in supply chain companies. Construction of ARIMA models, whether manual or automatic, is based on the information about autocorrelations (Stellwagen & Tashman, 2013). Still, ARIMA has certain limitations regarding the size of the observed time series.

ACF can be useful when determining the right ARIMA model, but also it gives insight into the stationarity of a time series. If the autocorrelations are still significant even after 15 to 20 lags, the time series isn't stationary (Montgomery et al., 2015). An ARIMA model is made up of three components, and is symbolized as ARIMA(p,d,q), where each letter indicates the order of the corresponding term. Letter p indicates the order of the autoregressive part, d the degree of differencing involved, and q indicates the order of the moving average part. The autoregressive component accounts for the patterns between the observed period and past periods. The moving average component measures how the forecast adapts to the forecast errors made before. The integrated component pertains to the trend as an integrative process in the data, and in the case of existing trends, differences through time must be modeled before the final forecast can be made, which are then integrated back into the data (Stellwagen & Tashman, 2013). A basic stationarity transformation is to calculate the differences between two successive data points (Mills, 2019). This transformation can be performed however many times necessary to induce data stationarity.

3. CASE STUDY

The Fast Moving Consumer Goods industry is very reliant on adequate demand forecasting. That is due to the characteristics of FMCG: highly dynamic market, short-term planning cycle, products that are always pushed to the consumer using marketing activities, but also that the decision to buy by the consumer is spontaneous and quick. All these characteristics make FMCG very difficult to predict. At the same time, because of the short shelf life and rapid deterioration of the product, it is of utmost importance to have accurate predictions about demand for them in order to maximize profits and minimize costs.

The FMCG case study observed in this paper presents the problem of forecasting demand for breakfast cereals product category. The historical products' sales data were obtained from small and big retail shops in Serbia from a period of 24 months. The more accurate forecasted demand from market allows the manufacturer and exclusive distributor to better plan and collaborate their level of business activities.

In this paper, the demand for three different types of breakfast cereals products is selected to be forecasted. Selected breakfast cereals belong to the best-selling products of the examined manufacturer. All three observed time series have data that show demand during a time period of two years, on a monthly basis. Each of the time series was split into training and test sets. For each method, the best possible model was fitted to the training set. Once that model was built, it was used to forecast values for months pertaining to the test set. Error values for both the training and test sets were calculated in order to compare the goodness of fit of each model to the data.

The benchmark methods used in this paper are naïve, seasonal naïve and mean methods. That means that in order for other methods to be considered as better, they will have to have lower error values for both Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE). As more advanced methods, simple exponential smoothing, Holt's linear trend method, Holt-Winters' method and ARIMA modelling were used. In order to get better acquainted with the observed time series, time series decomposition and simple analysis will first be executed.

As a side note, error values obtained from the test set are the ones of interest, because it is best to practise to evaluate models based on their performance on the data the model has not "seen" during its construction. This is achieved by omitting some of the available data that can then be used as a test set, so that we can get an immediate sense about how the model might perform in the real world, without having to wait for actual values of previously predicted time periods.

4. TIME SERIES DECOMPOSITION AND ANALYSIS

In order to get a better understanding of the underlying trend and seasonality that may possibly exist, we use classical decomposition, shown in Figure 1. In order to get a better understanding of the correlation between different points in time, we use autocorrelation, shown in Table 1, and partial autocorrelation functions.

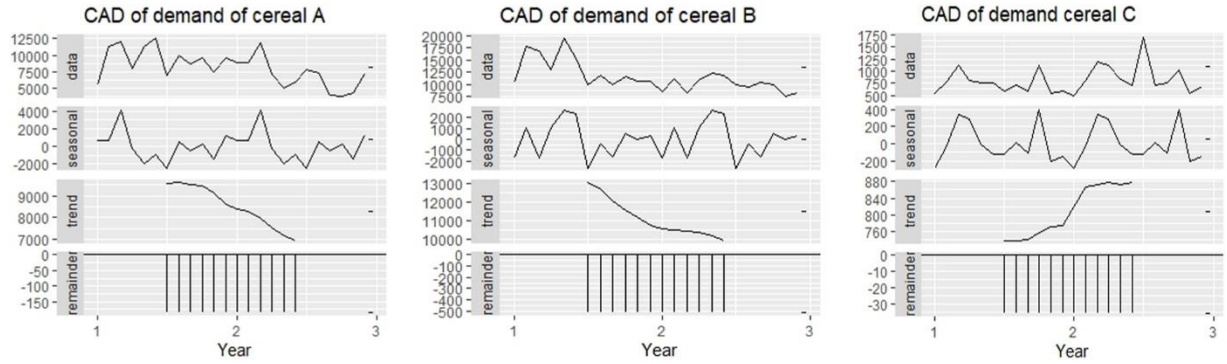

Figure 1: Graphical representation of time series decomposition

In Figure 1 we see that the time series of cereal A seems to be exhibiting a certain downward trend and seasonality. Same is true for cereal B. However, in case of cereal C, seasonality is accompanied by an upward trend. It is necessary to be aware of limitations of classical decomposition, and take these results with a grain of salt. Next, Table 1 presents the autocorrelation function (ACF) at up to 10 lags.

Table 1: Autocorrelation function results of all three types of cereal at 10 lags

Type	Lag									
	1	2	3	4	5	6	7	8	9	10
A	0.409*	0.195	0.329	0.201	0.108	0.115	0.002	-0.171	-0.014	0.051
B	0.479*	0.308	0.373	0.085	-0.034	0.003	-0.079	-0.017	-0.047	-0.157
C	-0.031	-0.108	0.124	-0.026	-0.008	-0.048	-0.046	-0.282	-0.008	-0.119

Autocorrelation function measures the effect past values have on the currently observed value, and as such can help define the order of the moving average part of an ARIMA model in certain cases. Table 1 shows that for cereal A and B, there is a statistically significant autocorrelation at lag 1. For cereal C, however, there is no significant autocorrelation. Partial autocorrelation function, however, measures the direct effect past values have on the currently observed value, excluding the indirect effects, and as such, can help define the order of the autoregressive part of an ARIMA model in certain cases. Partial ACF was also calculated but showed no significant findings at any lag for any type of cereal. These ACF and PACF results can be useful when constructing an ARIMA model, as is discussed above. From them, for instance, we can take an educated guess that the models chosen will probably be ARIMA(0,d,1), ARIMA(0,d,1) and ARIMA(0,d,0), for cereal A, B and C respectively, where parameter d will indicate how many times differencing will be required in order to induce stationarity.

5. RESULTS

In the case study simulation of forecasting demand, we applied several time series methods: naïve, average, seasonal naïve, simple exponential smoothing, Holt's linear trend model, Holt-Winters' model, and also ARIMA modelling

.

All results of the selected methods are organized in tables with products demand forecast (A, B, C) for three consecutive months (October, November, December), as well as with tables with errors in forecasting.

As a measure of forecasting accuracy and goodness of fit, we observed the errors most represented in literature: Mean Error (ME), RMSE, Mean Absolute Error (MAE), Mean Percentage Error (MPE) and MAPE.

The focus was put on RMSE and MAPE, and in order for a certain model to be deemed better than the benchmark methods, it had to have both RMSE and MAPE error values lower than the benchmark methods.

Using the naïve method on the training set, we get a prediction of 3972.9 for all three following months for cereal A, 10370.9 for cereal B, and 753.7 for cereal C. Using the mean method, we get a prediction of 8575.662 for all three following months for cereal A, 11905.1 for cereal B, and 819.395 for cereal C. Finally, using the seasonal naïve method, we get the following results in Table 2.

Table 2: Three month prediction using seasonal naïve method

Type of cereal	Prediction		
	October	November	December
A	9543.9	7510.3	9584.1
B	11647	10706.9	10570.9
C	1118.7	532.1	588.5

Testing the accuracy of those predictions using the test set, we get the following results presented in Table 3.

Table 3: Errors produced by forecasting with naïve, mean and seasonal naïve methods

Type of cereal	Method	Data	Error				
			ME	RMSE	MAE	MPE	MAPE
A	Naive method	Training set	-84.280	2893.405	2369.860	-8.063	30.275
		Test set	1153.400	1847.240	1203.867	16.918	18.213
	Mean method	Training set	0.000	2360.643	1953.383	-9.321	26.545
		Test set	-3449.362	3738.992	3449.362	-79.335	79.335
	Seasonal naive	Training set	-2215.444	3863.117	3123.600	-43.690	54.237
		Test set	-3753.133	3996.490	3753.133	-84.115	84.115
B	Naive method	Training set	2.785	3245.098	2555.675	-3.040	20.706
		Test set	-1838.467	2096.228	1838.467	-23.157	23.157
	Mean method	Training set	0.000	2984.791	2251.502	-5.320	18.331
		Test set	-3372.671	3519.819	3372.671	-41.377	41.377
	Seasonal naive	Training set	-3569.000	4724.352	3696.422	-35.307	36.545
		Test set	-2442.500	2509.073	2442.500	-29.744	29.744
C	Naive method	Training set	11.150	407.344	291.560	-7.534	34.654
		Test set	-0.400	209.947	187.867	-7.790	25.905
	Mean method	Training set	0.000	283.253	206.888	-9.759	25.418
		Test set	-66.095	220.105	209.765	-17.185	31.068
	Seasonal naive	Training set	186.333	396.316	201.622	13.130	15.691
		Test set	6.867	77.790	63.467	2.299	7.835

The error values pertaining to the test set will be used as benchmarks, and therefore, in order to be considered as usable, those are the values that future models will have to beat, where RMSE and MAPE errors are those that will be looked at first.

5.1. Simple exponential smoothing

Using the simple exponential smoothing method, we get the following models and predictions in Table 4. Alpha value vas obtained by fitting the model to the training set. That model was then used to predict values pertaining to the test set.

Table 4: Model parameters and forecasts produced using simple exponential smoothing

Type of cereal	alpha	level	Prediction		
			October	November	December
A	0.2219	9257.0770	6821.4850	6821.4850	6821.4850
B	0.3402	14081.2782	10337.9700	10337.9700	10337.9700
C	0.0001	819.4176	819.4176	819.4176	819.4176

In Table 5, it's possible to see error values these models produce.

Table 5: Errors produced by forecasting using simple exponential smoothing

Type of cereal	Data	Error				
		ME	RMSE	MAE	MPE	MAPE
A	Training set	-522.77	2322.226	1904.116	-14.826	26.68
	Test set	-1695.185	2226.122	1915.195	-42.651	45.728
B	Training set	-523.954	2728.93	2202.897	-8.185	18.877
	Test set	-1805.534	2067.405	1805.534	-22.766	22.766
C	Training set	0.024	283.267	206.895	-9.757	25.418
	Test set	-66.118	220.111	209.773	-17.189	31.07

Here we see that for cereal A and C, the benchmark methods perform better. However, for cereal B, simple exponential smoothing is actually a better method to use, since the errors are lower.

5.2. Holt's linear trend method

Using Holt's linear trend method, we get the following models and predictions in Table 6. Alpha and beta values were obtained by fitting the model to the training set, and that model was used to predict values pertaining to the test set.

Table 6: Model parameters and forecasts produced using Holt's linear trend method

Type of cereal	alpha	beta	level	b	Prediction		
					October	November	December
A	0.0581	0.0581	10185.5899	176.8282	5684.3590	5124.6110	4564.8630
B	0.0001	0.0001	16486.4037	-380.2113	8104.3140	7723.2780	7342.2420
C	0.0001	0.0001	735.8387	9.0967	935.2704	944.3329	953.3953

These models produce following errors presented in Table 7.

Table 7: Errors produced by forecasting using Holt's linear trend method

Type of cereal	Data	Error				
		ME	RMSE	MAE	MPE	MAPE
A	Training set	-603.651	2140.537	1724.489	-14.145	24.106
	Test set	1.689	1872.228	1722.735	-9.345	33.457
B	Training set	-392.628	2545.444	2110.676	-6.461	18.621
	Test set	809.155	1139.912	903.941	8.574	9.824
C	Training set	-16.28	273.98	214.94	-11.47	26.91
	Test set	-191.03	287.55	257.45	-35.2	41.61

Here, we also have a method that actually performs better than the benchmark methods, specifically, for cereal B, where both error values are lower than all the benchmark values. The other two types of cereal, however, are still forecasted the best using the simplest of available methods. Holt's method also beats the simple exponential smoothing method for cereal B, since the error values are lower for both RMSE and MAPE.

5.3. Holt-Winters' additive and multiplicative method

Using Holt-Winters' method, we get the following models in Table 8. Alpha, beta and gamma values were obtained by fitting the best possible model on the training set. That model was then used to predict values pertaining to the test set.

Table 8: Model parameters produced using Holt-Winters' method

Type of cereal	Add/Mult	alpha	beta	gamma	level	b
A	Add	0.0001	0.0001	0.9998	10639.9552	-177.0593
B	Mult	0.0530	0.0031	0.0003	14822.1636	-286.6611
C	Add	0.0001	0.0001	0.0001	645.0378	15.3006
C	Mult	0.0023	0.0023	0.0001	644.6169	14.4278

These models produce the following forecasts in Table 9.

Table 9: Forecasts produced using Holt-Winters' method

Type of cereal	Add/Mult	Prediction		
		October	November	December
A	Add	7422.1750	5388.4570	7462.1600
B	Mult	8458.2270	7527.0400	7579.8630
C	Add	1314.5270	729.1555	786.7818
C	Mult	1424.4626	584.8675	631.1502

As a result, the errors corresponding to the predictions are shown in Table 10 (both additive and multiplicative methods are shown for cereal C in all tables since we cannot definitively say that one is better than the other, based on RMSE and MAPE).

The conclusion is that still, for cereal A and C, the more advanced method is not able to beat the benchmark methods. However, for cereal B, we see that the Holt-Winters method beats all the benchmark methods, but not only that; it also beats all other more advanced methods used. Therefore, we can conclude that thus far, this is the best method to use for predicting the demand for cereal B.

Table 10: Errors produced by forecasting using Holt-Winters' method

Type of cereal	Data	Add/Mult	Error				
			ME	RMSE	MAE	MPE	MAPE
A	Training set	Add	-65.809	2096.988	1299.403	-5.049	19.983
	Test set		-1631.297	2132.437	1631.297	-39.744	39.744
B	Training set	Mult	115.888	1308.34	1046.953	0.023	9.296

	Test set		677.39	897.724	677.39	7.269	7.269
C	Training set	Add	-1.545	214.194	107.923	-3.55	11.504
	Test set		-190.188	204.992	190.188	-25.902	25.902
C	Training set	Mult	0.114	155.061	102.236	-2.087	13.121
	Test set		-126.86	229.935	168.76	-12.91	18.948

5.4. ARIMA method for forecasting

For cereal A, an ARIMA model of (0,1,1) was selected. Using this model, we get a forecast of 6560.33 for all three forecasted months. For cereal B, an ARIMA model of (0,1,1) was also chosen, and using it, we get a forecast of 10308.47 for all three forecasted months. For cereal C, an ARIMA model of (0,0,0) with a non-zero mean of 819.3952 was selected. This is to be expected, considering that the values from this time series do not seem to be significantly correlated to each other. Table 11 shows the errors obtained from application of the ARIMA method.

Table 11: Errors produced by forecasting using ARIMA method

Type of cereal	Data	Error				
		ME	RMSE	MAE	MPE	MAPE
A	Training set	-230.300	2326.300	1824.641	-10.483	24.342
	Test set	-1434.030	2034.308	1828.143	-37.190	42.701
B	Training set	-241.243	2731.577	2072.685	-5.651	17.316
	Test set	-1776.034	2041.692	1776.034	-22.416	22.416
C	Training set	0.000	283.253	206.888	-9.759	25.418
	Test set	-66.095	220.105	209.765	-17.185	31.068

For cereal A and C, we can see that there are benchmark methods that perform better. However, for cereal B, we see that this model is actually better than all the benchmark methods. Still, it is one of the worse performing models among the more advanced methods.

6. CONCLUSION

This paper presents the time-series analysis of real data from the FMCG industry. The analysis includes forecast application on 24 months of data about sales of breakfast cereals from the retail channel in the Serbian market. Time series methods that were applied are naïve, seasonal naïve and mean methods as benchmark methods, as well as simple exponential smoothing, Holt's linear trend method, Holt-Winters' method, and ARIMA modelling as competing advanced methods.

In order to evaluate applied forecasting models, after each method was used to fit the best model to the training set and then forecasting the values corresponding to the test set. Forecasting errors produced were looked at (namely RMSE and MAPE) in order to evaluate whether their performance was better than those of the benchmark methods.

The results showed that there is not one forecasting method which best fits to the sales data of all considered products. More detailed, none of the more advanced methods were able to outperform the benchmark methods when it comes to cereal A and C. This is, perhaps, to be expected, considering the fact that there barely seems to be any significant autocorrelation, partial or otherwise, which makes it difficult to predict future values based on past observed values. However, for cereal B, all advanced methods performed better than the benchmark methods, where the Holt-Winters method that encapsulates both trend and seasonality performed best.

Different methods give different results and it is necessary to continuously evaluate and supplement the chosen method and model with information from the marketing process. These results are almost certainly related to one of the biggest limitations of this study, which is the sample size. Two years worth of data may be too little to accurately forecast future demand. Since it has been very difficult to find firms from the industry willing to share large-scale data about sales. However, the research in this paper may point out new possibilities for upgrading the process of demand management especially in the domain of quantitative methods application.

Future research can be directed in the extension of sales data for more products and times periods. It would also be interesting to upgrade the quantitative forecasting system with correlation among observed products from the portfolio as well as how price and other elements of the marketing mix influence the future demand level.

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SPREADSHEET APPLICATION FOR INVENTORY CONTROL OF FROZEN FRUIT BASED ON STRUCTURED DESIGN

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Abstract: *The contemporary business environment imposes an increased need for the development of decision-support tools. Many of them are developed by people who are not professional programmers, but domain experts who need support in performing specific tasks and activities. These people are so-called end-user programmers. One of the most used tools by end-user programmers are spreadsheets. In order to develop a structured and reliable solution, spreadsheet engineering approaches are applied. Spreadsheet engineering is based on the principles of software engineering and directed toward the development and usage of high-quality spreadsheet solutions. This paper presents a spreadsheet solution based on the Jackson structured design, as a proven spreadsheet engineering approach. The solution will be described on the example of the inventory control model for frozen fruit wholesale, implemented as a spreadsheet application.*

Keywords*: spreadsheet engineering, inventory control, Jackson structured design, food industry*

1. INTRODUCTION

Considering market dynamics and changing business conditions managers in charge of inventory control face a significant challenge in defining of required inventory level at each point of accumulation within material flows they manage. In order to improve material flow management, decision-makers should have the appropriate form of support in the process of decision-making. For these purposes, decision-making models are widely used. These models should include all relevant information from the environment, and represent significant support to the decision-maker in choosing the available alternatives. Nowadays there are a lot of BI (business intelligence) tools and software solutions that provide necessary support in the process of decision-making. However, spreadsheets are still one of the most commonly used tools for decision-support because of their functionalities, ease of use, and flexibility.

Despite their overall acceptance and possibilities they provide, many researches indicate that the usage of spreadsheets can lead to bad business decisions and horrifying consequences due to their error proneness (Powell et. al., 2009; Panko & Aurigemma, 2010; Panko, 2005; Caulkins et. al., 2007). Spreadsheet solutions are often developed without defined structure and application of development methodologies. Recently, many researchers have increased awareness of this topic and developed approaches and methodologies for end-users in order to prevent errors in the process of usage and development of spreadsheet tools (Jannach et. al., 2014). To develop better spreadsheet solutions that are efficient, properly created and documented, it is necessary to expand and apply knowledge in the field of spreadsheet engineering. Spreadsheet engineering can be defined as the application of the principles of software engineering in the development of solutions in a spreadsheet environment (Đorđević, 2016). Software engineering covers many techniques (data referencing, modular structure, documenting, etc.) which fundamentals are founded as a result of errors and attempts of developers in the process of software systems development. Many of these techniques can be applied to spreadsheets and they define spreadsheet engineering. Adoption and implementation of spreadsheet principles have the potential to resolve some of the basic spreadsheet problems such as bad design, mixed data and calculations, lack of documentation, etc. (Antić & Đorđević, 2018). One of the main goals of the development of this field is the prevention, detection and error analysis in spreadsheet models and applications.

The spreadsheet solution which will be presented in this paper is developed in accordance with the spreadsheet engineering principles. It enables monitoring and control of material flow of frozen fruits through the entire process of delivery in wholesale on the German market. The specificity of the goods implies maintaining of cold chain throughout the whole delivery process. These goods need to be stored,

manipulated and transported under the special temperature regime and hygienic conditions. The movements of the goods are recorded and monitored in the developed spreadsheet solution. The central part of the solution is the spreadsheet model for inventory control, described in (Jeremić et. al., 2019), which is fully implemented but won't be presented in detail within this paper due to the page limitation. The model is implemented as a spreadsheet application. The methodology based on the application of Jackson structure diagram, presented in (Rajalingham et al. 2008), was applied during the development process of the application, in order to made it reliable and high quality in terms of implementation, use and maintenance. Jackson structured design has found great application in spreadsheet engineering and thus represents good practice in development of reliable and efficient solutions in a spreadsheet environment.

Starting from this point, the paper is structured as follows. In Section 2 the process of deep-frozen fruit wholesale delivery is described, followed by the existing spreadsheet solution for inventory control which is presented and analyzed in Section 3. Section 4 presents the development process of a new spreadsheet application through the steps of the methodology based on the Jackson structured design. Finally, the last section relates to the conclusions and summarizes all the above mentioned.

2. THE PROCESS OF DEEP-FROZEN FRUIT WHOLESALE DELIVERY

The company for which the spreadsheet application was developed operates within the food industry, in the sector of deep-frozen fruit and vegetables. The company cooperates with industrial and retail clients. The process of deep-frozen fruit wholesale on the German market will be described in this paper. The clients of the company are the biggest retailers on the German market. They are ordering the goods every week in smaller quantities and from many different locations. To keep the status of a reliable supplier, the company has to deliver each order in the requested quantity and within the requested time. Considering the mentioned requests and dynamics of sales, an external warehouses and developed distribution network on the German market are necessary to deliver each order under requested conditions. The company has engaged a 3PL (third-party logistics) partner for this purpose.

Since the company supplies one main distribution center, for the 3PL partner is required to have a developed logistics network and to be able to deliver each order to the customer on time. Therefore, it is necessary to apply the logistic concept of cross-docking delivery. Cross-docking implies the existence of one large, main distribution center from which smaller distribution centers are supplied (Vogt, 2012). Smaller distribution centers' locations provide the ability to cover all regions and delivery locations in Germany. The essence of this concept is that full truck (Full Truck Load - FTL) departs from the main distribution center loaded with the goods that have to be delivered to the multiple unloading points. The trucks arrive to smaller distribution centers and each of them serves several unloading points. Depending on which unloading point the goods have to be delivered, transshipment is performed in a smaller distribution center. Then, the goods are loaded into smaller vehicles which transport them to the final place of delivery. This concept of delivery proves to be efficient when it is necessary to deliver smaller quantities of 33 euro pallets, as is the standard for FTL, to more locations. The described concept enables savings in terms of time and costs.

The process of delivery is initiated with a sales order. Upon receiving the sales order logistics planner records it in the existing spreadsheet tool and checks the inventory level of ordered SKUs (Stock Keeping Unit). If there are enough inventories on stock, a planner proceeds to creation of sales order in ERP (Enterprise Resource Planning) system and creates a delivery note which is referred to the previously created sales order. If there are not enough inventories on stock, the replenishment order has to be created. The replenishment order should be created as soon as the stock level reaches a defined safety stock level. Safety stocks are often called reserve stocks. They should satisfy the demand, during unforeseen, sudden events, which were not foreseen in previous periods (machine failure in the production line, unrealized deliveries, etc.) (Antić, 2014). For the inventory control problem, considered in this paper, the safety stock was defined as an average daily sales for the current month multiplied by Lead Time. Lead Time is defined as the time between placing the replenishment order and delivering the goods to the customer. However, given the lack of an adequate procurement plan and the lack of tools to support the decision-maker in defining inventory replenishment points, this process represents a significant challenge for the planner controlling the process. The planner takes control actions based on his experience and his predictions of customer demand.

After order processing, a transport order with instructions for deliveries is created and forwarded to the logistics provider in Germany. The logistics provider should confirm deliveries within the required deadlines. According to the distance of the retail distribution center, one or two days before the required delivery date, the goods are collected and sorted, depending on the place of unloading, and transported to the appropriate distribution center. On the delivery day, the goods are delivered to the final place of unloading, and after the completion of deliveries in the current day, the logistics provider sends information about the status of all

deliveries. After confirmation of deliveries, invoices are sent to the customer thus completing the order delivery process.

The success of this process is depended upon successfulness of the inventory control process. The inventory control process is a key factor in the success of the delivery and ultimately customer satisfaction. To improve the process of inventory control, it is necessary to identify material flows and their subjects in the process of wholesale delivery. When material flows are defined, accumulation places of the flow's subject should be identified and implemented in the decision-support tool. In this way, a decision-maker has available information about the state of the flow's subject all the time. Based on this information, the planner takes control actions that will affect the state of the flows' subjects, and thus the entire delivery process.

Appropriate decision-support tool, for the logistics planner, should enable insight into data relevant for the process (inventory levels, forecasted demand, history sales data, etc.) and generate suggestions of control actions for the decision-making. The only tool that supported the planner in the process of decision-making was a Google Sheet table which will be presented in the following section.

3. EXISTING SPREADSHEET SOLUTION

ERP software is the only information system that the company disposes of. Since its usage is directed toward recordkeeping, the ERP doesn't have implemented modules for decision-support. Contemporary challenges of the business world require making many decisions regularly. For that cause decision-makers need appropriate decision-support. As the company doesn't have an IT department, spreadsheets are a perfect environment for the development of customized solutions for decision-support. One of them is the spreadsheet solution for inventory control in the process of wholesale delivery.

The existing spreadsheet solution is implemented as a Google Sheets table. This table allows insight into inventory levels for each SKU and it is the only form of decision-making support in the process of planning, monitoring and managing material flows of goods. For each SKU there is unified form in the table, which consists of the following groups of ranges: realization of the contracted quantities, order data, inventory levels (on stock and in transit) and planned replenishment. All of these SKU forms are placed one below the other within one sheet. These data are organized into sheets that represents a specific date, which means that each day user has to make a copy of a previous day sheet.

The order processing in the spreadsheet is carried out as follows: as the order is received, a user creates a record of it in the order data fields and if there is more than one SKU ordered, a user has to repeat the process. After delivery of the ordered SKUs, the user has to delete each record referred to the delivered order manually. The user has to update data in the fields of contract realization and inventory levels, also manually. Additional step is a record-making for delivered order in a separate sheet.

SKU replenishment data is recorded in the separate part of the form. The decisions regarding replenishments are made based on the current level of stocks, recent sales, contract realization and personal experience of the decision-makers. Replenishment orders are forwarded to the production department. After confirmation of the possibility of preparing the goods, the user is making a record of planned loadings for each SKU that has been ordered. When the goods have been loaded in the production unit, a user has to delete this record and to update the inventory level in transit manually. The same concept is applied after the unloading of the goods.

There is no automation of the existing tool. All changes are recorded manually, which means that a possibility of error occurrence is high, as well as the possible consequences to the decision-making. A user's lack of concentration can significantly negatively affect the accuracy of the displayed data. The consequences are directly related to the decision-making in managing the material flows of the items in the process of delivering goods to the customer. Consequently, it may completely lose its role as a decision-support tool. The structure of the tool isn't well defined which causes difficulties in access to the specific parts of it and requires a lot of manual work on a daily basis. To overcome these deficiencies, the need for the development of the new tool arose. A new solution has been developed in accordance with the methodology presented in (Rajalingham et al., 2008), based on the application of the structural algorithm to the creation of spreadsheet models.

4. SPREADSHEET APPLICATION BASED ON JACKSON STRUCTURED DESIGN

Spreadsheets represent one of the most successful tools for end-users. End-users developers are usually domain experts which don't have broad knowledge in the field of software development methodologies (Đorđević, Jeremić & Antić, 2018). According to (Ko et. al., 2011) end-user programming is defined as „programming to achieve the result of program primarily for personal, rather public use.“ End-users

programmers are developing customized solutions that are directed toward specific tasks in which they need computational support. They are developing software solutions using end-user software, such as text processing software, database software, presentation software, and spreadsheets. However, spreadsheets are still one of the most used end-user software because they allow end-users programmers to develop customized solutions without significant knowledge of software development principles.

The development of proper spreadsheet tools should be based on the principles that assure the efficiency of a developed solution in terms of implementation, utilization in its life span and further improvements. Spreadsheets represent an environment that enables end-users relatively simple development of decision-support models, without strict rules. Spreadsheet control models are implementing a conceptual mathematical model, which reflects the knowledge and experience of a domain expert. However, these models are prone to errors due to the development process which includes translating verbal and mathematical expressions into spreadsheet formulas and functions. Usually, end-user developers are not professional programmers and they are not introduced to model development and software implementation rules, which results in a series of errors and bad design of models and applications. Due to the lack of end-user training, errors are easily made, but hard to notice. Application of knowledge and experience, grouped and shaped into the area of spreadsheet engineering, has the potential to improve spreadsheet model and application development, as well as to enable prevention, detection and analysis of errors in them. In this paper, Jackson structured design will be applied as a support in the process of development and implementation of spreadsheet application for inventory control of frozen fruit.

According to (Rajalingham et al. 2008) spreadsheet models can be represented in a form of the Jackson structure diagram (Jackson 1975), which can be mapped onto program code. The methodology based on structured analysis of data, resulting in the outcome represented as *Jackson-like structures*, is suggested by the authors (Rajalingham et al. 2008) for a spreadsheet application development. The structured algorithm consists of the following stages: specification and design of outputs, conceptual design of the workings section, logical design of the workings section, construction of the workings section structure, construction of the input section structure, implementation of functions and relationships, and completion of the output section. The advantages of a structured format are comprehensibility, ease of maintenance, and error reduction (Knight et al. 2000).

4.1. Specification and design of outputs

This stage is oriented toward end-user of the solution being developed i.e. model interpreter. The end-user in this case is the person who uses the output of the model/application for a specific purpose i.e. decision-making. The methodology based on the structured design requires the outputs to be presented on separate worksheets. Since the solutions' main goal is the improvement of the material flows control, users require three types of reports: active sales orders report, replenishment realization report and delivery realization report.

Active sales orders report enables insight into all orders that will be delivered in the upcoming period or that are already in the process of delivery. This report has multiple benefits to the user of the application because it enables insight into deliveries of ordered SKUs in the current and upcoming period, and decision-making upon these deliveries (creating delivery routes, negotiating additional quantities, etc.). The replenishment realization report provides an overview of planned and realized inventory replenishments. The user has available different statuses, which he can use for replenishment orders filtering (by processing, in preparation, transit, realized and unrealized orders) and upon which he can perform various analyses. Delivery realization report provides an insight into realization of deliveries in the previous period. Based on these data the user performs analyses such as: dynamics of deliveries by SKUs, delivery locations, time period of the year, service level, etc.

4.2. Conceptual design of the workings section

Conceptual design of the workings section shows the hierarchical relationship of the model elements and their interconnections. It is created according to the importance of functions and elements in the process itself. The first step is defining of root elements, i.e. elements/functions of the highest level which do not have dependents. On the top of the hierarchy are located the elements of the highest importance, which represent the purpose of the process and below them are added the elements that are their direct predecessors. The main goal of this stage is to visualize instances of multiple dependants of a particular element of the model.

The purpose of developed spreadsheet application is an overview of all data relevant to the specific SKU, which are necessary for decision-making and control of SKUs material flow. Considering that, it is necessary to have available data regarding planned inputs, state of inventory levels and planned outputs for each SKU. Figure 1 shows conceptual design of the workings section.

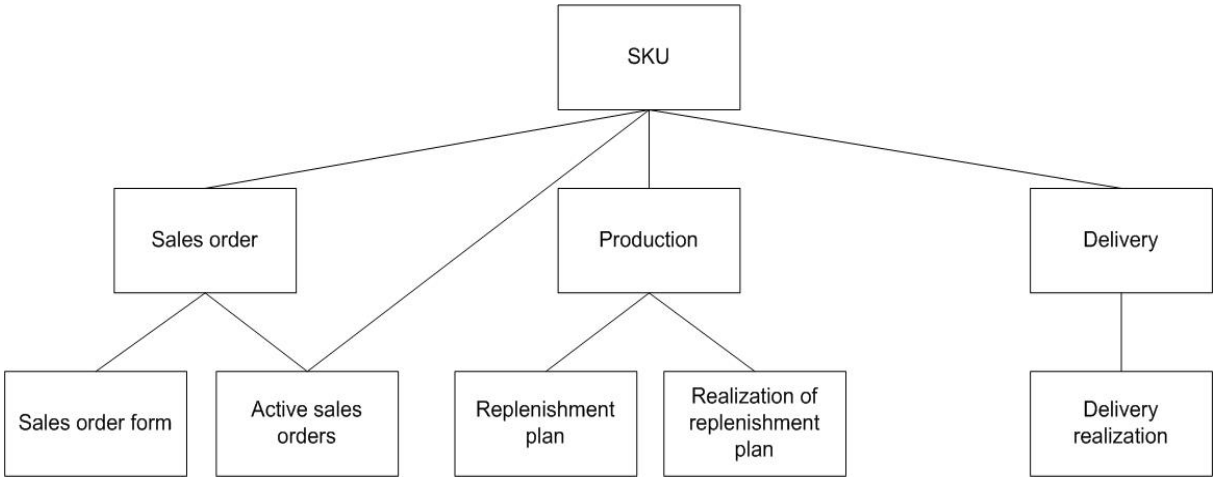

Figure 1: Conceptual design of workings section

4.3. Logical design of the workings section

In this stage it is necessary to describe the structure defined in the previous stage in more detail. Given that for complex spreadsheet models, a complex form of a graph can occur when defining a conceptual design, in this step, it is necessary to transform it into a tree form. Thereby, the two rules can be applied (Rajalingham et al. 2008). The first rule introduces duplicating of the elements with more than one dependant, whereby predecessors of these elements are not shown in the model at this stage. The second rule implies that predecessors of duplicated elements should be presented as a separate module in the tree form. Logical design of workings sections of developed spreadsheet application, in accordance with previously described, is shown in Figure 2. In this case, database of active sales orders represents predecessor of two elements – sales order and SKU. Since this element does not have predecessors, there was no need for presenting additional module.

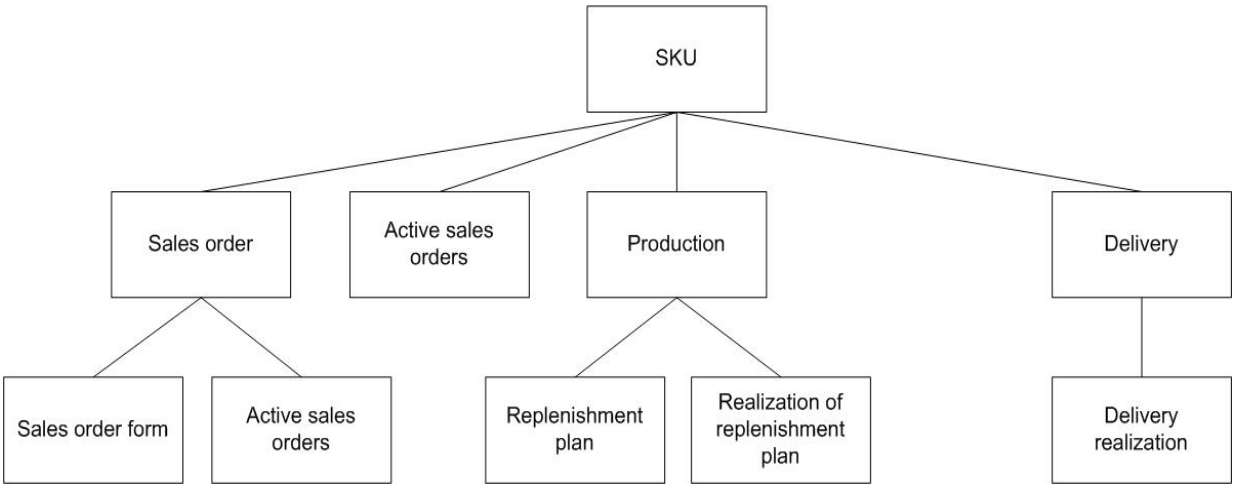

Figure 2: Logical design of workings section

4.4. Construction of the workings section structure

Construction of the workings section structure defines how the previously described structure and logic of the model are implemented in the spreadsheet. This stage is based on the indentation principle which is applied to the row labels and its corresponding values. Each value is indented by the assignment of a virtual spreadsheet column for each indentation level. The elements of the same hierarchical level are represented in the same column, whereby each row contains only one function. Since the developed spreadsheet application doesn't have functions that interconnect its elements, Figure 3 represents a modified workings section structure according to the applied structured methodology (Rajalingham et. al., 2008). Since one of

the main deficiencies of the existing spreadsheet tool was data overprocessing and the need for a lot of manual work, the new spreadsheet application is implemented with a significant level of work automation through the procedures developed in Visual Basic for Applications.

SKU	Procedure		
Sales order		Procedure	
Sales order form			Procedure
Active sales orders			Procedure
Production		Procedure	
Replenishment plan			Procedure
Realization of replenishment plan			Procedure
Delivery		Procedure	
Delivery realization			Procedure
Active sales orders		Procedure	

Figure 3: Construction of the workings section structure

Workings section is accessed through the main menu of the application or through the navigation menu which is implemented for each worksheet. By filling the sales order form users activate macro which transfers the data to the workings section. The sales order element considers sales order management. If there are enough inventories of ordered SKU, the user proceeds to the sales order processing. There are three different sales order statuses: pending, ordered, and delivered. Pending status means that the order is recorded but not processed. Ordered status considers that the sales order is processed and that the delivery order is forwarded to the logistics provider. Delivered status is active when the goods are delivered and its sales order can be archived in the database of realized deliveries. The user manages the sales order status depending on its realization, which is coordinated with the logistics provider.

If there is not enough of ordered goods on stock or its inventory level is below defined safety stock, the user has to place the replenishment order. The replenishment order form is the output of the inventory control model, which is implemented through the spreadsheet application, and it is a part of the production element. Each generated replenishment order has its status: ordered, in preparation, transit, delivered, unrealized. Ordered status means that the replenishment order is recorded and it is pending for approval from the production department. In preparation status defines that the order is confirmed and it is in the process of production. Transit status identifies that the order is on its way to the main distribution center. Unrealized status considers that the order is either rejected from the production unit or it is decided to cancel its realization. All replenishment orders are presented in two reports, active and archived orders. Active orders report consists of orders which have status pending, in preparation or transit. In the report of archived orders there are the orders with status delivered or unrealized. Depending on the realization of these orders, the user manages their statuses. When the status changes the user has to update the reports, which is done by activating the macro which transfers the data to the appropriate report.

In case when there are enough inventories on stock, the user processes the order through the ERP system, sends delivery order to 3PL partner and changes its status to ordered. After delivery realization, order status should be changed to delivered. By activating the macro from active orders report all delivered orders are archived to delivery realization report.

4.5. Construction of the input section

During this stage, it is important to separate the cells intended for the input of the data, for two reasons. The first one refers to the importance of obtaining accurate input data. The second reason is that data entry cells are often referenced in more than one formula. In this manner possibility of formulae overwriting is reduced, as well as accidental interference of users to the application functioning.

The input section of the developed application consists of two input forms: sales order form and replenishment order form. The sales order form implies following input data: sales order number, requested delivery date, delivery destination, ordered SKUs, the quantity of ordered SKUs. This order form is created considering the clarity and ease of use, but the data arrangement is different than for the working and output section. Therefore, a transition table is implemented in order to prepare the data in the form and formats of destination database. The replenishment order form is the output of the inventory control model that is implemented through this spreadsheet application. This form consists of the following data: ordered SKUs, the quantity of ordered SKUs and the requested loading date.

4.6. Implementation of functions and relationships

This step represents interdependences of model/application elements implemented through calculations and formulas. In this step formulas and calculations needed for the workings section are created. In contrast to the structure of conceptual and logical design of the workings section, in which the top-down approach is applied, this step is based on the bottom-up approach. The bottom-up approach implies moving from the lowest hierarchical levels to the highest during formula creation.

The spreadsheet application, described in this paper, except for the control model, does not have implemented calculations in the form of functions/formulas that interconnect the elements of the application. Simple calculations are used at the level of the working section, while interconnection of application elements is achieved by the implementation of procedures developed in Visual Basic for Application (Figure 4). The procedures fill the workings section and provide the appropriate output based on the given inputs.

SKU	SKUOverview ()		
Sales order		OrdersUpdate ()	
Sales order form			OrderEvidence ()
Active sales orders			OrdersReport ()
Production		RealizedReplenishmentsUpdate ()	
Replenishment plan			ReplenishmentEvidence ()
Realization of replenishment plan			ActiveReplenishmentsUpdate ()
Delivery		DeliveriesUpdate ()	
Realization of delivery			DeliveryEvidence ()
Active sales orders		OrdersReport ()	

Figure 4: Implementation of functions and relationships

4.7. Completion of the output section

Completion of the output section is the final stage of the application development and implies definition of the output, based on the previously shown input values and calculations. The output section of the described spreadsheet application consists of several reports which represent records of certain material flows. These reports are related to the elements of the structure diagram: sales order, production and delivery (Figure 1).

The sales order element contains active orders report which gives insight to all active sales orders in one place. This overview can be really useful in determination of trend dynamics according to different criteria. The element production generates two reports related to the realization of the replenishment orders, active orders and archived orders. The active orders represent evidence of the orders that are pending or they are in the process of realization. This report is divided into three parts related to ordered, in preparation and orders in transit. The archived orders are orders realized or rejected due to various circumstances. The delivery element results in a report of realized deliveries. Based on the data from the report the user can perform a various set of analysis, which can give him valuable information for the process of decision-making.

5. CONCLUSION

To be able to compete in a nowadays markets, companies have various decision-support systems. However, these systems are often expensive, implementation takes a long time and they are not flexible enough. Therefore, there is increased need for the development of customized solutions directed toward some specific goal. The spreadsheets are a very popular environment for creating efficient end-user tools. These solutions are often developed by people with expertise in domains other than software development. Consequently, these solutions are error-prone due to the end-user's lack of knowledge in the field of software development. To prevent errors and create sustainable spreadsheet solutions it is important to apply the knowledge and experience from the field of spreadsheet engineering. The methodology based on the Jackson structured design is one of the development methodologies within the spreadsheet engineering area. Corresponding principles make it possible to show the structure of the system by real objects, their connections and activities (Ourusoff, 2003).

This paper describes the spreadsheet application for inventory control, developed in accordance with the Jackson structured design based methodology. The newly developed application represents improvement of the existing spreadsheet solution by increased automation, upgraded structure and various reports upon which the user can perform different analyses. One of the greatest benefits is shifting users' focus from manual work to managing the process of frozen fruit delivery, and allowing him to think about the further improvement of both, process and application itself.

The main goal of this paper was to show the development of the application's structure, which enables an overview of module structure, error prevention, error detection and comprehensibility of the spreadsheet model. The paper points out the importance of spreadsheet engineering methods and principles application to the process of spreadsheet tools development and improvement, as well. Development directions related to the application are oriented toward connection with ERP system and implementation of Microsoft's Power Automate services, which will further improve the process of inventory control.

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APPLICATION OF BUSINESS INFORMATION SYSTEMS IN SERBIAN WOOD INDUSTRY

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Abstract: *The main objective of this paper is to present and analyze the research results of the level of business information systems (BIS) application in the wood industry companies of the Republic of Serbia. In addition, the objective is to establish the length of the period of BIS application in the business of these companies, show a comparison of the level of BIS application in companies in the areas C16 and C31, to perform an analyze and to show the number of companies which apply BIS, by the number of employees and type of production criterion, as well as the analysis of the most common used BIS modules in wood industry companies. The intention of this paper is to indicate the level of BIS application in wood industry companies in the Republic of Serbia. The purpose of this paper is to imply to these wood industry companies the need for BIS application in current business conditions and the advantages of its use. The research was conducted on a sample of the 100 wood industry companies in the Republic of Serbia. The research results show that a very small percentage of companies in this field apply BIS in their business. Also, a small number of companies perceive the need and plan the application of BIS in the next 18 months.*

Keywords*: Business Information Systems, ERP, Research, Wood Industry, Republic of Serbia.*

1. INTRODUCTION

The wood industry of the Republic of Serbia with 4.623 active business entities, over 25.000 employees, with annual exports of over half a billion Euros, the growth trend in exports and a significant surplus in inter-trade exchange, is one of the main pillars of the economic development of the Republic of Serbia (APR, 2019). Besides previously mentioned facts, this industry bases its production and development on domestic raw materials, which are ecologically friendly. Based on this, the potential and importance of this industry for the economy of the Republic of Serbia can be identified as well as the attention that must be dedicated to this area. The largest part of the Republic of Serbia's wood industry companies consists of Micro and Small Enterprises (MSEs) (APR, 2019).

Some of the underlying problems that these companies deal with are the production milling and the unrecognition of their products in the domestic and foreign markets (Kalem et al., 2019, p. 244). In addition, some of the problems related to the domain of production and business management. These companies must improve production and business management models to: maximize their business results and ultimately improve their business, remain or become more competitive in the domestic market, increase their share in the foreign market and exports. One of the opportunities is to increase the application of BIS in their business. The implementation of these systems would contribute to the faster collection of large data amounts, enable monitoring and control of business results, and facilitate and speed up making timely management decisions, which would directly contribute to improving business results. It would also enable more straightforward and faster integration of MSEs into the supply chains of large enterprises, increasing productivity and improving many other business processes. Without using proper BIS in the company, there is no visibility of performed operations and processes, no consolidated database on which operational reports are generated, problems appear because of the lack of a system that monitors the production processes, no information regarding quantities (of materials and/or final products), suppliers and clients (Blazeska et al., 2015, p. 110-111). These small enterprises increasingly implement "ERP systems and, compared to large enterprises, they differ in a number of inherent characteristics that are likely to impact the ERP system implementations" (Zach et al., 2014, p. 309).

2. AIM AND METHODOLOGY

The main objective of this paper is to represent the results of the conducted research about the level of BIS application in the wood industry companies of the Republic of Serbia. In addition, this paper has several specific objectives: to define the time period of BIS application in business of the companies in this industry of the Republic of Serbia (for those companies that already use BIS), show the compared results of the level of BIS application in companies of area C16 (wood processing and products of wood, cork, straw and willow, except furniture) and area C31 (furniture production), show the level of BIS application in the wood industry companies by the number of employees and type of production criterion, as well as analysis which BIS modules are the most often used in the companies of the wood industry of the Republic of Serbia.

In order to conduct the research for the purposes of this paper, a primary research technique was used. It has consisted of three phases. The first phase of the research is the selection of the 100 largest companies in the wood industry of the Republic of Serbia, based on data from the Serbian Business Registers Agency (APR) from the year 2017 (APR, 2017). The selection criterion was business income in the previous year (2016), and the selected companies were divided into two groups, according to the form of registration of the business entity. The first group consisted of 50 companies, and the second group of 50 entrepreneurs, i.e., entrepreneurial shops. The second phase of the research involved searching through the Internet in order to find the websites of the selected companies, which resulted in contact information for each company. The third phase of the research included the data collection process by the survey method, which was conducted by sending an online survey to all the companies whose contact was found in the second phase of the research. Therefore, the research was conducted on a sample of the 100 wood industry companies in the Republic of Serbia in the period August-September 2019.

3. APPLICATION OF BIS IN BUSINESS MANAGEMENT

“Information System (IS) can be presented as a combination of software, hardware, people, networks, data resources, communications and procedures and policies that stores, retrieves, transforms, and disseminates information in an organization” (O'Brien & Marakas, 2011, p. 103). Different kinds of IS are developed for different purposes for the last 20 years, depending on the need of the business. There are varieties of IS with “a different role in organizational hierarchy and management operations, such as: Transaction Processing Systems (TPS), Office Automation Systems (OAS), Management Information Systems (MIS), Decision Support System (DSS), Executive Information Systems (EIS), and Expert System (ES)” (Al-Mamary et al., 2014, p. 1279). For an IS “to be trustworthy, it must preserve the confidentiality and integrity of the transaction information, and that IS must have a high degree of availability, so parties who need to view the information, and who also have authority to do so, can do so upon demand” (Brandon, 2016, p. 33). “The challenge of evolutionary BIS is to provide a socio-technical information system infrastructure that is capable of meeting changing business requirements incrementally, where (unanticipated) changes can be incorporated incrementally (without service interruptions) directly by the stakeholders” (Neumann et al., 2014, p. 33-34).

Enterprise Resource Planning (ERP) systems present one type of BIS. These systems are highly complex BIS which implementation “requires a high cost, corporate time and resources” (Rajnoha et al., 2014, p. 165). “The ERP system implementation was in 88.3 [%] of surveyed companies considered to be a significant change that substantially affects the present and especially the future competitiveness of the company” (Rajnoha et al., 2014, p. 168). These “systems are specialized for the analysis of organization’s business operations” (Debeljački et al., 2015, p. 336). It presents “a set of integrated programs that manage the vital business operations for an entire multisite, global organization” (Stair & Reynolds, 2015, p. 23). “The system has a cycle of the system whose input is “data”, conversion process is “information processing” and output is “information””(Özkarabacak et al., 2014, p. 491). “ERP systems are based on Information Technology (IT) with the focus on integrating different business functions and departments in an efficient manner” (Cagatay & Ufuk, 2014, p. 232).

ERP systems enable the integration of all enterprise functions into one unit. These systems contribute to the improvement of business operations and can be used to design and monitor business growth. Also, these systems use a unique database, enabling fast and secure exchange of data among all users (employees). ERP systems are business programs adjusted for easier management of the company. In manufacturing companies, they are used to monitor and manage all production processes - from planning to production of the final product. “ERP is deployed in a form of internal company project usually with multi-years delivery plan depending on the size of company and number of selected ERP modules” (Hadidi et al., 2017, p. 594).

With the implementation of the ERP system, every employee can follow it at any time: the production process status, the product and quantity of production, the quantity of raw material used in the production and its necessity to re-procure, used capacity of a particular machine, etc. Thus, every employee has all the

necessary information. “The introduction of a new ERP system is a great contribution to the restructuring and the establishment of a business system” (Denic et al., 2016, p. 1339).

The main characteristic of an ERP system is modularity. The modules represent clustered business processes, i.e., company sectors, where each module represents a single function of the company. Some functions are included in various modules for more efficient monitoring and control. Modularity enables the company’s gradual upgrading of an ERP system, in accordance with the needs, growth of the company and increasing complexity of business processes. The module is a program or a group of programs where the data is stored in a unique database that users access according to the defined access authorizations. In order for an ERP system to be implemented in a company, it is necessary to know the underlying processes and understand the information flow. “Modules are integrated and provide seamless data flow among the modules, increasing operational transparency through standard interfaces” (Madanhire & Mbohwa, 2016, p. 226). According to the same authors, “ERP software is made up of many modules selected based on both economic and technical feasibility for manufacturing units”. “The basic modules, which are usually incorporated, are production planning, purchasing, inventory control, sales, marketing, finance and human resources”. “Variance in the use of the manufacturing planning and control features should not be biased by the firm-specific choices of software or the unique needs of different industry sectors, which would influence the use of many other ERP system modules, such as product configurations or project management tools” (Tenhiala & Helkio, 2015, p. 153). According to the authors (Cagatay & Ufuk, 2014, p. 268), following basic ERP modules “are coded for ease-of-use as: Purchasing (PR), Bill-of-Material (BOM), Production Management and Scheduling (PM), Inventory Management (IM), Sales (SL), Customer Relationship Management (CRM), Finance (FN), Accounting (AC), Master Planning (PL), Quality Management (QR), Human Resource Management (HR), Budgeting (BT), Data Automation (DA) and Maintenance Management (MM)”. Also, in the modern business environment, the Internet environment is essential for ERP implementation. A good connection is necessary for the smooth functioning of the data exchange system.

If an ERP system is intended for use in companies from a particular industry, it presents the optimized solution for that industry. It may not be a universal solution, i. e. it is a solution with specific characteristics for particular enterprise activities. However, when implementing an ERP system, it is important to pay attention to the following: long and thorough planning before implementing the system, engaging company representatives for each module during the system implementation process, focusing on system compliance with enterprise needs and standards, as less as possible system refinement and modification, the timely provision of realistic and accurate data, the adequate and on time training of all employees, competent implementation team with adequate testing results of the implemented system, complete transition from an old to the new system, continuous maintenance and improvement of the system, etc. “It is equally important for all the members of the company's management to participate in the project implementation of ERP solutions actively” (Denic et al., 2016, p. 1338). According to the same authors, “acceptability by users means that customers are satisfied with the proposed solutions, that it is really a solution that will serve as an aid in their everyday work”. The enterprise needs “to choose those ERP systems that are easy to customize (so that the cost and time consumed in the customization can be reduced as much as possible) and the upgrade of the ERP system is necessary (the technical advance results occur continuously)” (Zhang et al., 2005, p. 65).

4. RESULTS AND DISCUSSION

This chapter represents the results of the conducted research on the level of BIS application in the wood industry companies in the Republic of Serbia. As already mentioned, the research was conducted in three phases. In the first phase of the research 100 largest companies were selected in the wood industry, based on the criteria of business income in 2016. The second phase of the research was performed by doing research on the Internet to find contact information about the selected companies. In the third phase an online survey was conducted in the selected companies.

Based on the survey results, out of a total of 100 selected and surveyed companies, the number of companies that do not use BIS in their business is 9 (9 [%]). The number of companies that did not respond to the online survey is 44 (44 [%]). The survey was not sent to the 25 companies (25 [%]) whose contact was not found in the second phase. In addition, 5 companies (5 [%]) do not produce furniture and wood products, and these companies are excluded from the analysis. Also, 2 companies (2 [%]) are excluded from the analysis - they completed the survey, but they do not use BIS in business. Only 12 companies (12 [%]) apply BIS in their business and 3 companies (3 [%]) are planning to implement BIS in business in the next 18 months. The percentages of the results of the third phase of the survey - an online survey implementation are shown in Figure 1.

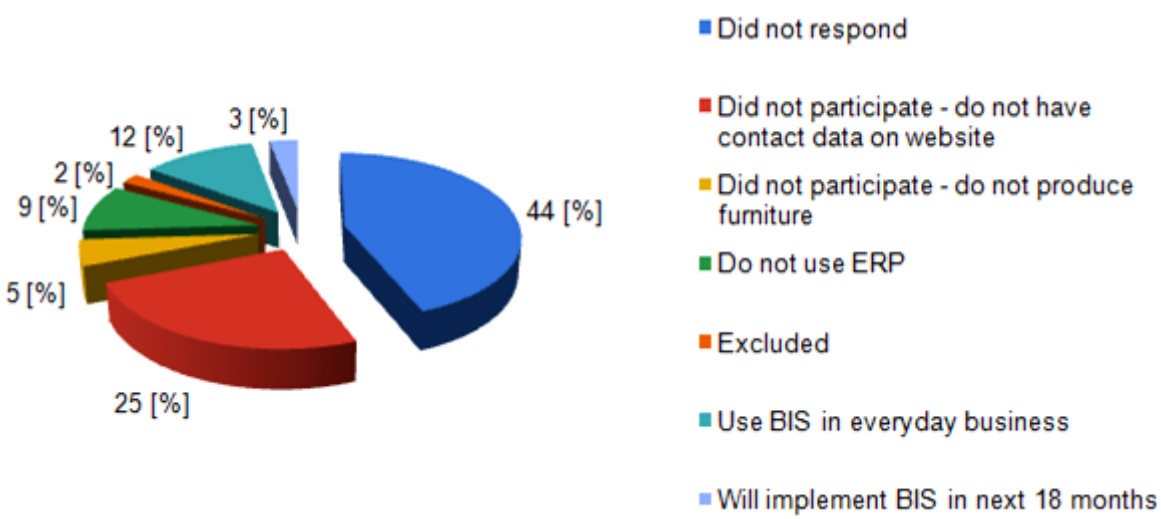

Figure 1: Number of the wood industry companies that apply BIS in business

Therefore, based on the survey results, only 12 [%] of the surveyed companies apply one of the BIS. It can be concluded that this is a relatively small percentage since the survey was conducted on the sample of the 100 largest companies or largest entrepreneurial companies of the wood industry in the Republic of Serbia, according to the revenue criterion in 2016. It can also be assumed that on a larger sample (larger number of companies), the percentage of companies that apply BIS in their business would be significantly smaller. The reason for such a conclusion is that, in that case, the companies taken as a sample would be smaller based on criteria: the number of employees, market share, market distribution and realized profit.

In addition to the questions related to the percentage of companies that use BIS in their business, this paper explores several other vital issues related to the BIS application in the wood industry companies of the Republic of Serbia. One of them is the time length of BIS application in business in the wood industry companies in the Republic of Serbia. The results of this study are shown in Figure 2.

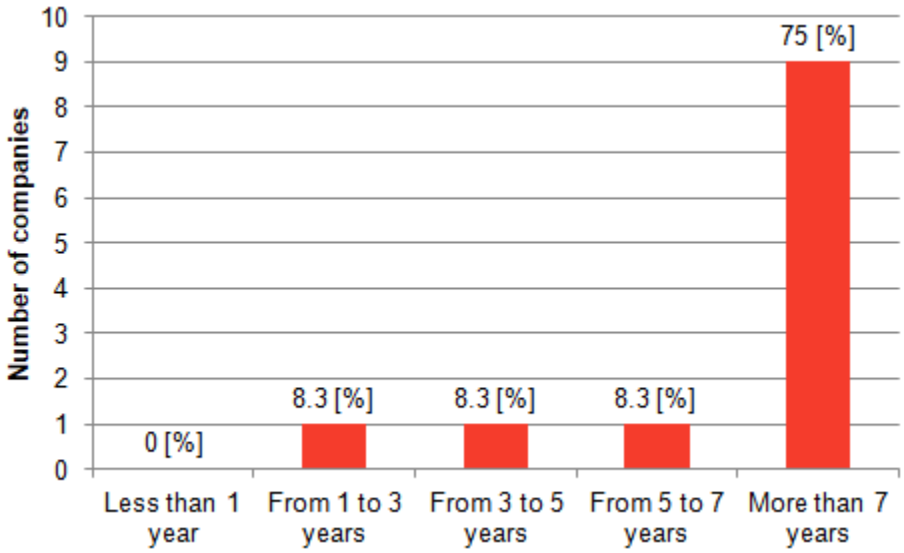

Figure 2: The time length of BIS application in the wood industry companies

Figure 2. shows that out of 12 companies that use BIS in their business, the most significant number of companies (9 or 75 [%]) has been applying BIS for more than 7 years. One company (8.3 [%]) has been applying BIS from 1 to 3 years, one company (8.3 [%]) from 3 to 5 years and one company (8.3 [%]) from 5 to 7 years. Figure 2. also shows that in the previous 12 months, no companies have implemented BIS in their business, which can be considered as worrisome.

The next question in the research was to determine the number of companies that use BIS in their business, according to the main activity of the company, i.e., areas C16 (wood processing and products of wood, cork, straw and willow, except furniture) and C31 (furniture production). The results of this research are shown in Figure 3.

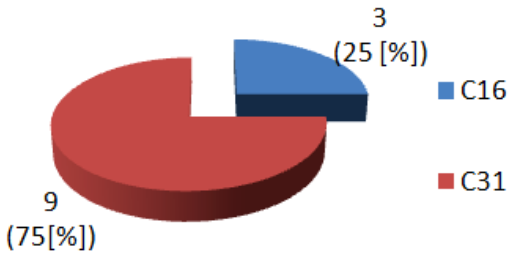

Figure 3: The number of wood industry companies by main business activity that apply BIS in business - areas C16 and C31

As shown in Figure 3, a significantly larger number of companies from C31 area apply BIS in their business than companies from C16 area. The results of the survey indicate that out of a total of 12 companies that apply BIS, 9 companies (75 [%]) belong to the C31 area, while 3 companies (25 [%]) belong to the C16 area.

The next question explored the difference in the BIS application in the wood industry companies, depending on the number of employees criterion. The results of this research are shown in Figure 4.

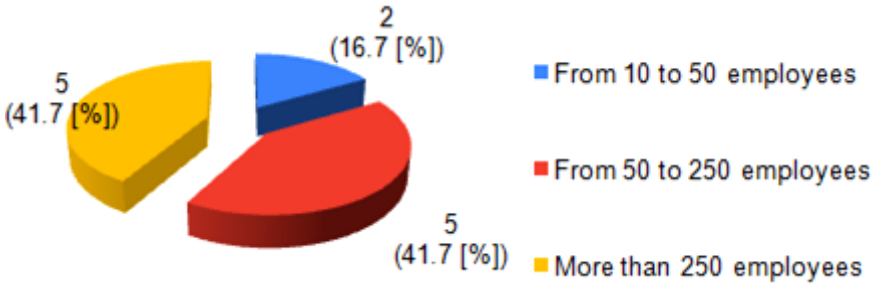

Figure 4: The level of BIS application in the wood industry companies depending on the number of employees criterion

Figure 4. shows that the application of the BIS in the wood industry companies depends on and grows with the number of employees. The most significant number of companies (5 or 41.7 [%]), which apply BIS in their business, has over 250 employees. According to the number of employees criteria, these companies belong to the group of large enterprises. The following 5 companies (41.7 [%]), according to the application of BIS, are companies between 50 and 250 employees. According to the number of employees criteria, these companies belong to the group of medium enterprises. According to the same criterion, 2 companies (16.7 [%]) that apply BIS in businesses are companies between 10 and 50 employees. These companies belong to the group of small enterprises. The companies that use BIS in business with less than 10 employees were not represented in the survey because no companies that participated in the survey belong to this group.

The next question in the research was related to the level of BIS application depending on the type of production. The difference in the BIS application depending on whether the company is engaged in mass, serial or individual production is examined. The results of this research are shown in Figure 5.

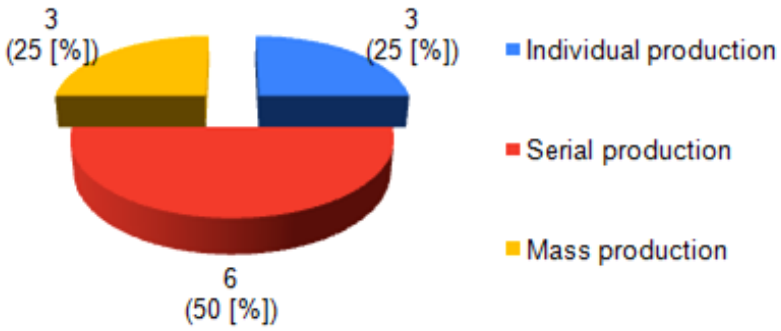

Figure 5: The level of BIS application in the wood industry companies depending on production type

The survey results are shown in Figure 5 and it can be concluded that the most significant number of companies that use BIS (6, or 50 [%]) is engaged in serial production. In individual production 3 companies (25 [%]) are engaged, as well as in mass production.

In addition, this research aimed to examine which BIS modules are most present in the Republic of Serbia's wood industry companies. The results of this research are shown in Figure 6.

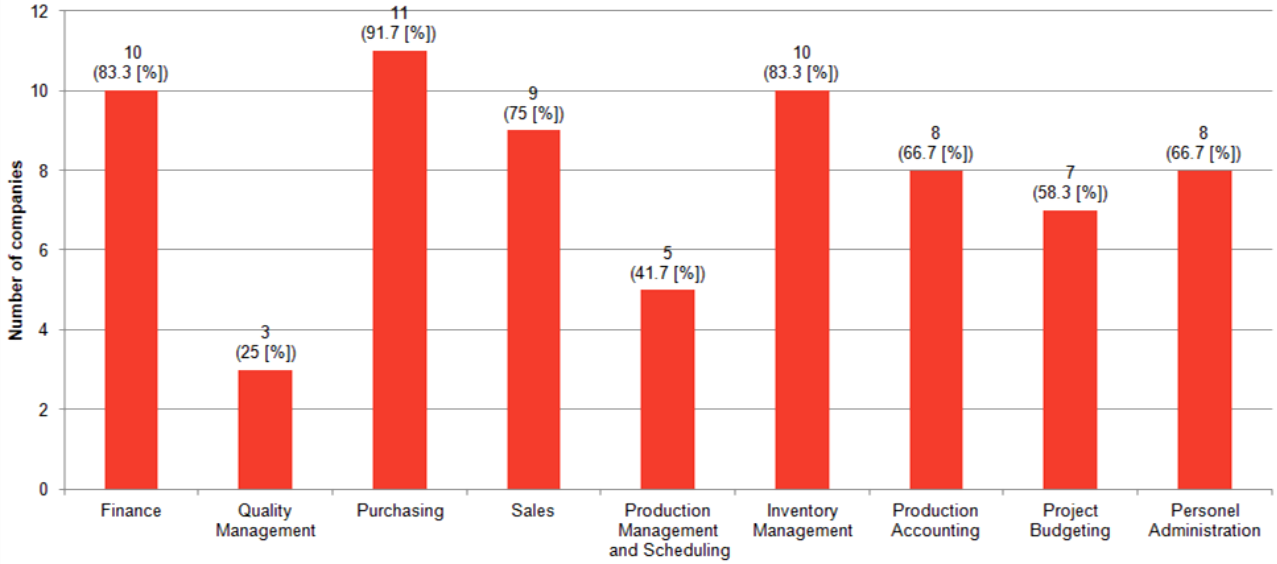

Figure 6: The level of the BIS modules application in wood industry companies

Based on the results of the surveys shown in Figure 6, it can be concluded that the most significant number of companies, 11 of them (91.7 [%]), apply the Purchasing module. The Finance and Inventory Management modules are used by 10 companies (83.3 [%]), while the Sales module is used by 9 companies (75 [%]). The Production Accounting module which is used for records and calculations of different costs incurred in production, and the Personnel Administration module is used by 8 companies (66.7 [%]). The Project Budgeting module is used by 7 companies (58.3 [%]). The Production Management and Scheduling module, which covers activities: capacity planning, work orders, job availability calculations, work time utilization by employee and workplace, etc., is used by a very small percentage of companies, only 5 of them (41.7 [%]) apply this module in their business. Also, another module with a very small percentage of usage is the Quality Management module, which includes the tasks: analysis and control of product quality, causes of procurement errors, sales and production, records of certificates for products, etc. Unfortunately, only 3 companies (25 [%]), use this BIS module in their operations.

4. CONCLUSION

Based on the results of the research presented in this paper, it can be concluded that the wood industry companies in the Republic of Serbia in a very small percentage apply BIS in their business, that is, only 12 [%] of selected companies. In addition, an encouraging fact is that only 3 [%] of companies that do not apply BIS in their business, plan to implement them in the next 18 months. Also, the negative trend of BIS application in the wood industry of the Republic of Serbia is indicated by the fact that out of 12 companies that apply BIS, 9 companies have implemented these systems for more than 7 years, and only 3 companies have implemented BIS in their business in the previous 5 years. Another conclusion of the research, which is also not encouraging, is a low level of application of the BIS in MSEs (as the most significant number of companies from the wood industry of the Republic of Serbia). The results of the survey show that BIS apply only 17 [%] of companies that can be classified as small enterprises by the number of employees criterion. Companies classified as micro enterprises by the number of employees are not presented in research sample.

The results of the research indicate that BIS is the most applied in the wood industry companies of the Republic of Serbia with serial production type (50 [%]), while 25 [%] are in the companies that are engaged in mass and individual production. As for the BIS module, the most significant number of the wood industry companies in the Republic of Serbia uses the modules for Finance, Purchasing and Inventory Management, while the smallest number of companies uses the modules for Production Management and Scheduling and Quality Management. The previously mentioned indicates that the most significant number of companies that use BIS in business does not use the maximum of its capabilities. The highlight is the small percentage of BIS applications for two modules (Production Management and Scheduling and Quality Management), which are considered as key processes, i.e., modules of each BIS, which are of great importance for the success of one production company. The basic recommendation that can be made based on the results of the research presented in this paper is the alarming need for the exceeded application of BIS in the wood industry

companies of the Republic of Serbia, especially in MSEs. Also, the exceeded application of BIS in all aspects of business and processes is recommended. Only in this way their application results in maximum business results of the company, which are reflected in: high level of productivity, efficiency, economy, timeliness of delivery, volume and data accuracy based on which right and timely management decisions can be made.

The first direction of further research of the authors of this paper would be that the same research will be conducted on the same number of companies in this field in the neighboring countries, and to make a comparative analysis with the results of the research presented in this paper. The results of this comparative analysis would indicate the similarities and differences existing in these studies conducted in different countries in the region. These results would lead to some new insights and recommendations to the wood industry companies of the Republic of Serbia to improve their business and competitiveness by applying BIS. The second direction of further research would be exploring the feasibility of using Cloud ERP. This would facilitate and accelerate the process of system implementation in the wood industry companies and reduce the cost of procurement and maintain this type of business information system.

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WORKING TIME OPTIMIZATION IN SEMI-AUTOMATED MANUFACTURING PROCESSES

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Abstract: *In manufacturing companies characterized by unbalanced daily needs for workforce, the problem of assigning working time to available, multi-skilled workers appears. In this paper, the problem is based on the experience of the company in the Republic of Serbia that produces cables for special-purpose vehicles. The main characteristics of the production in the observed company are: externally defined production volume that must be satisfied; required total or average productivity; constant measuring the productivity of each worker; and the possibility of employing overtime and reduced working time, both with accompanying additional costs. An original nonlinear mathematical model is formulated, consisting of working costs minimization subject to production demand, available workforce, and company's rules related to working time. A group of scenarios was analyzed in order to determine the structure of workers, in terms of productivity and costs, which is optimal to engage in order to achieve significant savings.*

Keywords*: productivity, cost, optimization,*

1. INTRODUCTION

In the last few decades, workforce optimization has become one of the key factors for the success and productivity within an organization (Collewet & Sauermann, 2017). Optimization of workforce includes: determining the type of expertise of workers, the required number of workers for a job, as well as the distribution of workers within certain time units. The goal of such optimization is primarily a reduction of the total costs of the company, and consequently an increase in the total productivity of the enterprise. The workforce optimization which is observed in this paper is one of the variants of the scheduling problem. The scheduling problem is widely analyzed in the literature (Bouajaja & Dridi 2017; Kletzander & Musliu, 2020). Given its complexity, there are many attempts to facilitate its solution using linear programing (LP). Al-Rawi and Mukherjee (2019) determine the number of staff members that should work part-time or full-time in order to minimize labour cost. They formulate LP model by assuming that all parameters are known and constant. Similar approach use Kharub and Sharma (2019), who assume that profit, costs, and return on investment are constant, which further enables formulation of LP model. The common issue in solving the scheduling problem is unfeasibility which is reflected in the inability to obtain schedule that meets all the requirements. To overcome the unfeasibility of solutions, Rashid et al. (2018) use the goal programming approach that enables introduction of soft constraints. Özder et al. (2019) also use goal programming to solve shifts scheduling problem according to the skills of the workers in natural gas power plant. Unfeasibility of the solution can be overcame by introducing the outsourcing of the workers, as in the (Tirkolaee et al, 2019) where fuzzy numbers are used for determination of the number of outsourced workers to deal with demand uncertainty. Scheduling problem often involve different uncertainty and flexibilities. Ağralı et al. (2017) recognise several types of flexibility that influence on good schedule of workers: flexibility in the intensity of demand, flexibility in the types of demand, and flexibility in the availability of human resources. All these characteristics make the scheduling problem hard to model and often hard to solve.

This paper considers the optimization of working time of direct workforce of small-series semi-automated cable production for vehicles in the company Egston Pancevo. Direct workforce consists of direct workers in production whose tasks are unbalanced due to the unbalanced demand. Gerlach et al. (2019) have shown that such flexibility in demand causes flexibility in employees' working time. One of the characteristics of manufacturing companies is the necessity of the existence of multi-skilled workforce. Otherwise, according to Henao et al. (2019), single-skilled workers should be trained to acquire additional skills. Anyhow, the knowledge and productivity of workers should also be considered (Wang & Liu, 2010; Wang & Zheng, 2011).

The well-being of workers is another important aspect of working schedule since, as McHugh et al. (2020) proved, the shift work experience is related to the five domains of workers well-being: workplace climate; physical environment and safety; health status; work evaluation; and social relationships. Additionally, Yanch and Wiechetek (2018) have shown that semi-automated production is characterized by some rules and modes of operation that require a special approach to solving workforce scheduling problem.

The structure of the paper is as follows. After the Introduction section, the problem of working time optimization in semi-automated manufacturing processes is described in Section 2. An original mathematical model of the described problem is presented in Section 3. Section 4 presents and discusses optimization results in several scenarios. Section 5 is devoted to the conclusions and further research.

2. PROBLEM DESCRIPTION

The problem starts from the unbalanced relationship between the demand from mother-company Egston Znojmo on the one side and the possibilities of the daughter-company Egston Pancevo on the other side. This is reflected at all hierarchical levels, from an individual operation of making one series of cables to a certain group, i.e. lines of workers, up to the level of the entire company. There are operations, such as ultrasonic welding of joints on cables or knitting insulation around cable wires, on which there is regularly more work than the workforce can satisfy. More precisely in 90% of cases these operations are bottlenecks. In this case, this increases the number of available working time for bottleneck operations. On the other hand, given the diverse structure of cables that Egston Pancevo receives for manufacturing, some of the workforce working on a certain group of cables is underutilized.

The solution for this problem is in levelling out the workforce, by employing additional working time for a certain job, and reducing working time for another job.

Each working hour is weighted by a certain productivity of workers. Every worker, working on a set of cable operations, has a certain productivity. This means that some workers will do the required job more productively, in the sense of a shorter period of time.

When managing the workforce through levelling out the working time, the management is faced with the employment costs: costs of employing additional working time and costs of reducing working time, so called dismissal costs. The employment costs appear when workers of a certain productivity work overtime in order to fulfill the projected demand, and refer to costs of additional working time. The dismissal costs appear when workers of a certain productivity work less than regular working time and refer to costs of reduced working time, and refer to the cost of overpaid time. Both of these costs are categorized as costs of irregular working time of workers of certain productivity.

The employment costs are equal to the product of the productive worker's employment price and the positive difference between the working time that the worker should work and the prescribed working time on a daily basis. The dismissal costs are equal to the product of the productive price of dismissal of the worker and the difference between the prescribed working time and the time that the worker should work on a daily basis.

The productive price of employment of a worker is equal to the quotient of the fixed price of employment and productivity of the worker, while the productive price of dismissal of a worker is equal to the product of fixed price of dismissal and productivity of the worker. The fixed price of employment of workers per minute is based on the price of payment of workers per minute increased by the percentage of employment of overtime per minute, which is determined in accordance with the policy of Egston Pancevo Company (9 RSD/min). The fixed price of dismissal of workers per minute is based on mandatory payment of workers per minute, regardless of presence at work, and in accordance with state law (5 RSD/min).

Given that the company faced a shortage of work in some periods, it was necessary to plan how many workers, when and with what productivity should work a certain working time in order to fulfill the required job and meet the projected productivity.

Workers work every day 8 hours, of which 7.5 hours of so-called prescribed working time are included in the calculation of productivity, while 0.5 hours is scheduled for a break. In accordance with the current policy of the company Egston Pancevo, workers can work overtime up to 2 hours, which means 9.5 hours of working time that are included in the calculation of productivity. On the other hand, workers must work at least 2 hours of working time per day. Productive working time for workers are those working time at which workers worked the effective norm time. Effective norm time is given as a predetermined time of making certain operations on cables Egston (2018).

Demand is projected in the form of effective norm time in minutes that must be delivered for each of the days. Each cable has its own production time, so-called normative, and demand is given as an aggregate of time of several operations, i.e. phases that must be met on one or more cables. Daily demand must be fully met. Demand is met when workers complete the required effective norm time in minutes for a given day. In order to ensure that the total demand will be met for the total given period, the direct workforce force can exceed the daily demand up to 5%.

Productivity is the basis for determining the price of additional employing or reducing of working time. It is obvious that more productive workers are cheaper for additional employment and more expensive for dismissal, and vice versa. No workers with productivity below 50% are included in the three-day project. Productivity is also the basis for determining the effective norm time worked per worker, i.e. it shows whether and how many working hours a worker needs to work in order to meet the effective norm time (minutes), in order to cover the necessary demand.

3. MATHEMATICAL MODEL FORMULATION

In order to solve the described problem, a nonlinear mathematical model has been developed in order to obtain a schedule for direct workforce such that:

- satisfies the need for direct workforce within the given period, and
- minimizes the amount of costs caused by changing the working time of workers – irregular working time of workers.

For this model, it is crucial to determine working time for workers of a certain productivity. Determining working time means defining the working time that a worker of a certain productivity should work on a given day in order to meet the required demand. The optimization criteria is the total cost of employing additional working minutes and reducing working minutes, i.e. the cost of irregular working time expressed in minutes in order to achieve the projected productivity. The constraints are related to: meeting the required demand on a daily basis, working time on a daily basis, as well as the presence of workers on a daily basis.

In order to formulate the mathematical model of the observed problem, the following notations was used:

- n - the number of workers,
- T - the number of days,
- p_i - the productivity of worker $i, i = \overline{1,n}$, expressed in percent,
- s_t - the number of effective norm minutes required for day $t, t = \overline{1,T}$,
- ss_t - the percentage increase in the number of required effective time for day $t, t = \overline{1,T}$,
- cz - the fixed cost of hiring workers in RSD,
- cz_i - the cost (RSD) of hiring the i-th worker based on his productivity, i.e. increased working time of the i-th worker on the basis of his productivity, $cz_i = cz / p_i,\ i = \overline{1,n}$,
- co - the fixed cost of workers dismissal in RSD,
- co_i - the cost (RSD) of the i-th worker dismissal based on his productivity, i.e. decreased working time of the i-th worker on the basis of his productivity, $co_i = co \cdot p_i,\ i = \overline{1,n}$,
- b – *the* prescribed working time on a daily basis, which is included in the calculation of productivity,
- bg – the maximum allowed percentage of working time on a daily basis,
- m - the lower limit of working time,
- M - high value auxiliary parameter.
- x_{it} - the number of minutes that the i-th worker should work on the t-th day, $x_{it} \in \mathbb{Z}^+,\ i = \overline{1,n},\ t = \overline{1,T}$
- y_{it} - the indicator of the presence of the i-th worker on the t-th day, $y_{it} \in \{0,1\},\ i = \overline{1,n},\ t = \overline{1,T}$

The mathematical model for working time optimization in semi-automated manufacturing processes is:

$$\min f(x,y) = \sum_{i=1}^{n} cz_i \sum_{t=1}^{T} \max\{0, x_{it} - b\} + \sum_{i=1}^{n} co_i \sum_{t=1}^{T} \max\{0, b - x_{it}\} + \sum_{i=1}^{n} \sum_{t=1}^{T} y_{it} \quad (1)$$

s.t.

$$s_t \le \sum_{i=1}^{n} p_i \cdot x_{it} \le ss_t \cdot s_t, \ t = \overline{1,T} \quad (2)$$

$$x_{it} \le bg \cdot b, \ i = \overline{1,n}, \ t = \overline{1,T} \quad (3)$$

$$x_{it} \ge m \cdot y_{it}, \ i = \overline{1,n}, \ t = \overline{1,T} \quad (4)$$

$$x_{it} \le M \cdot y_{it}, \ i = \overline{1,n}, \ t = \overline{1,T} \quad (5)$$

$$x_{it} \in \square^{+}, \ y_{it} \in \{0,1\}, \ i = \overline{1,n}, \ t = \overline{1,T} \quad (6)$$

The objective function (1) represents the total cost of employing additional working time and the total cost of reducing working time for all workers in the observed period. The last term in the objective function ensures that these costs are incurred with as few employees as possible. The first constraint (2) refers to the fact that the total production time on a daily basis must cover the daily effective norm minutes, but at most up to the given percentage increase. The constraint (3) limits the number of working minutes per day. The constraint (4) presents the minimum number of minutes that must be allocated on a daily basis, in case a worker is engaged a certain day. In addition, the last two constraints (4,5) link the variables x_{it} and y_{it} in order to track the hiring of workers on a given day. The constraint (4) ensures that variable y_{it} obtain the value 1 (worker *i* is present on the day *t*) each day when the worker *i* is engaged (variable $x_{it} > 0$). On the other hand, the constraint (5) ensures that variable y_{it} obtain the value 0 (worker *i* is not present on the day *t*) each day when the worker *i* is not engaged (variable $x_{it} = 0$). Since the constraint (5) is also satisfied for $x_{it} = 0$ and $y_{it} = 1$, the last term ($\sum_{i=1}^{n} \sum_{t=1}^{T} y_{it}$) is added in the objective function. Consequently, in the case of $x_{it} = 0$, the variable y_{it} will be equal to 0. In addition, $\sum_{i=1}^{n} \sum_{t=1}^{T} y_{it}$ will represent the total number of workers engaged in the entire period. By subtracting this value from the value of the objective function, the exact amount of costs is obtained. The line (6) define the integer and binary types of the variables.

4. NUMERICAL RESULTS

Using formulated mathematical model, several scenarios were examined. Given the confidentiality of the data, the majority of data used in this paper does not reflect the real values of data in the business of the company Egston Pancevo, but retains the relationship between parameter values. It is assumed that the sent material for making cables is complete and undamaged, as well as that all workers are trained to manufacture different cables. It is also assumed that all workers will be present in the planned three-day period. It should be noticed that, by adjusting the necessary parameters, model could also show the aggregate plan, i.e. quarterly or annual plan of working time that should meet a certain demand. The Table 1 shows the total demand for the period of the next three days, expressed in minutes.

Table 1: Demand per days

Demand/day	1.day	2.day	3.day
Effective norm mins	3300	2500	2700

The number of workers is determined based on demand, productivity and total working time for the requested period, in this case 3 working days (Table 2).

Table 2: 3-day product, productivity and workers demand

3-day demand	Productivity	Number of days	Number of minutes	Number of workers
8500	75%	3	450	9

The required number of workers, in accordance with the given parameters, on a daily basis is 9. Given that it is necessary to employ 9 workers for a period of 3 days, the total number of variables, which refers to the change of working time, used in solving this problem is 27. Each of the workers has a productivity that is fixed for a period of 3 days when planning working time. Productivity is taken based on the historical data of each of the workers for a period of 3 months, and represents the average result of productivity on one or more operations on one or more cables. It is assumed that productivity for 3 days is fixed, i.e. that it will neither increase nor decrease during that period. It is not based on one's experience, i.e. workers with less experience may have higher productivity than workers with more experience.

Several situations were simulated, in which workers of different productivity were examined. The average productivity of the selected group of workers was 75%, which is, in fact, the projected productivity of the company that must be achieved.

In the 1st scenario, the group of workers was changed in comparison to the initial scenario, more precisely, workers from different groups with different productivity are combined to do the required job for the given three-day period (workers who have over 100%, as well as more workers with lower productivity). In Scenario 2, workers with a productivity between 72% and 79% were selected. In Scenario 3, overtime was reduced to a maximum of 1 hour, as it was shown that most workers were unable to work 9.5 hours with full efficiency. Also in this scenario, the fixed price of employing additional working time was increased to 10 RSD. Scenario 4, as an experimental one, combines reduced overtime work from Scenario 3 with the group of workers from Scenario 1. The input productivities of workers for all scenarios are shown in the Table 3.

Table 3: Productivity of workers in different scenarios

Workers	Initial Scenario, Scenario 3	Scenario 1, Scenario 4	Scenario 2
W1	95%	110%	79%
W2	90%	100%	78%
W3	81%	95%	77%
W4	80%	75%	76%
W5	72%	66%	75%
W6	71%	65%	75%
W7	69%	56%	74%
W8	65%	56%	73%
W9	56%	55%	72%

The goal is to determine the working times for workers with certain productivity on a daily basis and accordingly make the most profitable plan of working time. The optimal solution of the initial scenario is given in Table 4. The optimal solutions of all scenarios are obtained using MS Excel Solver. Given the nonlinearity of the problem, Evolutionary engine of the MS Excel Solver is used as a solving method.

Table 4: Optimal solution of the initial scenario

	Total time (min)			Effective time (min)			Irregular working time costs (RSD)		
Workers	day 1	day 2	day 3	day 1	day 2	day 3	day 1	day 2	day 3
W1	570	570	570	541.5	541.5	541.5	1080	1080	1080
W2	570	570	570	513	513	513	1200	1200	1200
W3	570	570	570	461.7	461.7	461.7	1320	1320	1320
W4	570	570	570	456	456	456	1320	1320	1320
W5	570	570	570	410.4	410.4	410.4	1560	1560	1560
W6	570	166	448	404.7	117.86	318.08	1560	*1136*	*8*
W7	570	0	0	393.3	0	0	1560	*1350*	*1350*
W8	184	184	0	119.6	119.6	0	*798*	*798*	*1350*
W9	0	0	0	0	0	0	*1350*	*1350*	*1350*

The first three columns in the Table 4 represent the optimal solution (values of the variables x_{it}), while the next three columns represent the effective working time (total time reduced by break time). In the last three columns, costs of irregular working time are shown: the plan formatted numbers are related to the costs of additional working time costs while the italic formatted numbers refers to the reduced working time costs. According to the results, total effective time on days 1, 2 and 3 are: 3300.2, 2620.06, and 2700.68, respectively, which is consistent with the daily demand shown in the Table 1. As expected, additional working time is assigned to the most productive workers. Regarding irregular working time costs, distribution of daily costs is as follows: additional time costs are 9600, 6480, and 6480 RSD and reduced time costs are 2148, 4634, and 4058 RSD, for days 1,2 and 3, respectively. Thus, in the entire period, costs of additional working time are equal to 22560 RSD, while the costs of reduced working time are 10840 RSD.

The results of the optimization in the Scenarios 1-4 are shown in the Table 5. The table contains only the total time. Effective time and irregular working time costs can be obtained in the same way as in the Table 4.

Table 5: Optimal solutions of the scenarios 1-4

	Scenario 1			**Scenario 2**			**Scenario 3**			**Scenario 4**		
	day 1	**day 2**	**day 3**	**day 1**	**day 2**	**day 3**	**day 1**	**day 2**	**day 3**	**day 1**	**day 2**	**day 3**
W1	570	570	570	570	570	570	510	510	510	510	510	510
W2	570	570	570	570	570	570	510	510	510	510	510	510
W3	570	570	570	570	570	570	510	510	510	510	510	510
W4	570	570	570	570	570	570	510	510	510	510	510	510
W5	570	506	570	570	408	569	510	510	510	510	510	510
W6	570	0	243	570	570	569	510	510	510	510	347	510
W7	243	122	0	570	0	120	510	0	299	510	0	0
W8	570	0	0	351	0	0	510	0	0	510	0	168
W9	0	0	0	0	0	0	220	220	0	224	224	0

Based on the obtained results, an additional post-analysis was done in order to determine the highest cost on a daily basis and to determine the most productive day at the company level. It considers the costs of real worked time at work (regular working time), i.e. work without overtime and reduced time (irregular working time). The profit on a daily basis was also considered. The price of an effective norm minute, which corresponds to the demand, is fixed and amounts to 11 RSD. Based on the price of the effective norm minute, the demand revenue was obtained, i.e. the income from the worked effective minutes. Real worked time include working time of up to 450 minutes. The price of real worked time is fixed for all workers, regardless of worker productivity, and is 6 RSD / min. The cost of real worked time is the product of real worked time and the price of real worked time.

The results of the post-analysis are given in Table 6. All financial data are shown in RSD.

Table 6: Post-analysis results in different scenarios

	Initial	**Scenario1**	**Scenario2**	**Scenario3**	**Scenario4**
Costs of additional working time – employment	22.560	21.424	25.536	15.240	14.400
Costs of reduced working time – dismissal	10.840	11.676	12.684	7.233	7.911
Costs of irregular working time – total	33.400	33.100	38.220	22.473	22.311
Costs of regular working time	51.792	49.548	53.874	58.434	57.078
Total costs	85.192	82.648	92.094	80.907	79.389
Average employment price	12,22	12,67	12,00	13,56	14,11
Average dismissal price	3,89	3,89	4,00	3,89	3,89
Worked minutes	10672	10234	11137	10939	10653
Effective norm minutes	8621	8636	8510	8618	8624
Revenue	94.830	95.001	93.608	94.796	94.864
Profit	9.638	12.353	1.514	13.889	15.475

The weakest results shows scenario 2, where the group of workers with approximately similar productivity was selected. Namely, in this scenario, the highest costs are irregular working time, total costs, as well as the average dismissal price. In this scenario, the revenue is lowest, considering that the number of effective norm minutes most closely corresponds to the required demand, compared to other results from other scenarios. Therefore, this solution is the least cost-effective, and managers should exclude this scenario from everyday planning. It can have some application, in case the exact demand must be met, without some increase in the number of effective norm minutes.

The highest revenue was generated in Scenario 1, with workers of different productivity, as the solution achieved in this scenario generated the highest number of effective norm minutes. In this scenario, the minimum of worked minutes was achieved, and therefore the costs of regular working time are lowest.

In each of the scenarios, except for scenarios 3 and 4, where overtime work was reduced, it turned out to be more profitable to hire 8 workers, and to exclude the worker with the lowest productivity from the project (Tables 4 and 5). At the same time, these 8 workers of a certain productivity would work overtime or combined working time, which would include both overtime and reduced working time, depending on the required demand for a given day. The analysis shows that, in each scenario, there is a worker who represents the highest cost to complete the three-day project. These are mainly workers whose productivity oscillates around a middle value on the productivity scale for a particular group of workers. More precisely, in the initial solution it is a productivity worker 72%, in the 1st scenario a productivity worker 75%, in the 2nd scenario productivity workers 78%, 77%, 76% respectively, in the 3rd scenario productivity workers 72%, 71%. These workers have the highest cost of employment when employing overtime. Workers with higher productivity are more profitable to employ overtime, while workers with lower productivity are more profitable to engage combined working time.

Based on the Table 6, it can be concluded that scenario 4 is the most profitable for the production business in the company Egston Pancevo. It is, therefore, advisable to select a group of workers of different productivity, where there is clearly a greater distinction between the best and weakest workers in a group, with more productive workers working with reduced overtime capacity and workers with lower productivity with a combined overtime and reduced work regime, whereby workers would be paid more for overtime. In this scenario, the lowest costs of irregular working time were realized, which resulted in the most profitable management of working time. Due to this fact, which was primarily obtained due to reduced overtime work, the costs of regular working time are higher, i.e. after the costs from Scenario 3. It is considered that by choosing such a policy, the company Egston will achieve the projected productivity of 75% with as few losses as possible in a short period. This model can be also a basis for increasing the overall productivity of the company.

Some general conclusions can be drawn from the obtained results and analyzes:

- By selecting a group of workers of certain productivity, where the average productivity must be 75%, different results are achieved. Namely, the highest costs are realized by selecting workers of approximately similar or the same productivity. The greatest savings, as well as the greatest revenue, was obtained by selecting a group of workers in which there are greater differences, primarily between workers with lower productivity and workers with better productivity;
- Workers with average productivity, generally, represent the highest cost for a three-day project;
- Reduced overtime work reduces the cost of irregular working time, primarily additional working time costs but also costs of reduced working time, whereas, naturally, this increases the cost of regular working time;
- Average employment price reduces total costs;
- The average dismissal price does not have a significant impact on trends in total costs.

5. CONCLUSION

The aim of this paper was to formulate an original mathematical model for the problem of working time optimization in semi-automated manufacturing processes with unbalanced demand, and to explore the impact of the problem parameters on costs and revenue. The results showed that scenario 4 is most profitable which means, first of all, to introduce reduced overtime work of 1 hour, with an increased fixed price of employment to 10 RSD. This will achieve the greatest savings in costs of irregular working time. At the same time, all workers, with full or partial capacity, will be included in the three-day project. It has also been shown that the highest revenue is obtained by hiring more workers whose productivity oscillates to a greater extent. Therefore, production managers of Egston Pancevo are recommended to, in addition to reducing overtime, select workers from different productivity classes, where there will be workers with larger mutual deviations in productivity. This policy of managing the dynamics of working time is the most cost-effective for Egston Pancevo.

Operational planning of the human workforce along the lines of workers will eliminate the shortcomings of uneven sending of materials for the production of cables that affect, as well as insufficient sending of materials at the enterprise level that affect the decline in productivity. A good plan will give insight into which workers of a certain productivity should work a certain time on which day. Therefore, with a valid operational plan, savings of up to 30% of productivity can be achieved, as insufficiently sent material and unevenly sent material affect up to over 40% in total productivity.

The optimization problem presented in this paper appears in all systems with unbalanced requirements for the employees. Thus, the proposed approach can be used in a variety of industries. Since the formulated mathematical model is nonlinear, its exact solution for a large number of workers and days will not be possible in real-time using existing optimization solvers. Therefore, a heuristic algorithm should be developed to use the proposed model in a real system.

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IMPACT OF AI ON THE TRUCKING INDUSTRY IN THE U.S. - AUTONOMOUS TRUCKS

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Abstract: *This work intends to demonstrate the importance of Artificial Intelligence (AI) implementation in the trucking industry and to present Autonomous Vehicles (AV) technology as one that is rapidly emerging. The work will start with a brief introduction of AV technology and its current position in America. After the short overview of the size (and structure) of the trucking industry in the USA, it will be explained what role is expected AV to play in the industry and what it would be able to offer to supply chains. This paper will show the necessity for the integration of AV technology within the trucking industry in the USA.*

Keywords*: Artificial Intelligence, Autonomous Vehicles, Trucking Industry, Supply Chains*

1. INTRODUCTION - AUTONOMOUS VEHICLES

Autonomous Vehicles (AV) technology is a new and innovative technology that the broad area of Artificial Intelligence (AI) is about to offer to supply chains (Banker, 2020). AV technology has experienced drastic growth in the past few years (McMahon, 2020). Hi-tech companies, mostly from the US and China, have been working on developing highly sophisticated software that will allow trucks to transport cargo across the country without any assistance from the humane driver. It is projected that AV can save up to $10 billion to companies in a year (Agrawal, Gans, & Goldfarb, 2018). According to SAE International (formerly the Society of Automotive Engineers) and their J3016 standard, there are currently six levels of driving automation:

- Level 0 - No Driving Automatization
- Level 1 - Driver Assistance
- Level 2 - Partial Driving Automation
- Level 3 - Conditional Driving Automation
- Level 4 - High Driving Automation
- Level 5 - Full Driving Automation (SAE International, 2018).

The automation at the vehicle is at “Level 0” if the vehicle is operated by a driver who performs all dynamic driving tasks (DDT) and without any assistance from the autonomous driving system (ADS).

As summarized in Table 1, the first level of automation refers to the moment when ADS starts controlling either the lateral or the longitudinal vehicle motion, but performing only one task (for example, cruise control in charge of acceleration), while the driver has to conduct the rest of DDT. At the same time, ADS would operate under specific operational design domains (ODD). At this level, ADS is specifically designed to function only in certain operating conditions. For example, ADS can be developed for operating the vehicle only on the dry roads.

At the second level of automation, ADS takes control above both the lateral and the longitudinal vehicle motion. The driver is responsible for object and event detection and response (OEDR) and for “Fallback Strategy”. Basically, the human has to monitor the traffic around the vehicle, to detect hazardous stations (OEDR), and to avoid the danger (“Fallback Strategy”).

At the “Conditional Driving Automation” level, ADS performs all DDT tasks, it also monitors OEDR, but it only alarms a driver when danger is coming and does not take any of safety procedures in avoiding the threat. ADS also may request from the driver to take control over during the event that is out of ODD. For example, if it starts raining, and ADS can execute the tasks only on a dry road, the driver will have to operate the vehicle.

The level of “High Driving Automation” refers to the moment when ADS performs all of the DTT tasks and “Fallback Strategy” under specific ODD. The human would have to perform all driving tasks only if conditions are not under the ODD.
We would be able to say that the vehicle has reached Full Driving Automation at the moment when ADS performs equal to a human driver in all scenarios and conditions. Human on board (if any) would be only passengers. All six levels of driving automation are summarized in Table 1.

Table 1: Six levels of driving automation

Level	Name	Sustained Lateral and Longitudinal Vehicle Motion Control	Object and Event Detection and Response	Fallback Strategy	Operational Design Domains
0	No Driving Automation	Driver	Driver	Driver	N/A
1	Driver Assistance	ADS & Driver	Driver	Driver	Limited
2	Partial Driving Automation	ADS	Driver	Driver	Limited
3	Conditional Driving Automation	ADS	ADS	ADS & Driver	Limited
4	High Driving Automation	ADS	ADS	ADS	Limited
5	Full Driving Automation	ADS	ADS	ADS	Unlimited

2. CURRENT POSITION OF AV IN THE U.S.

AV test rides on the public roads are not a new thing anymore. The rapid growth of AV technologies had to be followed by governments and regulations. Twentynine states have brought legislation related to AV, and the additional six states have come out with executive orders and five with both (National Conference of State Legislatures, 2020). Figure 1 shows all states with AV enacted legislation and executive orders.

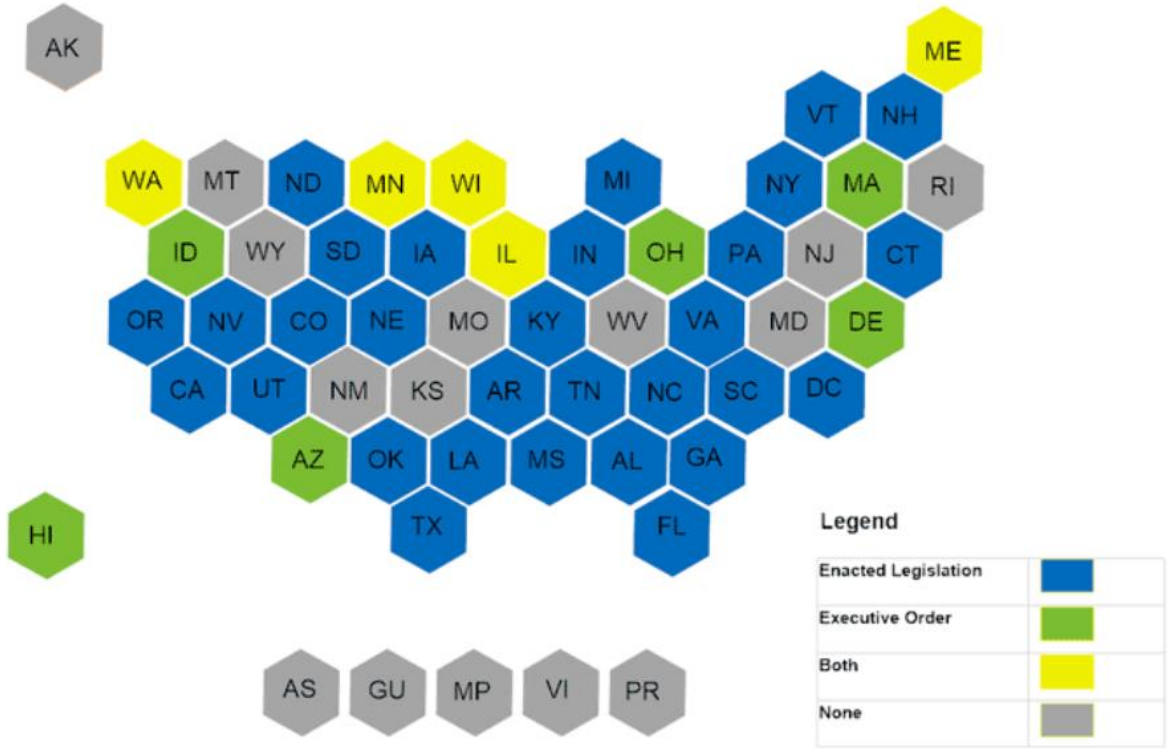

Figure 1: All states with AV enacted legislation and executive orders (National Conference of State Legislatures, 2020)

Only in California, 64 companies have Autonomous Vehicle Testing Permit for testing with a driver, and only Google’s project, Waymo LLC, has obtained the permit for AV testing without anyone behind the wheel (State of California Department of Motor Vehicles, 2020).

One of the challenges that AV is facing is the ability to prove to people that they will be safe in AV or using roads along AV. A survey conducted by 35,000 driving age people showed that almost half of respondents (48%) believe that fully automated cars will be unsafe. Also, more than two thirds (68%) do not feel comfortable about sharing the road with AV (Deloitte LLP, 2020). One of the reasons could be the absence of liability laws in some states that would allow a person injured by AV to suit the producer.

3. THE TRUCKING INDUSTRY IN THE USA

Trucks are considered as a "backbone" of the U.S. economy, moving more than 10 billion tons in 2017 (about 70% of all the freight moved in the country) and generating revenue of more than $700 billion. Trucking is officially the most significant industry in twenty-nine American states. The industry has been recording a stable growth of 2.1% annually in Texas during the past five years (Pettegrew, 2019). We should not be surprised by the fact that big companies like Google, Volkswagen, Volvo Mercedes, and Tesla are dedicated to developing driverless trucks as soon as possible since the stake is enormous.

In 2018, trucking companies reported revenue of $796,6 billion, which represents a 13.7% increase in comparison with 2017 (American Trucking Associations, 2019). It is essential to mention that operating revenue was only about half of the total revenue ($392 billion), but the demand still was big enough to create a driver shortage in companies. The situation in different industries mostly drives the demand in the trucking industry, and it could strongly depend on various factors such as retail sales, factory production, domestic contractions projects... Since the American economy was recording growth in previous years, it is logical that the trucking industry was expending and facing an increased need for drivers. Per the U.S. Bureau of Labor, the trucking businesses were employing 928,790 drivers in 2018, from which 880,710 were heavy truck drivers, followed by only 48,080 light and delivery services drivers (U.S. Bureau of Labor Statistics, 2020). Per certain estimates, there was room for additional 100,000 employees. The truck driver shortage was named as the number one issue in the American Transportation Research Institute's (ATRI) report in 2019. Increasing demand for truck drivers is one of the main reasons why, starting 2014, driver compensation (wages, benefits, bonuses) has been the highest line-item cost for trucking companies. Table 2 shows the distribution of costs in the trucking companies in the USA between 2008 and 2018 based on ATRI's report.

Table 2: Distribution of costs in the trucking companies in the USA

Year	Driver Wages	Fuel Costs	Purchase or Lease Payments	Driver Benefits	Repair & Maintenance	Truck Insurance	Tires	Tolls	Permits and Licenses
2018	33%	24%	15%	10%	9%	5%	2%	2%	1%
2017	33%	22%	16%	10%	10%	4%	2%	2%	1%
2016	33%	21%	16%	10%	10%	5%	2%	2%	1%
2015	32%	26%	15%	8%	10%	5%	3%	1%	1%
2014	27%	34%	13%	8%	9%	4%	3%	1%	1%
2013	26%	38%	10%	8%	9%	4%	2%	1%	2%
2012	26%	39%	11%	7%	8%	4%	3%	1%	1%
2011	27%	35%	11%	9%	9%	4%	2%	1%	2%
2010	29%	31%	12%	10%	8%	4%	2%	1%	3%
2009	28%	28%	18%	9%	8%	4%	2%	2%	2%
2008	26%	38%	13%	9%	6%	3%	2%	1%	1%

From 2012, driver wages and benefits have been recording constant growth. That was caused by already mentioned drivers' sacristy, followed by the industry's efforts to attract more employees and companies' desire to keep experienced drivers. Figure 2 presents driver wages and benefits per mile for the period between 2010 and 2018.

Due to external economic and geopolitical issues, longer-term economic predictions will be unthankful and challenging. If we presume that we will successfully avoid recession and that issues with international trade agreements will get resolved in, for the American economy, a positive manner, then we would be able to expect that demand for truck drivers will increase, followed by the increase in their wages. That will automatically lead to further growth of carriers' costs where driver compensation would play even a more substantial part in overall costs.

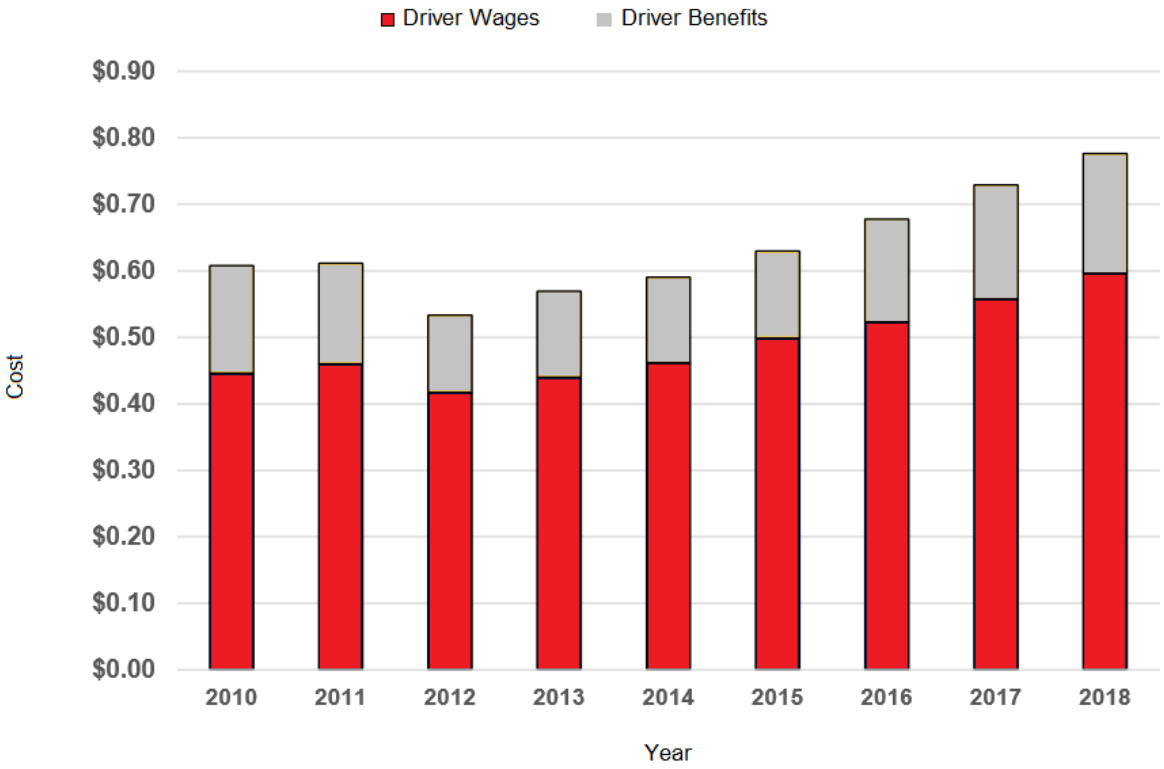

Figure 2: Driver Wages and Benefits per Mile Between 2010 and 2018 (Murray & Glidewell, 2019)

4. SPACE FOR AI AND AV IN THE TRUCKING INDUSTRY

Based on the current situation in the trucking industry in America, it is evident that AI would be able to bring improvements in:

- Fulfilling shortage in demand for experienced and reliable drivers
- Reducing companies' labor costs
- Allowing better planning and managing
- Increasing the level on the safety on the roads
- Increasing control of traffic flow

Per ATRI's 2014 research on drivers' demographic trends, the trucking industry even then was facing the issue of attracting young drivers to replace retiring once. Recent analyses of the U.S. Census Bureau have shown that the trucking industry has the lowest percentage on young people entering the industry. Currently, 55.3% of the truck drivers are the age of 45 or older, and less than 5% of the workforce is between 20 and 24 years old (Murray & Glidewell, 2019). The typical sequence of events would lead to a further increase of driver shortage as older drivers approach retirement. If on top of that, we add the already mentioned fact that per some estimates, there was room for additional 100,000 drivers in 2018, then implementation of AI in the industry cannot be considered as some fad. It must be seen as a necessity.

AI would be able to reduce companies' costs drastically, and that does not apply only to a labor cost. There would be other benefits since AI would be capable of adjusting itself to each shipment in order to increase efficiency. For example, just a driving style that suits well to the type of truck's engine, to the weight of the truckload, to terrain… may bring significant saves in different costs such as fuel and wear and tear. In the march of this year, TuSimple, a U.S.-Chinese tech startup with base in San Diego, California, announced that they would expend their cooperation with United Parcel Service (UPS) moving the number of routes covered by autonomous truck from 10 to 20 per week. Based on TuSimple and UPS research, driverless trucks have been saving more than 10% of fuel while they were operating for UPS than trucks driven by a human at the same routes (Heavy Duty Trucking, 2020). In December of 2019. TuSimple also came out with results of research conducted together with the University of California, San Diego, which showed that autonomous driving technology drastically reduces the fuel usage of heavy-duty trucks. That fuel savings can be super substantial if we keep in mind that per the International Energy Agency, trucking companies in the U.S., European Union, and China together use about one-fifth of the global oil demand (17 million barrels of oil a day) (Robinson, 2020). UPS and TuSimple, are confident that they will present the first fully self-driving truck

without any supervision in 2021. TuSimple's autonomous driving trucks perform about 20 drives a day for their clients. For now, all of them have a driver and an engineer on board monitoring the level of AI efficiency.

Driverless vehicles can bring improvements to the planning and management of shipments as well. Due to laws and regulations in some states, drivers can operate vehicles only specific numbers of hours per day. In the past, drivers had to track driven hours on their logbooks, while companies had to keep timesheets at their end, in order to determine the number of hours that drivers were running. That process allowed some loopholes for employers and employees, allowing them to present that drivers were operating vehicles way smaller number of hours than they did. Per regulation brought by Federal Motor Carrier Safety Administration, the entire process got moved for online fulfillment in December of the last year (Federal Motor Carrier Safety Administration, 2020). That authorities' move reduced the room for manipulation with driven hours and led to increased safety on the roads since drivers are not able to work long hours without any breaks. On the other hand, it raised the already existing need for additional drivers in the industry. Self-driving trucks would not need to worry about limitations related to driven hours since they can be on the road 24 hours, seven days a week.

In addition to direct higher labor costs, driverless trucks also would eliminate other costs associated with drivers, such as insurance and accident liability. Those expenses are directly linked to drivers, and their exposure to injuries is not negligible. Semi-trucks can be seen as small mobile warehouses, and drivers sometimes have to perform a variety of duties related to the trailer and cargo. Commercial truck drivers were confronted with 47,860 injuries or illnesses in 2017, and companies in 2019 had to pay between 8% and 15% of employee salary for the compensation insurance – between $4,580 to $8,550 annually based on the average drivers' salary for 2019. Moreover, with the drivers' history of being sick or injured, companies in California were paying premium rates for some employees as costly as $31,200 per driver (Pettegrew, 2019). It is evident that reduction in driver clams will lead to significant cost saving and that AI and self-driving trucks can make a huge impact and decrease the highest-rated trucking companies' costs (labor cost and fuel cost) significantly.

Autonomous trucks would be able to avoid pick hours choosing alternative routes a way easier and faster than the drivers would do. It is expected that they will increase the mileage driven in a day by 2.5 times in comparison with the current situation (RoboticsBiz, 2020). The tracks will be delivering shipments from coast to coast in only two days instead of currently needed five days. If we multiply those three days of saved time per shipment with the total number of shipments that trucking companies conduct form the cost to cost per year, we would be able to understand how significant impact AI can make on supply chain operations in the USA. We should also see trucking just as a piece in the supply chain puzzle and keep in the mind that AI is slowly becoming a trend through different supply chain activities (smart warehouses, robotics in production, more accurate predictions of demand...). With big companies on the global markets tending to automatize as many tasks as possible, we can be sure that the creation of a highly autonomous supply chain is just a matter of the time.

Another field where self-driving trucks will bring improvement is safety. Base on the U.S. Department of Labor, Bureau of Labor Statistics (BLS), vehicle accidents are the leading reason for workplace deaths. The number of vehicle crashes has been rising in the last five years, and those were causing 41% of all work-related deaths in 2017. That year 2,077 workers lost their lives, and according to The National Highway Traffic Safety Administration (NHTSA), 90% of accidents were due to driver error (Pettegrew, 2019). It is important to mention that per tracking companies, more than 70% of accidents, where trucks were involved, were not caused by trucks. AI implemented in trucks should be able to find a way how to avoid accidental situations faster and more efficiently than current truck drivers.

The flow of traffic can play an important role for trucking companies. Bad traffic can slow down shipments drastically. The drivels trucks would be able to collect the data form every single route they pass, creating a vast database, and identifying traffic patterns. After those get processed by another AI at companies, driverless trucks would be able to update their routs accurately to the most efficient once, avoiding all traffic congestion. Also, companies would be able to develop a real-time tracking which would not be helping only to better routing, but optimization on shipment scheduling in general.

5. CONCLUSION

Trucking, as the most significant industry in twenty-nine American states, suffers from employees' sacristy and runs with a lot of room for improvement. There should not be any doubts that powerful companies will try to leverage the problem since the stake is enormous.

AV technology is a necessity and something that unstoppable coming to the trucking industry in the US. It will make a drastic impact on companies and entire supply chains around the world. We have to keep in mind that AV will be only one part of AI integration in business. Eventually, everything will lead to highly automated supply chains under AI control. All of that may look too far from the current situation in industries around the

world, but on the other hand, we should remind ourselves how intense the progress of technologies has been in the past 20-30 years. If we try to track the chart, where x is the time and y level of progress, we will probably agree that the exponential curve has been getting extremely steep during the past few years.

TuSimple started working on autonomous trucks in 2015, and they are determined to launch the first trucks with Full Driving Automation (no human on board) at the start of next year. If they were able to develop such sophisticated technology in only six years, we would have to question ourselves and to rethink how really far away highly automated supply chains are.

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IMPACT OF AI ON THE WAREHOUSING INDUSTRY IN THE U.S. - SMART WAREHOUSES

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Abstract: *One of the elements that will be integrated into the autonomous supply chain is automated warehousing. This work intends to demonstrate the importance of Artificial Intelligence (AI) implementation in the warehousing industry in the U.S. The industry will face significant transformation in the coming years and this work will present key drivers of industrial change, as well, as what are the main obstacles on technological progress path. It will point out what the benefits of AI implementation are, and how that will affect the industry, companies, processes, and employees. It will explain why technological unevenness is widely present within the industry and how the whole warehousing will change over the next few years due to the implementation of new technologies.*

Keywords*: Supply Chains, Warehousing, Artificial Intelligence, Automation*

1. INTRODUCTION

For many logistic companies, digital transformation and Artificial Intelligence (AI) implementation could be described as a milestone of innovation. By 2018 AI contributed $15.7 trillion to the global economy as more businesses were implementing AI and machine learning. (Büsch, Nissen, & Wünscher, 2017). Over time, companies were detecting the potential that technology has, and today, 25% of the large companies in the United States are using AI (Custodio & Machado, 2020). It is expected that soon 70% of companies will be using AI and machine learning for their operations, which will increase production and the country's Gross Domestic Product (GDP). Currently, companies are increasing their profits and revenues at a rate of 5% per year, thanks to AI (Dash, McMurtrey, Rebman, & Kar, 2019).

The technology has endless potential in production, especially when combined with machine learning, algorithms, predictive analytics, and the Internet of Things (IoT).The future supply chains will develop and steer continuously. Thanks to autonomous learning that is based on the previous situation, and thanks to simulations of possible scenarios, AI will be capable of reacting fast to initiated changes. As a result of that, supply chains will develop advanced flexibility and unique agility dimensions (Custodio & Machado, 2020). The use of AI in logistics and supply chains has led to the development of smart warehouses. The warehousing industry will drastically change in the coming years due to the increasing level of automation within companies.

2. THE NEED FOR NEW TECHNOLOGIES IN WAREHOUSING IN THE USA

Mostly, warehouse operations in the U.S. include the following:

- Item Receiving – Recording the reception of items
- Item Cross-Docking – Bypassing the “putting away” and “picking” processes in order to expedite items directly from receiving to shipping location in the warehouse
- Putting Items Away – putting away items received from purchases, transfers, returns or production output based on the designed warehouse processes
- Moving Items – reorganizing items between bins
- Picking Items – Choosing items to be shipped, or transferred, or consumed in production or assembly, based on the designed warehouse process
- Ship Items - Recording the shipment of items (Microsoft, 2019).

It is evident that the warehousing industry will be transformed drastically with AI implementation since a significant percentage of jobs and activities can be automatable. For example, 58% of current jobs in warehouses could be eliminated due to automation (Muro, Maxim, & Whiton, 2019).

Based on the diffusion of innovations theory, consumers who are adopting the new technology can be classified in following groups: Innovators (2.5% of companies), Early Adopters (13.5%), Early Majority (34%), Late Majority (34%), Laggards (16%) (Rogers, 2003). We would be able to say that warehousing in the U.S. is an industry that is just beginning the process of technology diffusion.

E-commerce has become one of the leading drivers calling for changes. For example, Amazon has a strong influence on the online retail field, especially when it comes to delivery times. The speed with which orders must be shipped led companies towards innovations. However, the companies mostly decide to go with automatization of processes due to the high labor costs. Also, we should keep in mind that only a little bit more than 11% of whole retail sales in the fourth quarter of 2019 was committed online (The Census Bureau of the Department of Commerce, 2020). It is evident that E-commerce grows and that it will play a more significant role in retail sales in the coming years, which will request more efficient warehouses.

The technological first movers are the companies who are more pressured by wages of employees than the companies that would like to execute the fulfillment process fast. The companies that are trying to adopt different labor-saving technologies will be the ones leading experiments. If they prove that AI is successful, the wave of innovations will spread to others in the industry.

Based on the current situation in warehousing in the U.S., most likely variation is going to be the main characteristic of technological change and automation in the industry. It is expected that technological uptake will be uneven due to current unevenness in companies, unevenness across the whole industry, and unevenness even across technologies.

The companies' profile and culture can cause unevenness across firms. For a company, the new technology may look like having an excellent economic but not social sense. Businesses that will first adopt new technologies will be organizations with a large number of stock-keeping units (SKU). We have to be aware that different companies have a different understanding of the term of innovations. Some of them will see RFID scanners as the super-advanced technology, while others will have drones flying around the warehouse. The current situation in the industry makes us feel that companies who are racing in technological progress, are not in the same lap. It is evident that warehouse operations are in different stages of their techno-strategy development, and the most significant number of companies are moving slowly and carefully towards automation.

Another indicator of unevenness among the industry can be the usage of the Warehouse Management System (WMS) software. WMS is the most accepted technology within the warehousing industry, however, per Warehousing Education and Research Council, one-third of warehouses did not use WMS in 2018 (Kapadia, 2018). WMS is considered as a foundation for future technological development, and it is worrisome that 33% of warehouses in the U.S. still run using paper and spreadsheets. Also, we have to keep in mind that those two-thirds of companies who use WMS might implement the system a long time ago and run it without updating it for many years. Additionally, some of those systems are built "in house", and they cannot be developed to the desired level, which will be able to cover a high level of automation and allow the implementation of AI.

There could be many operations within the single firm that may be improved, and that can create unevenness within the firm. It is on the company to prioritize which processes it will improve with new technology. Even businesses that lead the innovation race in one field may fall behind in other areas. For example, a Californian courier company had made significant investments in a highly automated goods handling system and automated RFID technology, but managers still use excel and the paper on the information boards as the way to schedule employees and to inform them about their working hours.

There is uneven uptake within technologies since most of them are designed and adjusted to the only particular warehouse. The new technologies will be "narrowed down" since they may suit only certain types of companies. Even if some operations have an appropriate technological solution, and that solution is economically doable for the company, there will be a significant distinction within firms in their adoption of new technologies, which will even increase unevenness within the industry.

Based on the survey, in 2019, warehouses were mostly focused on strengthening the workforce (Michel, 2019). 54% of respondents tried to keep current stuff by increasing pay to employees during the last year. The struggles to recruit and retain a productive workforce are mainly caused by continued business growth and by the impact of e-commerce fulfillment activity. These are the main survey findings:

- Difficulties in attracting and retaining qualified employees were again the leading industry issue – that is stated by 50% of responders, which is a little bit lower than in 2018, but concerns to find a good supervisor went up from 26% to 35% in 2019

- Business showed a willingness to implement automation and software – 23% stated that they applied automation to their process to contain costs during 2019, which is an 8% increase in comparison with the answers form 2018
- Capital spending plans stayed healthy - The average projected spending for this year is $1.27 million, which is almost identical to last year
- Business confidence is on the high level - no matter the fact that businesses were dealing with a shortage of employees, 79% panning to expand during 2020, which would be 3% more than in 2019

Warehouses (especially those in the metro area) keep having an issue with attracting and retaining a capable workforce. Besides, 54% of companies who increased pay to employees, 38% had improved benefits in 2019. Warehouses will stay focused on overcoming labor scarcity, and they will try to decrease inefficiency in order to fulfill demand caused by the impacts of e-commerce growth. Figure 1 shows leading issues related to warehouse operations from 2016 to 2019 based on respondent answers.

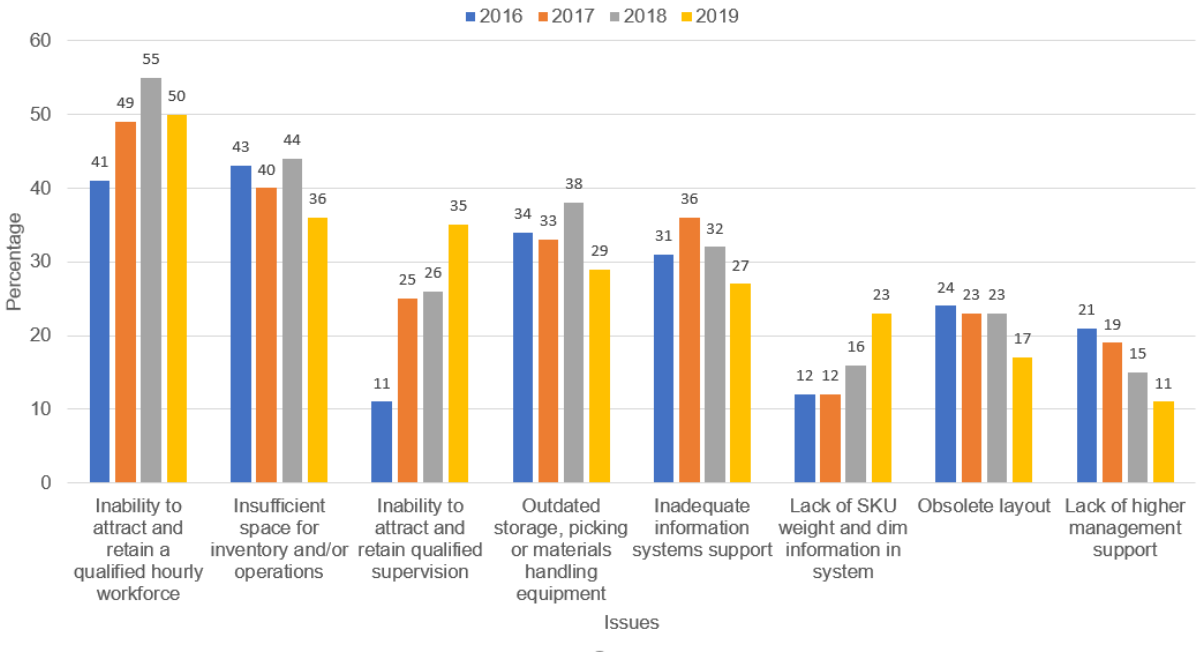

Figure 1: Leading issues related to warehouse operations from 2016 to 2019 (Michel, 2019)

In the coming years, companies will strive to automatize as many processes as they can. In comparison to 2018, last year's survey showed that companies now are budgeting for change – they will be looking to use more automation and technology along with improvements in their operational processes and controls.

The average number of employees in the main warehouse went down form from 182 in 2018 to 175 as the result of more automation in operational processes. Additionally, 38% of companies stated that they would continue increasing the use of automation and mechanization. Automated replenishment went up for 7% in 2019. The automated storage and retrieval systems (ASRS) solutions moved to 15% from 12%, and the usage of robotic/articulating arms moved slightly from 3% to 4%. The survey shows that for 45% of respondents, improving IT technology was the main action taken to lower costs while 23% tried to do the same by "adding automation equipment to processes" (Michel, 2019).

Companies showed interest in data quality issues. 23% stated that lack of adequate SKU weight and dimension is a major issue that reflects improper use of automation and related software. That is a 16% increase in comparison with 2018. That type of data issues may be seen as a minor from the IT perspective, but those are essential for proper slotting and warehouse automation, such as sorters, shuttles, ASRSs… Also, data quality is vital for different WMS solutions. Simply, the more automated the warehouse is, the more critical the data is. As more companies start implementing advanced automation and advanced WMS functionality, businesses will realize that they have to have fundamental data elements in place so the whole system may work on the way it is designed to work.

3. FACTORS DRIVING CHANGE IN WAREHOUSE INDUSTRY

AI and automation implementation in warehouses are mostly rushed by:

- Labor conditions
- Shorter fulfillment times
- Increasing multi-channel distribution networks
- Rising real estate costs
- Increasing energy costs.

Most companies in the industry see employment scarcity as the main challenge that they have to deal with. The industry was hiring 629,200 people in January of 2010, and the same month of 2020, warehouses were employing 1,198,900 workers (U.S. Bureau of Labor Statistics, 2020). At the same time, the American economy achieved a historically low unemployment rate, moving it down from 9.8% in 2010 to 3.6% in the first month of 2020 (U.S. Bureau of Labor Statistics, 2020).

Warehouses feel constantly rising pressure to accomplish tasks quickly and accurately. As already mentioned, E-commerce is one of the main factors that demand increased speed in order fulfillment processes. Amazon, with its fast deliveries, has managed to shape customers' expectations related to what should be standard delivery time. Furthermore, Amazon's Prime made customers expect free or super low shipping rates. That forced other big companies to review their distribution strategies and to rethink how the new technologies will be able to increase efficiency and reduce logistics costs.

E-commerce did not bring to warehousing only the request for increased speed. Together with global supply chains, it caused an increase in multi-channel distribution networks. Warehouse operations got more complex due to the significant differentiation between shipments that have to be handled. All of that placed even higher importance for efficient data gathering, saving, processing, and data distribution across the whole organization.

The real estate represents the highest fixed cost in warehousing. Per CBRE Group and its 2020 Real Estate Market Outlook Report, it is expected that the average warehouse will continue to rise the fifth year in the row with an increase higher of 5% in 2020 (Mongelluzzo, 2019). At the same time, available warehouse space has been declining for the last eight years (Morley, 2019).

The number of companies, which have defined sustainable practices as one of the core values, can be only more significant over time. The implementation of AI will be capable of transforming corporate sustainability activity. For example, only increased efficiency of operations will be able to make some reductions in energy usage and energy emission. Or, faster detections during the picking process of what can be reusable or recycled, may bring improvements while the company walks on its "go green" way.

4. BENEFITS OF AI IMPLEMENTATION

The AI, along with smart warehouse systems, can bring improvements to:

- Internal Communication
- Logistics
- Productivity
- Inventory Control
- Labor Cost

The communication between technologies will be on the way higher and more efficient levels if it is performed without any entries by a human. The system will be more accurate and faster if devices are connected by IoT and managed and controlled by AI. AI helps the machine by "deep learning" to conduct a constant analysis of generated data and to implement real-time adjustments, which will improve integrated warehouse management systems (Dash, McMurtrey, Rebman, & Kar, 2019). AI analyses the date in a fast manner, which helps in reducing the warehouse issues caused by human errors. Just that brings about a 5% increase in warehouse productivity (Hauer, 2019).

Also, AI transforms warehouse management through the optimization of its logistics activities. For example, it calculates the number of packages and pallets that will be delivered every day and came out with the number of robotic equipment that will be needed to facilitate that movement of items. The usage of the machine-algorithm enables detailed stock forecasting and more precise handling (Hauer, 2019). That significantly reduces warehouse operating error and the whole processing time, thus increasing the overall warehouse efficiency and productivity.

As already mentioned, AI brings improvements to the process of sorting and deploying items to certain locations at the warehouse. The AI also improves “pick-and-pack” processes. Some robots can now even pack the items themselves. All operating rules would be under the revision of AI, and there should not be any dilemmas that, over time, with the increase of collected data, AI will optimize all the processes to the highest possible level.

Since AI increases productivity and intern warehouse logistics, the company will be able to decrease inventory levels. That allows the business to reduce the amount of the capital trapped by unnecessary high levels of stock. AI also can reduce the level of inventory obsolescence due to better data processing.

One part of the initial technology implementation expenses will be compensated in the long run by AI reduction of the payroll expenses. At the initial stages of development, the robots are used to assists in executing the operations and AI to improve machine handling capacity. The usage of AI and robots in warehouse operations will make at least 30% of warehouse tasks fully automated by 2030 (Dash, McMurtrey, Rebman, & Kar, 2019).

5. TECHNOLOGY IN SMART WAREHOUSES

Smart warehouses use interconnected technologies working together in order to streamline warehouse operations and increase productivity and efficiency. Upon receiving goods at the smart warehouse, items are identified and sorted, put away, moved, packaged, and shipment with the almost entirely automated process and with minimal margin for error. The automation makes the process more agile, responds faster to demands, while AI is finding new solutions, and everything is followed with a higher volume in product flow.

Some of the technologies that warehouse use along AI are: RFID technology, robotics, IoT, and WMS.

RFID and digital tags allow the system not just to track what is coming and leaving the warehouse but to automatically scan the whole warehouse in a search for a particular item.

Upon attaching RFID to the products, the robots place the items in an appropriate place in the warehouse. Similarly, upon identifying the tags in RFID in the warehouse, the robots would pick the products and bring them to the human packer for delivery. They do that in a way faster manner than employees would do. Robots also carry more items and move faster than humans, so it is eminent that they increase efficiency in packing and sorting processes as well. Robot's role will expand as the AI implementation develops within companies. The whole process, which includes sorting of products and the trip that items pass from the pallet at the unloading deck to its storage place at the warehouse, is recognized as the one that can be the most beneficial if it gets automatized (Custodio & Machado, 2020).

The AI is paramount and allows the machine to collect and analyze the data. The mechanism allows consistent development and progress of the automated process. For example, AI can inform the robots about the most efficient routine that they need to follow when collecting and storing the items. Also, robots would be able to determine what would the convenient box size for item(s) be, the package type, as well as the size of the item, weight, and overall item density.

The IoT connects devices allowing the technologies to communicate with one other and share relevant data. The IoT can be seen metaphorically as a nervous system at humans that transmits nerve impulses between parts of the body. For example, a robot can easily get connected with RFID tags on items, manage to identify and pick items at their locations in the warehouse. Then, the robot sends the data to conveyor belts, which can update information into the WMS. The WMS sends information to employees informing them of the processes and how to pack items that need to be sent out of the warehouse. For the final step, the WMS connects with the RFID system at the warehouse exit and marks the items as sent when the package leaves the warehouse.

WMS can be considered as the cherry on the top of the smart warehouse system. It is a software that helps control and manage the day-to-day operations in a warehouse (IQMS, 2016). It can be a part of the Enterprise Resource Planning (ERP) system or as a separate module. In 2019 WMS vendors continued making progress in easy to navigate user interfaces (UIs). They also continued with the incising interoperability of WMS in mobile and IoT environments. Furthermore, AI was added to WSM in order to allow more efficient interaction with the warehouse automation and to enhance informed decision-making for management (Shacklett, 2019).

6. IMPACT OF AI IMPLEMENTATION ON EMPLOYEES

Most warehouses still depend on employees' strength and stamina, and for a start, new technologies will work towards work intensification. The companies will strive to replace the most grueling operations first. For

example, in the beginning, automation will replace all tasks that request lifting and long walks. That will bring economic benefits and reduce the stress on employees' bodies.

On the other hand, some of the new technologies will try to increase productivity with new methods of motivating and monitoring workers. An increasing number of companies rely on AI to manage workers and to determine workloads, which results in significant centralized power and control. For instance, Amazon dragged a lot of attention in the middle of 2019 after documents, on how the company tracks and terminates employees, come to daylight. The company sets performance targets for employees using AI. The “rate” is determined automatically and gets updated from day to day. If a worker does not meet the “rate”, he/she is subject to disciplinary action. Even termination has become an automated process (Lecher, 2019).

In July of 2019, the media was reporting about the strike in one of Amazon’s warehouses since employees faced difficulties with meeting “the rate” (Dzieza, 2019). In order to try to motivate employees to maintain high productivity rates, the company introduced MissionRacer, a video game that faces employees against one another as they complete customers’ orders (Bensinger, 2019). The MissionRacer has its limitations, but it is proof that companies seeking new ways to incentivize employees. There is evidence that gamification can reduce the monotony of repetitive work, but it also shows the tendency to wicked impacts of competition on workplace culture and to live a mark on employee’s health. Per Tae Wan Kim at Carnegie Mellon University in Pittsburgh “gamified systems have the potential to complicate and subvert ethical reasoning” (Gabrielle, 2018).

As mentioned, a significant percentage of warehouses in the U.S. still relays on the human body. As long as AI and automation do not start playing a more important part of warehouse operation, the assumption, that streamlining the processes leads to greater efficiencies and cost reduction, can be substantially flawed. All gains can be eliminated due to safety hazards, health issues, and increased employee turnover. The usage of AI on the way that has a bad influence on employees' motivation can put more pressure on them, causing resignations and dismissals. That may increase the already existing challenge that warehouses are facing - recruiting workers in tight labor markets.

AI will transform the way how workers are managed. New technologies can identify employee’s movement, including walking speed, walking routes, break time, and even bottlenecks. Thanks to productivity algorithms, the system can ask employees to increase the speed, change the route, increase/reduce the break, and at the end of the shift, the system can recalculate workers’ efficiency. At the same time, close monitoring may have a serious impact on employees’ morale. In 2018, Amazon asked its employees to start wearing wristbands, which will help them to increase efficiency (Yeginsu, 2018). They track and guide employees toward item locations, informing workers when they are close to the picking location. The technology quickly raised the question of employees’ privacy and the level of control that the company should have over its workers.

Technologies that include sensors can gather sensitive data on every workers’ move (Sheng, 2019). That data is valuable for management since it helps to monitor employees’ productivity along with safety hazards. From employees’ eyes, any automation takes them further from other employees, reducing social interaction. It also raises privacy concerns.

E-commerce volatility leads to scheduling instability were full-time employees tend to be replaced by part-timers. Just in time scheduling is something that AI can offer to warehouse management. On the other hand, advanced scheduling software can cause insecurity at employees' end. They cannot know how many working hours they can rely on since there is not any warranty that they will be assigned to a certain number of shifts. Experience shows that scheduling software may leave a positive impact on worker productivity if it has included in its algorithm employees' preferences for availability (Bauld, 2018)

Due to continued growth in demand, it is expected that the labor market will be facing even bigger scarcity. In the coming years, many workers will see their tasks changing since companies will inevitably be adapting to new technologies. In the long run, those technologies lead to a labor reduction. These are some of the labor replacing technologies: ASRS, machines with autobagging and autoboxing functions, RFID, drones.

We can say that the implementation of AI in warehouses will reflect on job tasks and employees in the following:

- It will replace or eliminate specific tasks
- It will increase monitoring
- It will calculate workers productivity on more sophisticated way
- It will offer new motivation techniques
- It will make the managing of employees easier
- It will offer just in time scheduling

7. LIMITATIONS OF AI IN SMART WAREHOUSE

In the same way, as some pushing factors are moving the warehousing towards innovations, certain obstacles are slowing down the transition to new technologies. The limitation for AI implementation in warehousing reflects in:

- AI's inability for convincing without pilot project
- Lack of standardization
- A small percentage of innovators in the industry
- Lack of intern flexibility and redlines to change.

The main challenge in developing new technologies is to provide guarantees that they will actually work in a real warehouse environment and on the way it is planned. It is hard for developers to convince warehouse management to pilot a technology since that can be disruptive to regular daily activities. Without proper pilot testing, new technologies absence the trustworthiness required to gain broad acceptance.

Lack of standardization can be an issue of implementing AI and automation. For example, one of the world's leading freight forwarding and logistics service providers has developed serious robotic at receiving stations at warehouses for unloading products from containers. However, the company was not able to remove the human factor from the process since boxes lack standardization, having a different dimension, and sometimes falling off the specific weight range.

The current state of technological progress and product variability can be an obstacle for AI implementation. Warehouses may keep a wide range of products that require certain technology that currently is not developed to the needed level. Also, some products may be hardly transferable or request special treatment and due that require manual handling.

Companies with long time established business philosophies may lack innovative temper and flexibility. Additionally, the absence of opportunity for developers to perform pilot projects can make the management of those companies to do not even try to increase the efficiency of warehouses and to go with outsourcing. Based on the recent survey, more than 80% of responders declared that they plan to increase outsourcing budget beyond warehousing in this year (Bigelow, 2019). Also, only 34% stated that saving the money is a priority which means that higher outsourcing is not a consequence of cost optimization but need for an update of technology (Bigelow, 2019).

Lack of flexibility and capacity for change can be a serious issue for the further technological update. Some existing but outdated technologies might cost a real fortune in the past, and the companies may try to rely on those as long as possible, even when a replacement may bring significant efficiency improvements.

8. CONCLUSION

Since AI technology adaptation is a costly and delicate process, only leading companies in the industry will have that "privilege" to try to leverage their position and gain significant competitive advantage through the early adoption of new technologies.

AI implementation and automation in warehouses are rushed by labor conditions, shorter fulfillment times, increasing multi-channel distribution networks, rising real estate costs, and increasing energy costs. On the other hand, new technologies face certain implementation limitations such as lack of ability to prove itself without pilot projects, lack of innovatively temper, and lack of intern flexibility and redlines to change. Significant shifts of any of those values can shorten or extend the timeline of total automatization.

Companies are becoming more aware of how crucial automatization can be and how much it can offer in combination with AI. The warehouse industry is on its way to gain significant efficiencies through technological development. On the other hand, specific measures will be needed to support employees who may lose jobs as a result of the change. It is evident that some jobs will be displaced or fundamentally changed due to AI implementation and automation. However, new technologies should leave a significant impact on the whole industry, which will create new job opportunities. Policymakers will have to find the way have to secure a smooth transition to those other employment opportunities for people who got displaced.

Companies, unions, and the government must work together on establishing regulations regard to AI implementation within the warehousing industry. Technological progress has the right purpose only if it is allowing everyone to enjoy the benefits of new technologies.

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DIGITAL HUMAN RESOURCE MANAGEMENT

CONTENT

DEMAND FOR COMPETENCIES IN 21ST CENTURY WORKPLACE: COMPANIES EXPECTATIONS FROM GRADUATES

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Abstract: *The innovations that the 21st century brings into the workplace, such as artificial intelligence (AI), are changing the nature of work, making a shift in demand for workforce skills. It is important that universities conduct researches in order to harmonize the curriculum with the needs of the companies and develop necessary skills among students for future workplace. This paper discusses the importance of general competences of graduates, according to employers' perceptions, in entering the 21st Century Workplace through an empirical research on Serbian market. Results obtained from 118 representatives from companies has shown that graduates need the general competencies such as ability of continuous learning, collaboration (teamwork), initiative and persistence, regardless of the specifics of the job.*

Keywords*: general competences, employability, graduates*

1. INTRODUCTION

Employability competences become a very important topic at labor market. These competences include sets of knowledge, skills, and personal attributes that make graduates ready for workplace (Yorke, 2004). The literature review found a number of employability skills attribute required by graduates, such as analytical and technical skills, communication skills, entrepreneurial skills, decision-making and problem solving skills, interpersonal and teamwork skills but also a lot of personal attributes such as self-motivation, self-awareness, independence, self-confidence, emotional intelligence, flexibility and adaptability (Hodge & Lear, 2011). The innovations that the 21st century brings into the workplace, such as artificial intelligence (AI), are changing the way how companies operate and people works, making a shift in demand for workforce competencies. For the start, all employees need to have digital skills as people increasingly interact with computers and in the virtual environment. That means that education system must be updated, to include knowledge and skills that are necessary for 21st century, to be able to increase students' competences which are important for them to get a job (Ruppert, 2010).

So far, the demand for competencies in the labor market in Serbia has not been researched in detail. Some findings indicate the existing gap between the needs of employers and the competencies of candidates, and as one of the solutions propose closer cooperation between the economy and educational institutions (Radović-Marković, 2011). Certainly, establishing communication between students, educational institutions, and employers is an important step in identifying needs and opportunities. In this regard, efforts have been made in Serbia related to the necessary competencies for the successful performance of certain professions, for example, on the competencies of teachers (Korać, 2015) or military officers (Milošević-Stolić & Marček, 2017).

With the idea to recognize which competences are important for workplace generally, in order to adopt the curriculum with the needs, team from the Faculty of organizational sciences, University of Belgrade was conducted the research "Recognition of the needs for competences of graduates for employment in Serbia". The focus of the research was on the general competencies (readiness for work, interpersonal, entrepreneurial and personal competencies) that are to some extent required in all junior positions, regardless of the specifics of the job.

2. 21ST CENTURY WORKPLACE: AI SHAPES THE WORK ENVIRONMENT

AI definitely affects the whole functioning of the people in their daily activities, but also affects people in their work environment, how they operate, affects businesses, industries, consumers. There are three forms of AI: Assisted intelligence, Augmented intelligence, Autonomous intelligence (Hassani, Silva, Unger, Mazinani &

Mac Feely, 2020). For example, in work environment, there are many positions where digital assistants and chatbots work instead of people. That is example of Assisted intelligence, which automating simple processes and tasks using Big Data, cloud and data science in decision-making. There is also Augmented intelligence which allows that machines make better and faster decisions than humans. The most advanced form of AI is autonomous intelligence, that allows machines, bots and systems to act on their own, without human intervention (Hassani et al., 2020).

As AI leads to changes in the way employees perform tasks, and machines can do a lot of tasks without humans, the role of employees and the set of their competencies also must be changed and adopted. Many studies show that with the increasing digitization and the introduction of artificial intelligence have caused that many jobs are disappearing. Acemoglu and Restrepo (2018) analyze effects of technological change on employees. Their conclusion is that AI replacement employees in performing specific tasks that can be automated. This leads to job losses and decreasing compensations. But these scholars (Acemoglu & Restrepo, 2018) also explains that this negative impact on labor is counterbalance by the positive effects. As certain positions and jobs disappear the new ones are emerging at the same speed. This puts organizations and employees in the position that they have to upgrade their existing knowledge or skills, or acquire some brand-new ones. So, very important skills for employees are flexibility and adaptability, and only that ensures that the business and employees can track all changes and continue working without problems (Bedwell, Fiore & Salas, 2014). Effect of AI depends on the ability of employees and the organization to adapt to the new requirements of the job, to adapt the set of their competencies (Frontier economics, 2018). Some scholars explain that AI could create a lot of new work positions where employees will be engaged in high-level thinking and creativity tasks.

Many scholars have based their researches on predicting which competencies will be needed in the future, and which will be less in demand or completely disappeared. According to Bughin and associates (2018) some predictions for 2030 are that demand for:

- Basic cognitive skills will decrease;
- Physical and manual skills will decrease;
- Leadership and human resources will increase, but that processes need to adapt to new workplace;
- High-skill workers will increase, but demand for low-skill workers will decrease.

The ability to monitor and adapt to changes in the development of the necessary skills among employees and future employees is possible only with the collaboration of all stakeholders, companies, educational institutions and governments. The future of the workplace requires that ongoing education and upskilling is necessary, so companies should work together with educators to reshape and update school and university curricula, to adopt to new needs of workplace, and educators can help with up-skilling and re-skilling of employees in the companies. If we look at the fact that many jobs will disappear and new ones will appear, reskilling is necessary. Governments will need to support employees in education, up-skilling and re-skilling as the workplace is changing and labor market is seeking for new competences among employees.

3. DEMAND FOR COMPETENCIES IN 21ST CENTURY WORKPLACE

A review of the literature and contemporary researches on the topic which competencies are needed for future employment leads to more lists that focus mainly on similar competency groups, such as basic competencies needed for employment (readiness for work), technical or technological skills, personal and interpersonal skills, entrepreneurial and cognitive skills.

According to the research presented by McKinsey Global Institute in discussion paper “Skill shift automation and the future of the workforce”, conducted by Bughin and associates (2018), there will be significant shifts in workforce skills from now until 2030. Since AI and digitalization are expanding, and even more will be in the coming years, the most needed skills for the workplace will be technological skills, both advanced (programming, advanced data analysis, and tech design) and basic digital skills, since every work position will be digitalized in the future (Bughin et al., 2018). Research has shown that the need for technological competences will increase by 69 percent in the United States and by 65 percent in Europe by 2030 (Bughin et al., 2018).

Beside technological skills, employers are looking for soft skills (Hurrell, 2016). A good candidate for future work environment should possess strong interpersonal skills (Kleckner & Marshall, 2014) and various types of social and emotional skill, skills that machines cannot learn (Bughin et al., 2018).

The fastest growing demand is for entrepreneurship skills such as creativity, innovations and initiative (Bughin et al., 2018) since the innovations in evolving business environment leads companies to competitive advantage (Lee & Benza, 2015). All employees should contribute to company and work environment towards new ideas,

proactivity and inspiration (Sripirabaa & Maheswari, 2015), so that are very important skills that should be develop trough educational process.

Cognitive skills are important for everyday working and the resolution of everyday tasks, especially important are higher cognitive skills that includes complex decision making, critical thinking and creativity. Demand for these skills will increase since new jobs will emerge where employees will be engaged in high-level thinking, complex information processing and creativity tasks. A lot of employers during the selection process put focus on skills such problem solving or critical thinking, as a very important for employment (Weaver & Kulesza, 2014), so students must gain that skills through educational process.

The survey published in The Future of Jobs Report 2018 conducted by the World Economic Forum made a comparative analysis of the skills needed in 2018, those which will grow and be needed in 2022, and those for which the need will decrease and which may disappear by 2022 (World Economic Forum, 2018). Results presented in the Table 1 are very similar with MGI research.

Table 1: Comparing skills demand, 2018 vs. 2022, top ten (Source: Future of Jobs Survey 2018, World Economic Forum)

2018	Trending, 2022	Declining, 2022
Analytical thinking and innovation	Analytical thinking and innovation	Manual dexterity, endurance and precision
Complex problem-solving Critical thinking and analysis Active learning and learning strategies	Active learning and learning strategies	Memory, verbal, auditory and spatial abilities Management of financial, material resources
Creativity, originality and initiative	Creativity, originality and initiative	Technology installation and maintenance
Attention to detail	Technology design and programming	Reading, writing, math and active listening
Trustworthiness	Critical thinking and analysis	Management of personnel
Emotional intelligence	Complex problem-solving	Quality control and safety awareness
Reasoning, problem-solving and ideation	Leadership and social influence	Coordination and time management
Leadership and social influence	Emotional intelligence	Visual, auditory and speech abilities
Coordination and time management	Reasoning, problem-solving and ideation	Technology use, monitoring and control
	Systems analysis and evaluation	

One interesting study that deals with the competencies needed for graduated students to enter the work environment is research conducted by the University of Virginia Weldon Cooper Center for Public Service, Demographics Research Group in 2017 (Crespin, 2018). Research was conducted among employers and workforce professionals who share their opinions about Workplace Readiness Skills by participating in an online survey. The sample includes nearly 400 people. They gave their opinion (prediction) about the importance of the workplace readiness skills for junior positions in the next five years. Table 2 groups the skills according to the importance (lists them in decreasing order of importance).

Table 2: Future importance of workplace readiness skills (Source: Framework for the Future: Virginia's Workplace Readiness Skills in Virginia)

Future importance of workplace readiness skills	
More important in the future	**About the same importance in the future**
Critical Thinking and Problem Solving	Conflict Resolution
Information Technology	Integrity
Initiative and Self-Direction	Organizations, Systems, and Climates
Information Literacy	Reading and Writing
Creativity and Innovation	Health and Safety
Respect for Diversity	Mathematics
Internet Use and Security	Job Acquisition and Advancement
Teamwork	Self-Representation
Lifelong Learning	

In the same research, employers and workforce professionals were also asked to give opinion about the skills that are lacking among candidates on junior positions. The results show that candidates for junior positions have problems with critical thinking and problem-solving skills, positive work ethic, initiative and self-direction, time, task, and resource management (Crespin, 2018).

For all those who work in educational institutions and are engaged in educating young people and training for the work environment, the question is whether the speed with which technology develops and changes in the work environment occur, can adapt teaching materials and develop students' necessary skills for future employment. All researches indicate that there are changes in the required competencies for employment and states which competencies will be needed. That helps educators and professors to develop their teaching materials and focus on the development of specific knowledge and skills among students. Team form the Faculty of organizational sciences, University of Belgrade, conducted their own research in order to harmonize the curriculum with the needs of the companies.

4. AN EMPIRICAL RESEARCH: COMPETENCES REQUIRED OF GRADUATES FOR EMPLOYMENT IN SERBIA

The characteristics of the modern education system, both in the Republic of Serbia and in foreign countries, are related to the dynamics of changes and innovations in the education system, as well as in the business environment and expansion of areas offered as employment opportunities after graduation. The education system needs to be adequately adapted to the needs of the market so that students have the opportunity to easily get a job after graduation. Accordingly, it is very important to notice the importance of the knowledge that students need to get a job, as well as the general competences that they should develop in the educational process. The team from the Faculty of Organizational Sciences conducted a research "Recognition of needs for competences of graduates for employment in Serbia " in order to examine which general competencies (Readiness for work, Interpersonal competencies, Entrepreneurial competencies, Personal competencies) company representatives expect in initial (junior) positions, regardless of the specifics of the job

4.1. Defining competencies and preparing questionnaire

The term competencies often refer to the knowledge, skills, attitudes that an individual possesses, and HR experts almost always examine them among candidates in the selection process, especially those who apply for junior positions. During the research, the goal was to identify the competencies that are expected, and therefore necessary, in order that newly graduated students enter the workplace.

During the preparation of questionnaire, the research team did an analysis of the content of world researches on the topic of necessary competencies for work, now and in the future (*World Economic Forum: The Future of Jobs Report; Deloitte: Preparing tomorrow's workforce for the Fourth Industrial Revolution; LinkedIn: The Skills Companies Need Most in 2019).* Content of job advertisements available on LinkedIn and Infostud (Serbian website for job posting) was also analyzed in order to provide an overview of the competencies that employers expect. The team take a look on 100 actual advertisement and chose 35 advertisement from different filed. From every job post required abilities, knowledge skills and specific tasks were analyzed. This approach has contributed to the understanding of job requirements in junior positions, as well as the competencies required in those positions.

Table 3: Competences required of graduates for employment

Competences required of graduates for employment			
Readiness for work	**Interpersonal competencies**	**Entrepreneurial competencies**	**Personal competencies**
Ability of continuous learning	Collaboration (teamwork)	Work under pressure	Self-confidence
Resourcefulness in a business environment	Competitiveness (competitive spirit)	Innovation	Self-motivation
Fitting into business values	Taking responsibility	Proactivity	Persistence
Ability to adapt to change	Self-presentation	Creativity	Goal orientation
Conscientiousness	Leadership and social influences	Curiosity	Ethics
Problem solving	Communication skills	Independence	Social intelligence
Organizing and time management	Presentation skills	Initiative	Systematic and analytical

Questionnaire was created to examine the general competencies needed for work in junior positions. General competencies were classified into the following categories: readiness for work, interpersonal, entrepreneurial and personal competencies. A more detailed description of the categories is presented in the Table 3.

Based on the stated classification of competencies, questions for the questionnaire were defined. The idea of the research was that people from companies who participating in the selection process (HR Experts or domain experts) assess the extent to which the listed competencies are needed by graduate students when they leave the faculty and look for their first job, on the Likert scale (1- not necessary at all, 5- very necessary). The need for these competencies does not apply only to graduate students, but to all those who apply for junior positions.

4.2. Sample

The online questionnaire was sent to about 400 addresses, to companies from the territory of Serbia. The questionnaire was filled out by 118 representatives from companies from different business domains: informatics (45%), trade (23%), financial sector (13%) and others (pharmacy construction industry, energy, telecommunications - 19%). The respondents were HR experts (41%), directors and managers (22%), recruiters (10%), IT experts and other domain experts (27%) involved in employee selection process. The length of work experience of the respondents is from 6 months to 30 years. The number of employees in the companies in which they work varied from 2 to 15,000 employees. Responses were collected online. Descriptive statistics were used for data analysis.

5. RESULTS

The demand and the importance of competencies among graduated students can be analyzed within the defined categories of competencies.

If the focus is on the competencies from the group related to readiness for work, as the most important, and those that are needed by candidates when hiring, experts from companies' state ability of continuous learning, conscientiousness (responsibility and reliability), and ability to adapt to change (Table 4).

Table 4: Results for group of competences Readiness for work

Readiness for work:	Mean	Std. Deviation	N
Ability of continuous learning	4,76	0,623	118
Conscientiousness	4,69	0,634	118
Ability to adapt to change	4,29	0,807	118
Problem solving (problem identification, focus on solutions)	4,19	0,837	118
Fit into business values	4,12	0,829	118
Resourcefulness in the business environment	4,08	0,869	118
Organizing and managing time	3,94	0,809	118

In the group of interpersonal competencies, they stand out collaboration (teamwork), communication skills (active listening, assertiveness and accepting feedback), and taking responsibility (Table 5).

Table 5: Results for group of Interpersonal competencies

Interpersonal competencies	Mean	Std. Deviation	N
Collaboration (teamwork)	4,47	0,792	118
Communication skills	4,46	0,781	118
Taking responsibility, reliability	4,29	0,786	118
Presentation skills	3,53	1,035	118
Leadership and social impact	3,45	0,948	118
Self-presentation, creating a public image of oneself	3,25	0,987	118
Competitiveness, competitive spirit	3,08	1,075	118

The category of entrepreneurial competencies is gaining in importance. The competencies that companies single out as essential for entering the work environment are initiative, proactivity and curiosity (exploratory spirit) (Table 6).

Table 6: Results for group of Entrepreneurial competencies

Entrepreneurial competencies:	Mean	Std. Deviation	N
Initiative	4,26	0,756	118
Proactivity	4,25	0,797	118
Curiosity, exploratory spirit	4,07	0,845	118
Independence	3,97	0,857	118
Innovation	3,85	0,883	118
Creativity, inventiveness, originality	3,81	0,840	118
Work under pressure	3,78	0,888	118

The personal competencies that employers and HR managers especially value during the selection process among candidates for junior positions are persistence, ethics (attitude towards work, socially responsible behavior), and self-motivation (intrinsic motivation) (Table 7).

Table 7: Results for group of Personal competencies

Personal competencies:	Mean	Std. Deviation	N
Persistence	4,42	0,733	118
Ethics, attitudes towards work, socially responsible behavior	4,41	0,808	118
Self-motivation, intrinsic motivation	4,37	0,726	118
Goal orientation	4,34	0,707	118
Flexibility	4,20	0,769	118
Systematic and analytical	4,18	0,747	118
Social intelligence, empathy, self-control	4,10	0,871	118

If we analyze the list of all the mentioned competencies, based on the rank that the representatives of the companies have assigned to the desirable competencies among graduate students, a profile of the ideal candidate can be made. In the first place, quite expected in a time of rapid change, is the candidate's tendency to learn continuously. Developed communication skills and cooperation are also characteristics of an ideal candidate that would help him function in a team, organization and maintain constructive relationships with associates. It is interesting that such a profile is complemented by characteristics that we can call "human qualities", such as persistence and ethics. Adapted to the business context, they imply that the employee performs his work responsibly and reliably, does not give up when he encounters difficulties and is aware of the consequences that his decisions may have on other parties involved. Therefore, according to the needs of the companies, the junior would be a constructive member of the team, eager for knowledge, who understands the role of his work in a complex system, and does the job in the best possible way.

6. DISCUSSION AND CONCLUSION

The work environment is changing rapidly and organizations increasingly seek individuals who are flexible and who can adopt to different situations. The responsibility of the university, but also of all other stakeholders (the state, companies and families) is to prepare young people to enter the work environment.

At the Faculty, in addition to acquiring the necessary knowledge, the student should also develop all the necessary skills for future workplace. The ability of continuous learning, but also cooperation and teamwork, proved to be very important, and that is something that a student can learn at the university. Continuous learning ability has the highest score not only in Readiness for work category but in general. Despite its importance, students didn’t recognize any systematic effort of the University regarding this issue (Toracco, 2008). Self-awareness of strengths and weaknesses is critical for continuous learning (Maurer & Weiss, 2010) which means students can benefit from regular and constructive feedback. Another step toward the promotion of continuous learning is career counseling as it was shown that setting a career goal is a significant factor of positive attitudes towards learning (Ng, 2010). It's necessary to pay more attention to study habits and provide students with training on learning techniques as the positive correlations of good study habits with continuous learning tendencies were established (Wu & Perng, 2016).

Organizations count on teamwork, good interpersonal communication, digital and face-to-face collaboration, innovation and excellent performance (Maruping & Magni, 2015). During the educational process, students should work together on students’ tasks and projects, in digital and traditional environment, in order to be prepared for the workplace. Teamwork training tailored for students is essential where interprofessional collaboration is of great importance as it is for the students of management or medicine. To achieve interprofessional teamwork, students should be introduced to themes such as student autonomy and workload, understanding of other professional roles, communication, shared knowledge, interprofessional teamwork/collaboration, and the “inner circle”, or being part of the unit team (Morphet et al., 2014). The success of teamwork competency development seems to be independent of the teaching method according to research conducted among the medical student population (Hobgood et al., 2010). The capability of being a team player is highly appreciated for students involved in scientific projects as well. Skilled young researchers should be capable of building external working relationships, accepting cultural diversity, inspiring moral trust, etc. (Gibert, Tozer & Westoby, 2017).

Initiative is one of the most important skills in the group of entrepreneurial competencies and it could be developed during the university time. As a part of stress management training, Australian college students were introduced to personal initiative components (how to recognize, demonstrate, and develop each of them), how problems can be solved using a personal initiative theoretical framework, creation of a personal change

plan, etc. which had a positive influence on their proactive behaviour (Searle, 2008). Based on findings that personal initiative skills were important for ruling a small business the similar efforts were made to develop these skills among entrepreneurs. Providing training programs on the self-starting approach to planning, time management, goal-setting, the ability to overcome barriers achieved a good short- and long-term results among learners (Campos et al., 2017).

On the other hand, some values such as conscientiousness and persistence are needed, and they acquired throughout life, through functioning in the family, school, college and company. So possible solution, in developing these skills among young people, consists in the division of responsibilities and a common strategic approach of the families, companies and educational institutions. In this way, continuity in the development path of young people is achieved and potentially meet the needs of all parties involved. Increasing student persistence is a project that has to be led on the organizational level. Based on empirical research recommendations include involving students in the organizational decision-making process and political activity on campus, providing students with advocates, and pay attention to students' perception of organizational goals, values, policies, and procedures (Berger, 2001). Student support services implementation is another approach that brings similar benefits (Cooper, 2010). Experience of receiving and giving support when it comes to initial information about the college, career planning, or another issue is a good way to learn about the role of community and how maintaining relationships with others helps to stay persisted. It is reasonable to assume that students who have actively participated in college and practiced being persisted would be capable to do the same once they start their careers.

Given that changes in the work environment and the demand for competencies occur quickly, it is necessary to provide continuous education and training. The future of the workplace requires that ongoing education and upskilling is necessary. If we look at the fact that many jobs will disappear and new ones will appear, reskilling is also necessary. The government and companies in that case can help with retraining programs. All further efforts in preparing students and youth as well as all current employees for the new workplace should be based on the cooperation of all stakeholders and the willingness of individuals to continuously learn and adapt to change.

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ARE FRESHMEN DIGITALIZED? DIGITAL READINESS AMONG REPRESENTATIVES OF GENERATION Z

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Abstract: *The aim of this paper is to provide insight into the digital competences of freshmen, popularly known as the Generation Z, of Faculty of Organizational Sciences in Belgrade. Given the popularity of the topic of digitalization, the idea of the research was to create a clearer picture of the potential for the usage of digitization in the everyday and business environments of students. The paper should also provide useful information to educators about which segments of digital competencies student's need to improve. The theoretical part is completed by empirical data of research conducted on a sample of 454 students. The research instrument was made up of 61 questions that primarily referred to the determination of the established practices of students in the online environment.*

Keywords*: Generation Z, freshmen, digital competences, digital platforms*

1. INTRODUCTION

During college time, students should develop all the necessary competencies for employment and future workplace. Besides the general competencies such as interpersonal, technical, entrepreneurial, or personal, for the current and future workplace digital competencies are indispensable, at least the basic ones (Gallardo-Echenique, de Oliveira, Marques-Molias & Esteve-Mon, 2015).

Digitalization is a very popular topic since a lot of current employees don't have the needed level of these competencies or even don't know what exactly these competencies include. They have to be part of up-skilling or re-skilling programs in order to adapt to a new digital environment. Some researches show that 62% of EU population uses the internet every day (EC, 2014), but almost half the EU population (47%) have either "low" or "no" digital skills and isn't considered to be functional in a digital society (EC, 2014). On the other hand, there is young generation, who already spent a lot of time in the digital environment, and they can be a great help in digital workplace. The problem is that some researches shows that students after graduation do not have digital competences required by companies (Martín, Frias & Martínez, 2017). Thus, it is not enough that youth spent a lot of time in digital environment, it is important that during education process they develop digital competences that are going to be useful in the digital workplace.

The aim of this study was to examine how much time freshmen spend in the digital environment, how they spent that time, and which digital competencies they have already acquired and bring at University. Results should help educators and professors in the preparation for the development of higher digital competences during studies among students for the workplace. Development of digital competences during university time can reduce the gap between existing and required digital competencies among graduate students.

2. DIGITAL COMPETENCES

We are all aware of digitalization of our society, which leads to higher employment, work efficiency and development of society. Digitalization can be defined as "*the adoption or increase use of digital or computer technology by an organization, industry, or country*" (Brennen & Kreiss, 2014). Every individual, especially every employee, is expected to possess or develop digital competencies. The role and importance of digital competence in organizations can be found in many researches of these topics (Malekifar, Taghizadeh, Rahman & Khan, 2014; Vieru, Bourdeau, Bernier & Yapo, 2015; Shahlaei, Rangraz & Stenmark, 2017). Companies make great efforts to educate, upskill or reskill their employees so that they acquire the necessary digital competencies and adapt to new work processes, and changes that are coming. However, the great potential for the digital development of companies lies precisely in the young and new generations entering the workplace.

Digital competencies include the ability, skills and knowledge of employees to "*access, manage, understand, integrate, communicate, evaluate and create information in a secure and appropriate ways using digital technologies, for the purpose of doing their job*" (Law, Woo, de la Torre & Wong, 2018). According to the European Digital Competences Framework, there are 21 competences, and they are divided into 5 categories (ECDL and DIGCOMP DESCRIBING, DEVELOPING & CERTIFYCE DIGITAL COMPETENCE):

- **Information and data literacy** refer to information processing in digital environment and includes competences of person to search, filter and evaluate data, information, and digital content.
- **Communication and collaboration** in the digital environment include interaction and communication through digital solutions (email, Skype, Whats app, Viber, Facebook…), sharing materials (images, documents, videos...) and participation in civic initiatives through digital technologies. Competencies related to communication in a digital environment include also netiquette (preferably online behavior) and online identity (selection of appropriate content in communication, use of one or more accounts in business and online).
- **Creating digital content** includes creation and changing digital content (text, images...) of different formats (.doc, .jpeg, .png, .xlsx, .pdf.), with formatting functions within different tools, and to use digital content in a legal and ethical manner, taking into account copyrights and licenses.
- **Safety** in the digital environment refers to the different ways of protecting personal data and privacy (understand data-policy statements when it is necessary to share personal data), to be able to protect the health and well-being (e.g. ergonomics, addiction risk, cyber violence) and to recognize the impact of digital technologies on environment (energy saving, use of electronic documents, economical settings on devices).
- **Problem-solving** refers to the competences in digital environment regarding technical issues that encounters during the use of digital technologies and to maintain them on a daily basis. It is also important to use digital technologies to innovate the knowledge (online tutorials, online courses, webinars, chat with colleagues about problems, sharing experiences) and to know how to choose a digital tool and adjust the options regarding problem or task.

Digital competences are very important for workplace, since a lot of job positions are changing and required new competences from workers. For example, incorporation of digital technologies into production processes leads to less demand for workers who performing mechanical tasks and increase demanded for those who can interact with the technology. The same situation is in all other fields: marketing, sales, human resources… It is very important that companies, but also countries have strategic approach related to the development of digital competence among employees, and the Eurydice report (2012) shows that almost all European countries have defined national strategy related to digital competence. Very important step in strategy is the incorporation of digital competences into educational process trough teaching of specific digital competences and usage of ICT for learning. All schools must have digital and technological resources. Additionally, teachers must be prepared to apply innovative pedagogical methods that promote learning while contributing to the development of digital skills.

3. GENERATION Z

Now, in work environment there is a generation Z, well-known as „Digital Natives", the "Internet Generation" or even called the "Google Generation" (Tapscott, 1989; Prensky, 2001; Tari, 2011). A lot of researchers analyzed characteristic and behavior patterns of this generation, and now in the literature can be found a lot of information about them. They are tech savvy and globally connected, very fast in searching and collecting all needed information, they are smarter and flexible (Ensari, 2017; Tayfun & Yuksel, 2015; Singh, 2014). Generation Z is born between 1995 – 2012 and Fexia explain that "*from the moment they begin to understand their environment they are surrounded by electronic devices that have configured their vision of life and the world*" (Feixa, 2006). Already at a very young age they possess electronic gadgets such as mobiles, tablets, they are using Internet and social networking sites, so they spend a lot of time in the digital environment, globally connected.

Shortly after the appearance of such concepts, their criticisms appeared. Ng (2012) believes that the new generations, although growing up surrounded with digital technologies, do not have a systematic experience in working with them. Essential characteristic of this generation is that they know how to handle computers and mobile devices and to accept social media as the basic means of communication. The problem is that most of them use these technologies just to search and exchange texts, photos, audio and video materials, search the Internet, geographically locate or navigate, use social networking sites or authorized access to closed data.

Underwood and Farrington-Flint (2015) call them the e-generation for which digital technologies represent the context in which they are developing. They use different life patterns compared to the previous ones,

since online resources are the default option for them. The problem arises because they are approaching to online resources indiscriminately, given that Internet search engines have taken on the role of teachers, librarians and other professionals. The term e-generation has a greater use value than digital natives, at least on a descriptive level because it indicates the fact that it is a generation that has introduced digital technologies into its everyday life.

Although this generation is expected to have very well-developed digital competencies when it comes to the work environment, there is a big gap between the needs of companies and the digital competencies of these "Digital Natives" (Martín, Frias & Martínez, 2017). Most members of these generations are not able to do any serious work, using digital devices, if they do not use them directly in the educational or work process (Bennett, Maton & Kervin, 2008). There are two potential problems:

- The first one is that education process is not adequate, so students do not develop the necessary digital competencies for the work environment.

A lot of researchers analyzed digital competences in an education context on higher levels of education, secondary education and university context (Cabero & Llorente, 2008; Sendín, Gaona & García, 2014). Most of them were focused on the evaluation and development of digital skills. Teachers and educators should be aware that digital competences can be develop during primary education too in case of Generation Z, since 82.7% of 2nd graders claim to use more than one technological device, in their daily life (Pérez-Escoda, Castro-Zubizarreta & Fandos-Igado, 2016). Education process should be adapted to the way how this generation learns and digital technology should be used to empower better sources for learning and inspires both students and teachers to enjoy learning process (Walker, 2014). Development of digital competences such as information and data literacy, communication and collaboration and safety should be incorporated in the educational process, even in primary education, since it is very important that young people use digital technology on the appropriate and safe way.

- The second potential problem is the way how Generation Z spends time in the digital environment, what activities they deal with and thus which competencies they develop.

They are always present in digital environment because everything for them happen there. It results with many problems, such as chronic sleep deprivation because they do not want to miss anything (Tari, 2011). They use their digital devices to be in contact and communicate with others; send text messages, do chatting, download/upload information, spent time on Facebook or Twitter. They are searching for compliments and confirmation, they need opinion from peers, and their opinion is overrated and becomes the most important (Tari, 2011). They also playing games, listen to music or chill out (Leena, Tomi & Arja, 2005). Digital environment is source of entertainment (Choiz, 2012). A lot of youth doesn't worry about safety, helth and wellbeing. Overuse of digital devices causes problems with addiction that lead to physiological and psychological problems among youth (Kesici & Tunc, 2018; Arslan, Kirik, Karaman & Cetinkaya, 2015).

This brings us to the question of the lower limit of digital literacy, i.e. whether it makes sense to observe digital literacy only in the basic form of knowledge of working on computers and similar electronic devices and coping in basic activities on the Internet. The Internet user must be able to identify competent sources, to find information that suits him, to select them according to different criteria, etc. This ability should be the lower limit of the definition of digital literacy. Digital natives, as seen by Prensky, are not a priori trained for such activities. The fact that they are growing up with new technologies has helped them to accept them more easily than the older ones and to learn to work on them faster. Everything else is a matter of systematic training and personal effort. Therefore, the status of a digital native, with the characteristics given to it by Prensky, is neither innate, nor endemic or any similar component of one's personality, but a product of a long and systematic education, which, in most cases, was missing.

4. EMPIRICAL RESEARCH: DIGITAL COMPETENCES AMONG FRESHMEN

Regarding importance of digital competences in workplace, and potential of young generation called "Digital Natives"; this research was conduct in order to access presence in a digital environment and digital competences among freshman at the Faculty of Organizational Sciences, University of Belgrade, Republic of Serbia.

4.1. Questionnaire preparation and data collection

The aim of this study was to examine how much time freshmen spend in the digital environment, how they spent that time, and which digital competencies they have already acquired during that time. Results should help educators and professors in the preparation of curricula for the development of higher digital competences among students for the workplace.

The subject of this study was to assess:

- Presence in a digital environment and the extent of the use of technological devices as well as the Internet by the freshman.
- Level of information and data literacy competences among freshman in informal digital environment
- Level of communication and collaboration competences among freshman in informal digital environment
- Level of safety competences among freshman in informal digital environment

Table 1: Demographic information, Time spent in a digital environment, Digital competences

Blocks	Items includes information about:
Demographic information	Gender, Age, Education, Parents education, Location
Time spent in a digital environment	Time spent on internet, Activities, Devices, Connection
Information and data literacy	Platforms for searching, filter and evaluate digital content
Communication and collaboration	Communication, sharing and civic participation in digital environment and netiquette
Safety	Protection of personal data and privacy and health and wellbeing in digital environment

Regarding these topics' questionnaire was prepared. It includes 61 question about demographic information, presence in a digital environment, and digital competences. Competences which refer to content creation and problem solving in the digital environment were not analyzed. Competences regarding information and data literacy, communication and collaboration and safety were in focus because they are part of everyday activity of young generation in digital environment.

The questionnaire was distributed to all freshmen at the Faculty of Organizational Sciences, University of Belgrade, during the first semester of the 2019/2020 school year.

4.2. Sample

There were 454 respondents who as freshmen can be considered as representatives of generation z, from which 61% were female and 39% male. As for educational structure, we should mention that most students came from gymnasiums (77%) while a little more above a fifth came from a four-year high school (21%). The majority of students have their parents finished faculty (41%), and there are 13% of students' parents who have the title of master. When it comes to the assessment of material condition majority of surveyed students said that they and their family live average life (72%), there is 16% of them who said that them and their family live below the average and 7% of them who said that they are living above the average. Mostly our respondents are from a big city with 100.000 citizens and more. Additionally, 81% of them said that they are coming from town, 13% from the suburban settlement, and 6% from the village.

5. RESULTS

The results will be presented according to the blocks presented above. It all refers to the established practices and behaviors of students in the online environment. Results should give some insights in digital readiness of freshman, and could be useful information to educators and employers in order to see which segments of digital competencies of student's needs improvement for digital workplace.

5.1. Time spent in a digital environment

The first goal of the research was to assess the presence and activities of freshman in a digital environment, by asking them how and where they spend their time. Results showed that going out and spending time with friends was the most common answer for 65% of respondents, while only 8% of them are spending their free time on their cell phones, 9% by watching television, and only 2% of them on their computers. Even thou the results from the next question shows that they actually spend most of their time online, it seems that most of them do not have a perspective how much of their daily activities are related to digital environment.

Average student is spending more than 4 hours online, to be more specific 4.5 hours a day. We could conclude that the average student spends more than a quarter of the day on the internet. For two-thirds of students, a phone is the main device they use to access the Internet. At last 17% of respondents are using different devices for internet access. Only 1% of respondents do not have internet access on their phones, meaning 99% have all-day internet access.

5.2. Information and data literacy

Regarding this segment, the aim of the research was to assess which digital platforms are the most used among our respondents, and on the other hand which potentials of these platforms are not used enough. No arguing, Instagram, and YouTube are two most used digital platforms among students. There are 93% of students, who use Instagram every day, and 81% of those who use YouTube every day, plus 13% of those who are using this platform every other day.

Also there are two platforms whose potentials haven't been sufficiently exploited. In the case of Twitter, there are 81% of students who never use it. Only 4% of students are using this platform on a daily base. The second platform is LinkedIn in case of which 91% of our respondents don't use this platform at all, and 4% are using it rarely. Only 1% is using this platform every day. It seems that the vast majority of our respondents still didn't see the huge potential that this platform provides, primarily in making new business contacts.

5.3. Communication and Collaboration

In the second area of digital competences, which includes communication and collaboration, the aim was to assess type of communication and platforms that freshman use for everyday interacting through digital technologies. Most common way of communication with friends for students is through Whats App (41%), immediately followed by SMS used by 31% of respondents. There are 15% of those who prefer to make a phone call, and 7% of those who use Facebook Messenger. Interestingly, only 1% said that they are using Viber.

When it comes to sharing information and digital content respondents were asked which content they share via digital platforms. Results showed that 34% of respondents don't share video content from their everyday life on digital platforms, while 46% of them do it rarely. There are 15% of those respondents who share this type of content every day. There is more than half of those surveyed (51%) who never share news from other portals or websites, and only 7% of those who do it regularly. Three quarters said that they don't share business information's on their digital platforms at all. Only 3% share this type of information every day.

Regarding citizen participation in the online environment, there was a question how often they share information, for example, on humanitarian actions. There were 40% of those don't share this type of content at all, and 43% more who do it infrequently. Every ninth respondent share this type of information's on regular basis.

Since very important competence regarding communication and collaboration in the digital environment is netiquette, preferably online behavior, the aim of the research was also to assess forms of behavior among freshman. Following the above, we asked them do they possess a fake profile on any digital platform and which platform is that. More than three quarters (79%) do not possess a fake profile on any digital platform. On the other hand, there are 17% of those who have a fake profile on Instagram, and 4% of those who have a fake profile on Facebook. Most of respondent have a fake profile to see what people, who they don't want to follow, are doing (37%), 14% made a fake profile to follow what the person who they like is doing. An interesting finding is that there are noticeable differences in the gender structure of the respondents when it comes to fake profiles on different digital platforms. For example, above-average fake accounts on Instagram are made by female respondents, while the situation is reversed in the case of Facebook.

5.4. Safety

Safety and competences related to safety are very important in the digital environment. Questionnaire include questions regarding protection of personal data and privacy, more precisely how familiar freshman are with the security and privacy policies that are applied on digital platforms. There are more than a third (35%) of respondents who stated that they know a lot about security and privacy policies that are applied on digital platforms. Only 6% stated that they do not know anything about this topic.

There was also question do they use Facebook's privacy and security policy to be protected on this platform. Most of the respondents stated that they use only the basics, but they do not go into details (53%), but 16% uses all privacy and security mechanisms. There are 27% of those who do not use the mentioned protection mechanism at all, and only 4% of those who don't believe in that kind of protection.

The average age for our respondents when they made the first profile on one of the digital platforms is 11, which means that most of them brooked the security policy while making their first profile on a chosen digital platform, since the age limit for making profiles on any digital platform is 12.

Safety also includes health and wellbeing of youth while using digital technology. The questions, regarding these competences, were does freshman knows how to protect themselves and how to avoid health risks related to the use of technology. Regarding potential addiction, there was question could they survive without using the internet. Results show that 28% believes that they couldn't live without using the internet. Still, there is a majority of those who said that they could live without internet (53%).

Majority of respondents didn't agree with standpoint that situations where they can't use the phone are extremely stressful (69%). Only 13% of them supported this point of view. Also, 71% of freshman's didn't support the standpoint where it claims that they avoid staying in rooms where's no internet access. Only 9% supported this standpoint. There are also one-fifth of respondents who ask for a Wi-Fi code when they enter a cafe/restaurant or someone's home, and 58% of them don't do that.

The questionnaire also includes questions such as do students ignore their friends/family and prefer to spend time online, and do they stay up late at night spending time online and using different kinds of applications. These questions are intended to determine the extent to which the Internet affects the social life of students. There are only 6% of those ignore their friends/family and prefer to spend time online, but none of them expressed complete agreement with the standpoint. The vast majority of the freshman's expressed disagreement (82%). Results also show that almost half (47%) of respondents stay up late at night spending time online and using different kinds of applications.

6. CONCLUSION

Given the fact that modern society is increasingly subject to the effects of digitalization, as well as that digital competencies are becoming one of the basic competencies necessary for gaining work experience, this type of competencies must be developed at the earliest possible stages of the study. Although the examined sample is about digital natives, the results also showed some unexpected conclusions. First of all, when it comes to the dependence of students on the usage of the Internet and digital platforms, i.e. the area related to health care, we can conclude that most students have a developed perception of the harmfulness of excessive use of these technologies. Although it is evident that a significant number of them spend most of their free time on the Internet and digital platforms, as well as that they spend the time needed for rest on surfing the Internet and using applications. If we add to this the finding that the average age for creating accounts on digital platforms for our respondents is 11, it is clear that this is a generation of young people who have spent most of their lives in a digital environment and that are not a foreign phenomenon for them. From the data presented in this paper, such as the frequency of use of certain digital platforms, we can conclude that students do not use the full potential that these platforms can provide. This view is supported by the fact that over 90 percent of students never use LinkedIn, a platform that is extremely important for learning and for acquiring new and maintaining existing business contacts. Also, based on the content that students most often share on their profiles, we can see that digital platforms are still perceived exclusively as a means of entertainment and maintaining contacts with their friends, while other potentials of these technologies are limited. During the studies, they need to get a broader picture of the possibilities of using digital technologies, but also to acquire all the competencies in order to spend their time safely and productively, and in order to quickly adapt to the needs of the work environment when they complete their studies.

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DIGITAL COMPETENCIES FOR VIRTUAL TEAMWORK: HOW TO BRIDGE THE GAP IN SELECTION PROCESS

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Abstract: *Digitalization increases the number of organizations using virtual team as a common collaborating practice. Consequently, the new set of required competencies emerges and become relevant. Some of the implications to HR are seen in challenging the selection process in the new working context. This research tries to access the optimal level of digital communication and collaboration competencies needed for effective team work while exploring the existing selection practices among organizations with virtual teams. Quantitative analysis based on answers of the HR professionals` showed that it is expected from candidates to develop flexible and autonomous digital skills, especially in the domain of using digital communication tools. Qualitative analysis, based on HR expert focus group, reveals that in the process of selection digital skills are evaluated implicitly, with some of them implied and others believed to be dependent on concrete digital platform that would be used.*

Keywords*: digital competencies, digital communication and collaboration, virtual teamwork, selection process*

1. INTRODUCTION

Collaborative work through different virtual platforms requires besides some personal characteristics for successful teamwork, additional competencies and skills. The experience of virtual teamwork differs from the offline experience and has its own rules. Members of virtual teams rely on technology-mediated communication to interact with one another across multiple boundaries to work on interdependent task (Gibson & Cohen, 2003).

Technological advances make work life dependent on technology and change organizational practices toward digital transformation implying transition to new business model. It seems that organizations are less agile and ready to embrace these changes than individual employees to adopt new digital skills (Deloitte, 2017). From the organizational perspective, first step and indicator of organizational readiness for digital transformation is to provide digital tools for communication and collaboration (Störmer et al., 2014). It has a wide range of consequences and one of them considers employees` new role as a member of virtual team. There is even a new concept of digital workforce and employees (Parry & Strohmeier, 2014), with digital literacy seen as the main competence that qualify them to operate with information, both technically and mentally.

In HR practice, at least two changes are brought. First, there is an emerging demand for digital competencies at labour market, with possible gaps between needed and present levels of competencies. Next, there is a challenge to adjust the selection procedure to include this category of skills, referring on teamwork and digitalization. This *European Digital Competence Framework* (EDCF) (Carretero, Vuorikari, & Punie, 2017) enables standardized approach toward the sets of skills relevant for effective virtual teamwork.

The aim of this research is to reveal the concept of digital competencies in the context of teamwork while recognizing and focusing on those that have the priority for the virtual teamwork in the contemporary organizational practices. This research has two main objectives. More scientific objective is to identify the required level of digital competencies for communication and collaboration from the organizational perspective (as HR experts see it). More applied objective strives toward defining the right model of selecting employees to exceed in virtual teamwork and bridge the potential gap between demanded competencies and the existing ones.

2. THEORETICAL CONSIDERATIONS: DIGITALIZING TEAMWORK

The prevalence of virtually working engagements is owed to its spatial and temporal flexibility that enables "to remain competitive regarding new technological opportunities, employee retention and cost efficiency in an increasingly digital environment" (Großer, & Baumol, 2017, p. 21). Studies showed that between 50 till 85% of organizations all around the world use virtual teams (Minton-Eversole, 2012). Nevertheless, working virtually is the question of degree depending on task characteristics and the organizational digitalization level. Valsamis and colleagues (2015) in the development of the digital competencies needed for performing work see an inherent indicator of the level of organizational digitalization. Also, two indicators of digital transformation are seen in the assessment of the digital competencies in the hiring process and in the provision of trainings for digital technology (Kovačević et al., 2019).

2.1. Working virtually in teams

In virtual teams jobs and tasks are mostly done through virtual collaboration enabled by different virtual channels (Hill & Bartol, 2016) supported by digital tools. The lack of opportunity to communicate might diminish the outcome teamwork endeavors and bring distrust in the relations. While trust between team members is based on the opportunity to observe directly others (Clark, et al., 2010), the virtual team might deny this kind of transparency. Marlow (2017) believes that "high virtuality reduces communication quality as a consequence of using tools low in informal value" (584) and that the task complexity might be an additional burden to it. Anders (2016) found that communication in virtual teams is more task oriented which goes in favour to virtual team efficacy at the expense of socio-emotional dimension. Some applications are designed for cooperation as virtual team platform; others incorporate that option beside its main purpose. So, one of the competencies should include skill to select the appropriate technology for the task (Dorr, Kelly, & Director, 2011).

Levi (2015) systemized ways that communication and collaboration technologies are used to support teamwork and structure team member activities. It is typical that digital tool for collaboration has collaborative document management systems and electronic whiteboards for gathering and presenting information. Also, they all provide means for mutual and external communication. Team processes are maintained by system`s meeting agendas and different project management applications. Finally, members are enabled to arrange brainstorming activities, to solve problems and make decisions collaboratively. While main team activities stay the same, it seems that digitalization makes the key difference between real and virtual team, implying different applications for sharing and design documentation, so called white boars for brainstorming, chat and messaging systems, as well as video conferencing options to support collaboration (Korba et al., 2006).

2.2. Digital competencies for teamwork

As a response to the digitalization of collaboration processes in organizations, new demands toward personnel arise, bringing into focus of attention the concept of digital competencies. Labor market researches support the fact that the basic employability skills of modern employees are the ones that are increasingly build on technology use and imply so-called digital literacy. There are authors that consider digital competencies as the synonym of digital literacy (Ilomäki, Kantosalo, & Lakkala, 2011). Digitally literate person can understand, create, express and convey meanings and ideas through different digital media. Similarly, digital competencies are seen as someone`s ability to *access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship"* (Law et al., 2018). So, digital competencies go beyond working skills and they encompass the activities of information usage and creation, as well as expressing one self, being able to choose appropriate tool and to do it safely, protecting his and well-being of others.

This conception is well elaborated in the EDCF (Carretero, Vuorikari, & Punie, 2017), authorized agenda for developing instruments for assessing digital skills in different domains: work and entrepreneurship, learning and education, entertainment and leisure time, citizenship and participation in society. The framework recognizes 21 competencies that are grouped into five areas of competency to assess at eight levels of proficiency: (1) Information and data literacy, (2) Communication and collaboration, (3) Digital content creation, (4) Safety and (5) Problem solving.

Analyzing the content of every specific competence area, it is more than obvious that for the virtual teamwork all competencies are important but it seems not equally essential for effective performance. The main effort in virtual teamwork lies into the opportunity to transform individual knowledge into social (Alsharo, Gregg, & Ramirez, 2017), which means developing shared mental model that provide team members the common ground for "effectively respond to the team environment and task requirements" (Großer, & Baumol, 2017, p. 22). Shared mental model encompass four components, two of them cover team interaction and team members 'characteristics (also skills), and the other two equipment and task itself (Scheutz, et al., 2017). As

it develops on experience, knowledge and imagination (Payne, 2012), it is obvious that designing technology in order to support accurate shared mental model is not enough. There is a specific experience and knowledge that have to be acquired. Also, technology might be different and the knowledge of it might vary between members, so, they have to have their training and adjusting individual skills in order to understand how to use it collectively.

3. RESEARCH PROBLEM: SELECTING FOR VIRTUAL TEAMS

The main research problem is to specify the area of technical readiness for teamwork cooperation in this very moment of technological development. Although selection is often more focused on basic and lasting features that is expected from employee and have higher predictive validity, it is also important to access someone`s current skillfulness in the domain of virtual collaboration tools. It might be an additional factor to consider, not only when choosing the team member but also while deciding for the modality of performing task. Cramton (2001) claims that the inherent strain of virtual communication comes from the fact that virtual teams often experience technological problems like audio and video delaying or difficulties with text interpretation without opportunity to hear message verbally. More competence leads to more richness of communication leading toward more mutual trust and finally better performance. While the most obvious characteristic of virtual teams is the fact that its members primarily rely on technology when cooperate and communicate with each other (Liao, 2017), it is common to take into a consideration the technology (Dulebohn & Hoch, 2017) but not the members` level of knowledge and skillfulness with the mentioned technology. It is regularly avoided and not mentioned explicitly.

If we consider Competency Model, virtual teamwork should have its own set of knowledge, skills, abilities and other characteristics that will guarantee the effectiveness. Comparing virtual and traditional teams, Krumm and colleagues (2016), found that virtual and traditional teams have the similar set of personality traits that are desired but leading, deciding, analyzing and interpreting is more valuable for virtual teams. Hertel and associates (2005) developed Virtual Team Competency Inventory (VTCI) and validated it for selection of virtual team members. While, they were focusing on team member activities (tasks, team interaction, and virtual cooperation) in terms of knowledge, skills and attitudes, the competencies concerning technical prerequisites for virtual teamwork were rather neglected. They were observed in a global way in the context of professional expertise and technical training. Lately, Großer and Baumol (2017) develops system of factors influencing the performance of virtual teamwork incorporating in framework dimensions of communication, distance, goals and group characteristics the aspects of technology (technology properties and team support) and management (technology usage and leadership skills).

From this research we expected to gain knowledge about the level of required digital communication and collaboration competencies in order to be an effective virtual team member. The implication of that awareness might and should be taken into a consideration by HR professionals when planning and performing the selection procedure of potential employees that should in contemporary organizations expecting them to work in virtual teams. First objective is focused on empirical analysis of the organizational demands for digital communication and collaboration competencies of prospect employees (represented through the opinion of HR). Second one focuses to the potential adjustments in selection practice that organizations convey in order to assess the digital competency assets that applying candidates carry.

4. RESEARCH METHOD

There are two phases of the research with two separate objectives integrated with the goal to investigate the required digital competencies for working in virtual teams and the way how it is treated in the selection process. The focus of the research was on the area of the competencies considering usage of communication and collaboration tools. Quantitative part of the research considers survey with disseminating questionnaire inquiring the level of the desired digital competency and targeting the HR experts in Serbian companies as respondents and is a part of the larger project of digital competencies: “Recongizing the needs for the digital competencies of employees from the perspective of labour market” (USAID, 2019). Qualitative part of the research goes into the depth of the problem of digital competencies gap. It consists of the focus group with HR experts where digital competencies were elaborated in the context of selection process and scarce competencies for contemporary workplaces.

4.1. Research instruments

For the purposes of the **quantitative** part of the research we developed items for the questionnaire based on the EDCF (Carretero, Vuorikari, & Punie, 2017) including only the communication and collaboration sector that covers six competencies: The used framework propose that communication and collaboration section covers six competencies: (1) interacting (Q1: *Employee is able to use internet technologies for communication; i.e. email, skype, WhatsApp, Viber, intranet*…), (2) sharing (Q2: *Employee is able to use*

companies' digital storage for sharing information; i.e. Dropbox, OneDrive, Google Drive...), (3) engaging in citizenship (Q3:*Employee is able to use digital services for following and participating in digital environment; i.e. communication using forums and social networks*…), (4) collaborating (Q4: *Employee is able to use digital tool for collaborative teamwork; i.e. Dropbox, Google Drive, Microsoft Teams, Trello, Slack..)* through digital technologies, (5) netiquette (Q5: *Employee follows code of conduct and communication in virtual environment i.e. understands the difference between the rules on different platforms*) and (6) managing digital identity (Q6: *Employee is able to manage online identity; i.e. choosing appropriate content in communication, managing one or more digital accounts*). These six competencies are transformed into a six concrete statements that describe the situation of real tool usage when working virtually.
Beside the general questions about the characteristics of their organization (sector, work area and the level of organizational digitalization), these six items were assessed on five points Likert scale asking respondents to assess each competency based of these level descriptions of task performance (via digital tool for communication and collaboration): 1 – null: not needed at all (irrelevant); 2 – basic: with the help or support from others; 3 – intermediate: alone if the problem is simple and familiar; 4 – advanced: help others and choose right tool, 5 – expert: adapt and develop new digital solutions.

The **qualitative** stage of the research was conducted with the focus group technique, with previously prepared guidelines leading participants toward discussing the difference in required competencies for real and virtual teams, and indicating the concrete implementation of those competencies and how to assess them when selecting potential candidates. The aim of the focus group was to use its dynamics to gain insight into the essence of the digital virtual teams and come toward the tools for selection of the candidates to work virtually.

Topics considered are: (1) their everyday organizational practices (focused on the digitalization issues) and organizational role in the context of the recruitment and selection processes, (2) description of the selection process focusing on potential differences before digitalization (if there is any knowledge about that) and current practices, (3) defining and identifying competencies needed in contemporary business environment, (4) HR experts` definition of digital skills and competencies, (5) the main difference between competency requirements for virtual and real teams, mapping the key competencies for working in virtual teams, (6) selection techniques they use to test digital competencies for communication and collaboration, (7) forecasting future scenarios of selection (in the context of digital transformation of organization.

4.2. Research sample

All companies that have any kind of virtual teamwork are qualified for our sample, so the questionnaire was send to over 400 companies on the territory of Serbia. The request is addressed to the HR person or sector electronically and the questionnaire is administered also electronically. Finally, we got the number of 184 HR totally or partially valid answers from the professionals (classifying as selection experts and as managers), from more than 100 companies. It is important to emphasize that almost 50% of responding companies are classified as large, medium and small companies (with almost the same number of them) represent other half of the sample. Majority of organizations in sample are operating in the territory of Belgrade (over 80% of them) and most of them are from the private sector (87%), with about 1/3 of them are IT and technological companies, followed by the service, marketing and sales companies. They all reported relatively high level of digitalization.

Participants in the focus group were HR directors and managers with more than five years of relevant experience. They are chosen from the list of the most digitally advanced companies on our market and represent four large IT companies in Serbia and four large companies with their core business strongly relying on the digital technology and have exceptionally developed IT sector.

5. RESEARCH RESULTS

There are two series of results considering the level of skills needed for virtual team members and considering these digital competencies in the context of the HR process of selection.

5.1. Autonomously adapting behavior to fit both task and the platform

As it is given in the Table 1, we see that the highest level of competency is needed for communicating (using internet technologies for communication). Virtual team members are expected to be able to adapt the systems to their needs and tasks. It is not surprising, due to the importance of communication process, as well as the trust that is achieved accordingly, that netiquette is the next in the range of the level of expertise needed. It means that team member has to behave in virtual interaction being aware of differences and respecting diverse rules of conduct, altering their interaction depending on platform (and not only to be able to do it independently but also to provide some help to others). Sharing information and managing online

identities follows and should be also done independently and with ability to adjust them to task characteristics. Although participating in social digital environment and collaborating are rated the least important, it still consider that it is done without help and not only for simple, well known tasks. Also, since the same tools are often used both for communication and collaboration, they might be seen as incorporated into communicating tools.

Table 1: Assessed levels of communication and collaboration competencies for digital teamwork

DIGITAL COMPETENCE	N	M	SD	Rank
Communicating	181	4,38	,670	1
Sharing	184	3,76	1,103	3
Citizenship	177	3,63	1,103	5
Collaborating	179	3,61	1,121	6
Netiquette	177	3,85	,992	2
Managing identity	176	3,75	1,086	4
Communication and collaboration	**184**	**3,83**	**,853**	

5.2. Implicit way of testing digital competencies

Focus group respondents agreed that, as the methodology of work has changed due to the digital technologies involved, the recruitment and selection process is changed accordingly. Starting from the way someone applies to work, toward the automatized way of analyzing biographical data and communicating with candidates online and via internet. Also, they often use electronically submitted questionnaires to test different individual characteristics. It is also an implicit way to see if candidate is *digitally illiterate*. If someone finds the e-application form and is able to create and send his CV electronically, and complete e-tests, he has basic digital competencies.

Sometimes, for some positions, the trial period of working virtually on some project is essential for candidate to take into a serious consideration and organizations have lot of external, virtually engaged employees that become a part of the relatively stable teams and member of staff after years of collaboration digitally. Nevertheless, *the majority of employees are available both virtually and face-to-face*. It seems that testing digital competencies of the candidates is done implicitly, as something that is rather implying.

Further, respondents agreed that organizations rarely test concrete digital competencies directly expecting that for someone who is ready to learn and opened to new experiences, also having positive experience with technology, is going *to be easy to learn to use different communication and collaboration platforms*. Particularly because *these technological solutions varies from company to company and rapidly change*, HR experts believe that it is not necessary to test someone`s specific virtue to work in the concrete digital setting but *rather to be prone to learn fast, to adjust to different demands with readiness for change*.

About future perspective, it is important to say that participants in focus group could not imagine that only couple of months later, majority of human resource would be forced to operate in virtual teams and from different online platforms. Yet, they spoke about the transition toward that way of working as all the pre-selection, and some parts of the selection being done using technology (via chat bots and video conferences).

6. DISCUSSION AND CONCLUSION: COMPETENCY TRAINING OR SELECTION

Results of quantitative and qualitative endeavors reveal the digital competence requirements for virtual team work in local contemporary organizations as well as selection practices respectively, lead toward some preliminary conclusions. It seems that digital communication and collaboration competencies are needed at the level of their essential role in the team work process. It is expected that skillfulness in usage of communication tools, that enables establishing links and trust, as well as shared mental model, has to be developed as much as it possible. Concretely, it involves employee`s ability to choose different tools for different purposes (to organize meetings, post tasks…), to be able to do it without help, rather to be able to help others. The specific flexibility is also expected while using different tools and adjusting to their particular rules of conducting (netiquette). Other competencies, sharing, managing online identity, social activism (citizenship) and collaboration are slightly lower in the expertise demands. Nevertheless, the autonomy of performing all those tasks is essential.

The question of the selection and specific techniques of testing candidates' digital skills seems as less clear. As basic competencies, sometimes called digital literacy, is implicitly expected and they are inherently

present in the process of application. Candidates usually apply via different e-platforms and they are contacted in the similar way. So, if their application is received and he is in the pool of potential employees, he already has basic skills. The specific digital communication and collaboration competencies are rarely tested directly and the reason for it is in the existence of diverse digital tools. Although some of them are more user-friendly and tailor-made for collaboration, while others require some adjustments, expecting users to be capable to modify HR professionals believe that if the candidate has set of skills that are relevant for the job and positive experience and attitudes toward technology, they would be able to learn to use different collaborative tools.

There are many different digital platforms for communication and collaboration and organizations often change them. So, it is not possible and required to learn them all. More universal skills are demanded. It raises one more important question about those universal skills and knowledge that has to be acquired in order to be able to participate in virtual teams via modern technological devices. The idea is to prepare students for virtual collaboration with their colleagues during studies assigning them virtual team projects, simulating the work-like setting. Larson (2017, p. 334) and colleagues say that it is an “experiential immersion in a virtual working environment similar to that which they may be working in during their careers”. Other solution might come from the ideas of Dorr and associates (2011) who presented the model for virtual training program, incorporating the module for mastering virtual team technology and communication skills as electronic etiquette, cultural awareness, brainstorming and decision making electronically. It means that employees would not be tested in the domain of digital competencies in the process of selection but they would be offered a training program for that purposes.

Some limitations of the study and the ideas to go further in developing potential model of analysing the topic we perceive as following. Future research might consider the whole variety of digital competencies and the question of fit between digital platform, task and individual competency. Wahl (2016) proposed different tools for different teamwork phases and authors often emphasise different team member roles. For example, the role of team leader requires him to be skillful with different digital tools (Liao, 2017) and good in resolving virtual conflicts that might occur due to the lack of technical support provided (Kankanhalli, Tan, & Wei, 2006). So, the next step in researches should be to consider differences in team roles and phases, as well as to focus on question of developing and train relevant competencies, rather than just to test them.

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GAMIFYING RECRUITMENT AND SELECTION

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Abstract: *The use of gamification in HRM, particularly in recruitment and selection, has become an increasingly popular topic lately as organizations all over the world turn toward the implementing new technologies to meet their goals. The aim of this paper is to address, identify and explain the possibilities of implementing gamification in recruitment and selection process, its benefits and preconditions for successful implementation in organizations. Research has shown that gamified recruitment and selection processes have been giving positive effects enabling companies to attract the largest number of technology-oriented and future guided individuals. The use of gamification in these processes may attract a large number of young candidates through making the process of applying for jobs more interesting and at the same time making the impression of a company that keeps up with trends and develops both itself and its employees. The conclusion of the paper highlights that ignoring these trends and novelties in the recruitment and selection processes may be a limiting factor for a company's image and its development in the future.*

Keywords*: recruitment, selection, gamification, HR, employee*

1. INTRODUCTION

Despite the increasing percentage of highly educated people, the growing discrepancy between skills employers are searching for and those potential employees possess has become a trend that can hardly be ignored. As a consequence, HR departments have been struggling to find qualified candidates to fill up vacancies (Abdullah, Sobia & Hossan, 2015). In answer to these problems an increasing number of companies gradually have begun to include digitalization in their HR activities thus implementing new ways of recruiting (Argue, 2015).

Game-thinking has started to apply to a range of non-gaming contexts (Armstrong, Landers & Collmus, 2016). The use of gamification in HRM (e.g. in recruitment, selection, onboarding, training and development, performance management) is rising in organizations all over the world as they turn toward the implementing new technologies to meet their goals (Callan, Bauer, & Landers, 2015; DuVernet & Popp, 2014). Recent reports by organizations studying and applying HRM theory have identified gamification as a top trend in this field (Munson, 2013). The results of gamified recruitment processes have been showing positive effects (Chow & Chapman, 2013).

The aim of this paper is to address, identify and explain the possibilities of implementing gamification in recruitment and selection process, its benefits and preconditions for successful implementation in organizations.

2. INTRODUCING THE CONCEPT OF GAMIFICATION IN HRM

The use of gamification in business environment has become an increasingly popular topic lately. Gamification is mostly defined as the implementation of gaming principles in a non-gaming experience. A non-gaming experience denotes everyday human activities in different contexts, either work, home, university and other (Center for Game Science, 2008), while gaming principles refer to characteristics and processes which are mostly linked to games, such as collecting points, competing, finding solution for challenges and working out set tasks, winning awards, etc. (Woźniak, 2015).

Of course, the implementation of gamification in a business environment is much more than a game, it should not be brought down just to the use of gaming elements, but it should be regarded as a mechanism that enables an organization to attain its objectives and fulfill its tasks (Nenadić, 2019). The inclusion of HR sector into digitalization and the implementation of new methods, such as gamification, is a way for the companies to attract the largest number of technology-oriented and future guided individuals and at the

same time make the impression of a company that keeps up with trends and develops both itself and its employees (Nenadić, 2019). It can be used both during recruitment of potential employees, training of newly employed and their inclusion into organization, during training and development of employees, essentially as an innovative and interactive method of learning (Woźniak, 2015).

Zogby's (2015) research on video games conducted with 1,019 respondents aged between 18 and 34 shows that 57% of them play video games at least three times a week. An even more significant fact especially for the HR sector is that 67% of subjects believe that games help them to develop skills necessary for creating winning strategies, that no less than 70% of them think that playing video games has helped them to develop the problem-solving skills, while 63% stress the fact that through video games they have learnt to work in a team (Zogby, 2015). These data are exceptionally significant for the HR sector and selection of adequate strategies as far as recruitment and selection of candidates are concerned.

3. GAMIFICATION IN RECRUITMENT AND SELECTION VS. TRADITIONAL APPROACHES

In relation to the traditional approach where HR department uses information about job applicants acquired via resumes, psychometric and/or knowledge-based tests, gamification offers a direct insight that makes comparison and obtaining feedback information about candidates easier based on their performance (Nenadić, 2019). In the past decades online recruitment has become a globally accepted trend, so an increasing number of potential candidates and recruiters are turning to internet as a means for finding new workforce (Cappelli, 2001). According to the statements of Allen, VanScotter and Otondo (2004), about 50% of employees in companies are recruited via recruitment sites of a company. These websites are conceived to offer information to candidates both about the company and about job requirements mostly via an interactive form of communication stressing in this way a positive image of the organization (Allen, Van Scotter, & Otondo, 2004). However, the consequences of online recruitment are recruiters overwhelmed with a large number of applications, so initial screening of applications which do not fulfill the requirements is a time-consuming process (Lee, 2005).

Gamified selection processes are not based solely on games but are developed on scientific data and analyses that provide employers with an insight into mental agility, cognitive speed, attentiveness and capabilities. Data on a candidate collected by playing a game are used for psychometric analyses and scoring, and no significant differences between them and classical psychometric tests have been recorded (Abdullah et al., 2015). Games are performance oriented and require from an individual to demonstrate his/her skills, knowledge and capabilities, unlike traditional assessments based on recollection and giving information, as well as choosing between multiple answers.

Traditional ways of assessment provide a single opportunity and a candidate has no possibility of a repeated attempt. When playing games candidates mostly have several attempts in various spheres in order to complete the game. On the one hand, this gives an insight into the manner in which drill affects an individual and how quickly he/she makes progress, and on the other, it gives the possibility of measuring the number of attempts of an individual to fulfill a certain task (Zapata-Rivera & Bauer, 2012). However, the consequence of the effects of drill is that it is hard to determine the reliability of gamification (Landers, 2015).

Gamification in recruitment and selection is primarily intended to target individuals who have just completed education, and more rarely for older candidates and the ones with many years of experience (Hawkes, Cek & Handler, 2018). The reason for that is higher involvement of younger generations into role-playing and competitive games, and their preference for feedback which is most frequently received through points or badges won. For that reason, gamification in the process of recruitment can be extremely useful for Millenial applicants (Nenadić, 2019).

Depending on their context, two types of games can be distinguished. The first refers to games that ask the candidate to assume the role of an employee in the company and by doing that to acquire knowledge on the working context and an insight into job requirements. In this way chances are reduced for the occurrence of any obscurities concerning the tasks of the job the individual is applying for (Woźniak, 2015). The other type of games asks the candidate to do the tasks identical to the ones employees do, providing feedback information both to the sector of human resources and the individual on whether that individual meets the criteria that specific job requires (Woźniak, 2015). By playing the game candidates are given the opportunity to solve real problems and this offers recruiters the possibility to measure skills and capabilities that are otherwise difficult to measure with traditional recruitment methods (Abdullah et al., 2015).

3.1. Benefits of using gamification in recruitment and selection

The application of gamification in recruitment and selection process has a number of benefits. One of the fundamental benefits refers to lower costs, faster and easier access to applications and reaching out to a

broader and heterogeneous group of candidates. One of the goals of the implementation of gamification in recruitment and selection is to present the company as pleasant working environment inclined towards innovations and development, to stimulate candidates to apply for jobs offered (Woźniak, 2015), making the process of recruitment more attractive and more interesting (Abdullah et al., 2015).

One of the benefits is also the possibility to check whether capabilities of candidates meet the requirements of the organization. By testing skills such as time management, creativity, innovativeness, the selection of candidates is much faster. On the other hand, in an interesting way the candidates themselves obtain the information about the company, the manner in which it operates and its culture. In addition, by simulating its actual operation the organization obtains information on the performance of individuals at work and also on actual capabilities and behavior of candidates the determination of which is very difficult with traditional tests (Joy, 2017).

However, the most important factor of the effectiveness of gamification is that it provides candidates with feedback, that it is the feedback message based on true performance of individuals or the message automatically sent to everybody after a certain score is achieved (Zapata-Rivera & Bauer, 2012). The possibility to compare one's own results with those of others along with the insight into progress and how much more remains until the completion of the mission are one of the main driving forces of motivation in gamification (Woźniak, 2015).

Despite the fact that gamification in the process of recruitment and selection does not measure applicants' motivation, the benefits of using games in relation to traditional recruitment methods are that games can motivate individuals who otherwise would not be interested in taking traditional tests. In addition, in this way the individuals who are ready to devote more time to the process will be filtered out. Another reason is that recruitment through games reduces anxiety which leads to higher reliability and validity of collected information. And finally, games have the possibility to examine behavior directly, as opposed to psychometric tests which are mostly based on self-reporting (Landers, 2015).

3.2. Preconditions for successful implementation of gamification in recruitment and selection

In addition to all the listed benefits there are also certain challenges. For that reason one must keep in mind the fact that in as many as 80% of cases of the implementation of gamification it does not succeed in meeting the requirements and goals set by the company (Nenadić, 2019). In order to appropriately implement gamification in the recruitment and selection process, the company must define both short-term and long-term skills necessary for a certain job and then address the workforce existing in the market and adapt recruitment and selection games to potential candidates. When implementing gamification in these processes, the organization must consider the goals it wishes to achieve, the manner in which it shall measure the produced result (Joy, 2017), and how it will effectuate it by applying gaming principles. It is important to determine whether gamification conforms to the culture of the organization or not, and what is the viewpoint of its management about this concept (Simpson & Jenkins, 2015).

Another significant aspect refers to how to stimulate intrinsic motivation among players and connect it to the job (Simpson & Jenkins, 2015). When creating games it is essential to design them well and establish a mechanism that leaves no space for manipulation by candidates. It is also necessary to take into account validity (Hawkes, Cek, & Handler, 2018) and reliability (Landers, 2015). A particularly important aspect which requires close attention while designing games is how to determine an adequate level of challenge and when an individual is ready to pass onto the next level depending on his/her potential. And also whether there are mechanisms of cooperation in the game and whether they are evaluated, whether team work, mentoring and sharing should be part of the game design.

In addition, motivation and engrossment are higher in real-life situations, so the probability is also higher that certain tasks shall be completed than in games (Woźniak, 2015). The question that arises is whether individuals who play games in everyday life achieve better performance in gamification. For instance, Ausburn (2012) believes that orientation in space, level of self-confidence and estimation of task difficulty which are significant in playing games are determined by gender, age and experience in playing games.

What should be kept in mind is that the consequence of implementing solely gamification in the recruitment and selection process may be discrimination of certain categories, either individuals with visual or motor disorders or also discrimination based on certain subtle characteristics. In the effort to enrich a game as much as possible, not rarely tasks are set and skills required in the game that are not the ones that are measured (Zapata- Rivera & Bauer, 2012).

4. CONCLUSION

Having in mind that competent and skillful employees represent the foundation of company development, recruitment and selection may be considered fundamental activities of human resource management. For that reason it is very important to develop effective and efficient methods of recruitment and selection which will attract a substantial pool of potential candidates and thus provide a higher chance to find an adequate candidate among them (Argue, 2015; Abdullah et al., 2015).

An increasing number of organizations are searching for innovative employees with a high level of motivation, but at the same time a small number of them organize recruitment and selection processes in the manner which would attract such individuals (Simpson & Jenkins, 2015). The use of gamification in these processes may attract a large number of young candidates from the market dominated by strong competition for talents. Apart from making the process of applying for jobs more interesting, recruitment via games helps individuals develop skills required by the employers (Abdullah et al., 2015). Ignoring these trends and novelties in the recruitment and selection process may be a limiting factor for company's image and development in the future.

However, despite all the stated benefits of gamification, it should be kept in mind that not all candidates are online or willing to play games. That is the reason why gamification should not completely replace traditional methods, but it should be implemented into a broader recruitment and selection strategy (Abdullah et al., 2015).

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ADVANCING HUMAN RESOURCES MANAGEMENT WITH PEOPLE ANALYTICS EDUCATION

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Abstract: *Present data collection and analytical technologies give organizations the opportunity to undertake advanced people analytics. With such data and analytical capabilities, modern organizations may address large-scale organizational collaborative challenges and social biases that prevent the best from rising to the top of organizations. We present research on two use cases of advanced people analytics highlighting how advanced people analytics may advance human resources management. To guide educational efforts, we review some of the requisite set of knowledge and skills human resources professionals need to acquire to do people analytics. We conclude with how people analytics may advance more than just business organizations.*

Keywords*: human resources management, people analytics, data knowledge and skills*

1. THE CASE FOR PEOPLE ANALYTICS EDUCATION

Present data collection technologies offer organizations the possibility to collect more fine-grained, longitudinally-intensive, and big data on the work behaviors, individual characteristics, and networked relations of employees than previously possible (Tonidandel, King, & Cortina, 2015). Today, organizations may track employee communications (e.g., via multiple platforms such as e-mail, chat messaging, and social media), live employee collaboration (e.g., video recording virtual or in-person meetings), and a variety of employee work activities (e.g., general work activities like reporting type spent on a client or specific activities like updating documents for reports) on a daily, hourly, minute, second, or even millisecond basis. Furthermore, organizations may keep a record of the entire work history of all past and current employees who worked for them to create big databases. Surprisingly, many organizations collect such data without taking advantage of it. In order to take advantage of such data collection on employees, organizations need dedicated people analytics capabilities to garner insights for organizational policies, allocation of human capital to strategic objectives, and employee development, among numerous other applications.

We define people analytics as the application of quantitative methods (e.g., supervised and unsupervised learning, network analysis, natural language processing, time series analysis, computational modeling) to understand employee work processes and outcomes. In other words, people analytics capabilities afford organizational members the possibility to better understand the core of any human organization, all of the employees who compose the organization. This includes not only better understanding the most common employees, such as the employees working in entry-level or common functions, but employees at any organizational level, position, or rank (e.g., top management team). Indeed, optimizing a system's (e.g., an organization of people) behavior requires understanding the characteristics of the system's components, the behavior of the system's components, and how the system's components interact to operate as a collective (Kozlowski, Chao, Grand, Braun, & Kuljanin, 2016). People analytics provide a gateway through which organizations may design work to fit the knowledge, skills, and abilities of employees, build effective employee collaborative processes, and formulate strategies for employees to adapt to dynamic, competitive environments. In order to achieve such aims, organizational members should look to spread insights from people analytics efforts to all members of an organization.

Recent trends suggest an increase in the number of organizations investing in people analytics capabilities (Bersin, 2016a). Yet, advanced applications of people analytics in organizations still falls short of common practice, leaving much room for advancement. Fundamentally, this implies some organizations simply fail to even give themselves a chance to optimize employee work processes and outcomes. Organizations, who

invest in people analytics capabilities and implement these capabilities effectively, may benefit from a considerable market competitive advantage. Naturally, if an organization succeeds in effectively utilizing the collective set of knowledge, skills, and abilities of its employees, and it implements work processes that can integrate and adapt to a changing set of organizational members, then such organizations will come out ahead of its competitors. After all, the people make the place (Schneider, 1987).

A part of the explanation for the organizational shortfall in the investment in people analytics may stem from a deficit in knowledge and skills by organizational members best suited to perform people analytics, the employees in the human resources department. In other words, organizations may lack individuals making the case for people analytics. The need and importance of people analytics work in organizations makes human resources professionals with such knowledge and skills more attractive with respect to employability. Furthermore, such human resources professional would gain expert power within any particular organization given the universal need of such expertise. Conclusively, these set of arguments suggest a critical need for people analytics education for human resources professionals and organizational members writ large.

2. WHAT DOES PEOPLE ANALYTICS DO FOR ORGANIZATIONS?

People analytics focuses on all questions and problems pertaining to the characteristics, work processes and activities, and outcomes of organizational members and the teams, departments, units, and the organizations they compose. In particular, people analytics facilitates the implementation of human resources management and organizational behavior: (1) work design, (2) job and role assignments, (3) performance evaluation, (4) recruitment, (5) staffing, (6) retention, (7) training and development, (8) compensation, (9) equity, diversity, and inclusion, (10) motivation and engagement, (11) work-life balance and work stress, (12) teamwork, (13) leadership, and (14) organizational structure, culture, and systems. Ideally, people analytics leads organizational members to implement human resources management and organizational behavior for the collective benefit of all organizational members. We describe two exciting applications of people analytics to organizational life.

2.1. Large-Scale Organizational Collaboration

The decades after World War II saw an ever-increasing reliance on teams and associated teamwork in modern, large organizations to accomplish organizational objectives. We may represent the dominant form of work accomplishment in modern, large organizations as a network of teams with organizational members belonging to several teams at any moment in time, each team accomplishing its set of objectives, and members exchanging information, knowledge, and insights within and across teams (Bersin, 2016b). This presents a large-scale collaboration problem in such organizations. In particular, such large organizational networks may fall prey to a version of Braess' paradox, which observes that adding roads to a congested traffic network (e.g., a large city) may sometimes actually lead to worsening average commute times for commuters as a collective (Skinner, 2010). For large, networked organizations, the careless deployment of teams to organizational objectives may lead to far from optimal organizational performance. This phenomenon becomes particularly interesting when deploying a team composed of the best, most-capable employees into the existing network structure. Such a highly capable team may very well accomplish its assigned organizational objectives effectively, while, at the same time, disrupting the effective accomplishment of organizational objectives assigned to teams connected to it. This phenomenon may emerge when connections between teams implies the work activities and accomplishments of one team impact the choices and actions of connected teams. Large, modern organizations overwhelmingly find themselves in such an arrangement.

The appearance of a version of Braess' paradox in large, modern organizations may intrigue the mind even more so than its appearance in traffic networks. For the time being, there generally exist no sufficiently active managers, overseers, or authorities who manage traffic networks. Therefore, each commuter merely acts in one's own interest, eventually leading to a selfish Nash equilibrium that sub-optimizes average commute time. No manger, overseer, or authority, nor the commuters themselves, guide the actions of individual commuters to the benefit of the collective. On the other hand, large, modern organizations do, in actual practice, utilize managers, overseers, and authorities to guide actions of teams of individuals. Despite the use of such overseers, the phenomenon may emerge regardless, under particular collaborative conditions. Solving this organizational problem quickly becomes intractable for any human mind as psychologists convincingly portray the human mind as a limited-capacity information processor (Simon, 1962). To stand a chance to address this problem continuously and dynamically, managers, overseers, authorities, or organizational members themselves, need people analytics tools to guide their actions in order for the collective to benefit. Dynamic organizational network analysis, and generative computational models more broadly, facilitate the study of complex organizational networks of teams (Kozlowski, Chao, Grand, Braun, & Kuljanin, 2013). Tracking the exchanges of information (e.g., via e-mail, documents, chat messaging, meetings) between organizational members provides the necessary empirical data to examine such a

collaborative challenge (Butts & Marcum, 2017). Organizational network analysis can identify the most important individuals and teams facilitating organization-wide collaboration and which individuals and teams fail to receive, send, or transmit pertinent information. Such data and tools allow managers or constituents to continuously and dynamically monitor and adapt to the existence of organizational cacophonies by representing and modeling the interactions across the organizational network. These data and tools allow managers or constituents to intervene as needed to adapt to changing circumstances whether those circumstances change due to internal (e.g., organizational members arriving and leaving or changing teams) or external (e.g., the organizational consequences of the appearance of a world-wide pandemic) organizational happening.

As an illustrative example, we provide results from a virtual experiment utilizing a computational model built to investigate the effectiveness of multi-team systems (e.g., Asencio & DeChurch, 2017). The computational model simulates ten agents composing each of three teams composing a single multi-team system (MTS). Each team in the MTS performs a set of tasks assigned to them where performance on one team's set of tasks impacts the decisions members in a different team make with respect to accomplishing task objectives. Figure 1 displays a simplified version of connections between tasks of one team and tasks of other teams in an MTS. Briefly, in this particular virtual experiment, the agents in the first team of the MTS worked on tasks independent of other tasks (i.e., pooled subtasks). Yet, as agents in the first team made progress on their subtasks, they impacted the likelihood of agents in the second team working on their first assigned subtask. When agents in the second team of the MTS worked on any of their assigned subtasks, then this impacted the likelihood of those agents working on all other subtasks assigned to them due to the full connection between their subtasks (i.e., intensive subtasks). As the agents in the second team worked on their subtasks, they impacted the likelihood of agents in the third team of the MTS working on their first assigned subtask. When agents in the third team worked on their subtasks, then they increased the likelihood of working on other subtasks in a particular order (i.e., sequential subtasks). The virtual experiment simulated 161,644 MTS performing in this task environment generating 581 gigabytes of data.

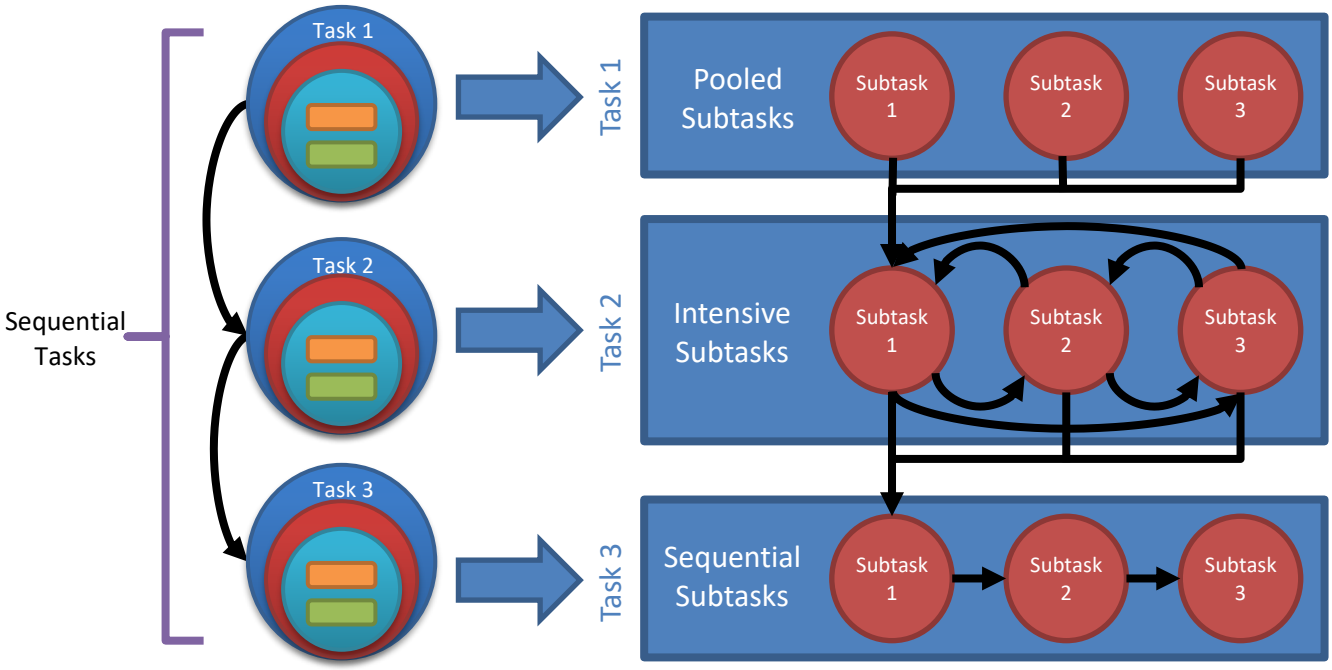

Figure 1: A multi-team system interconnected by the tasks component teams perform

The teams in the MTS made decisions to complete their tasks in such a way to optimize team performance. This mandate for local, team optimization of performance held a consequence for global, MTS optimization of performance. In particular, due to the connections between the tasks that teams performed, the agents as an MTS optimized MTS performance when the team of agents working on the intensive subtasks sacrificed their own performance for the good of the performance of the MTS. Figure 2 illustrates this phenomenon. The y-axis and colors reflect quartiles of performance for the team working on the intensive subtasks (i.e., the colors) and the MTS (i.e., the y-axis). In both cases, the first quartile represents top performance. For the worst-performing MTS (i.e., the fourth quartile on the y-axis), the best-performing intensive teams (i.e., first quartile colored red) compose *most* of these MTS (i.e., 40.5%), whereas, for the best-performing MTS (i.e., the first quartile on the y-axis), the best-performing intensive teams compose *least* of these MTS (i.e., 16.7%). In other words, the best MTS performance involved the intensive team sacrificing its performance for

the good of the MTS. Unfortunately, word constraints prohibit further elaboration. Importantly, this highlights an example of the utility of advanced people analytics to understand organizational phenomena.

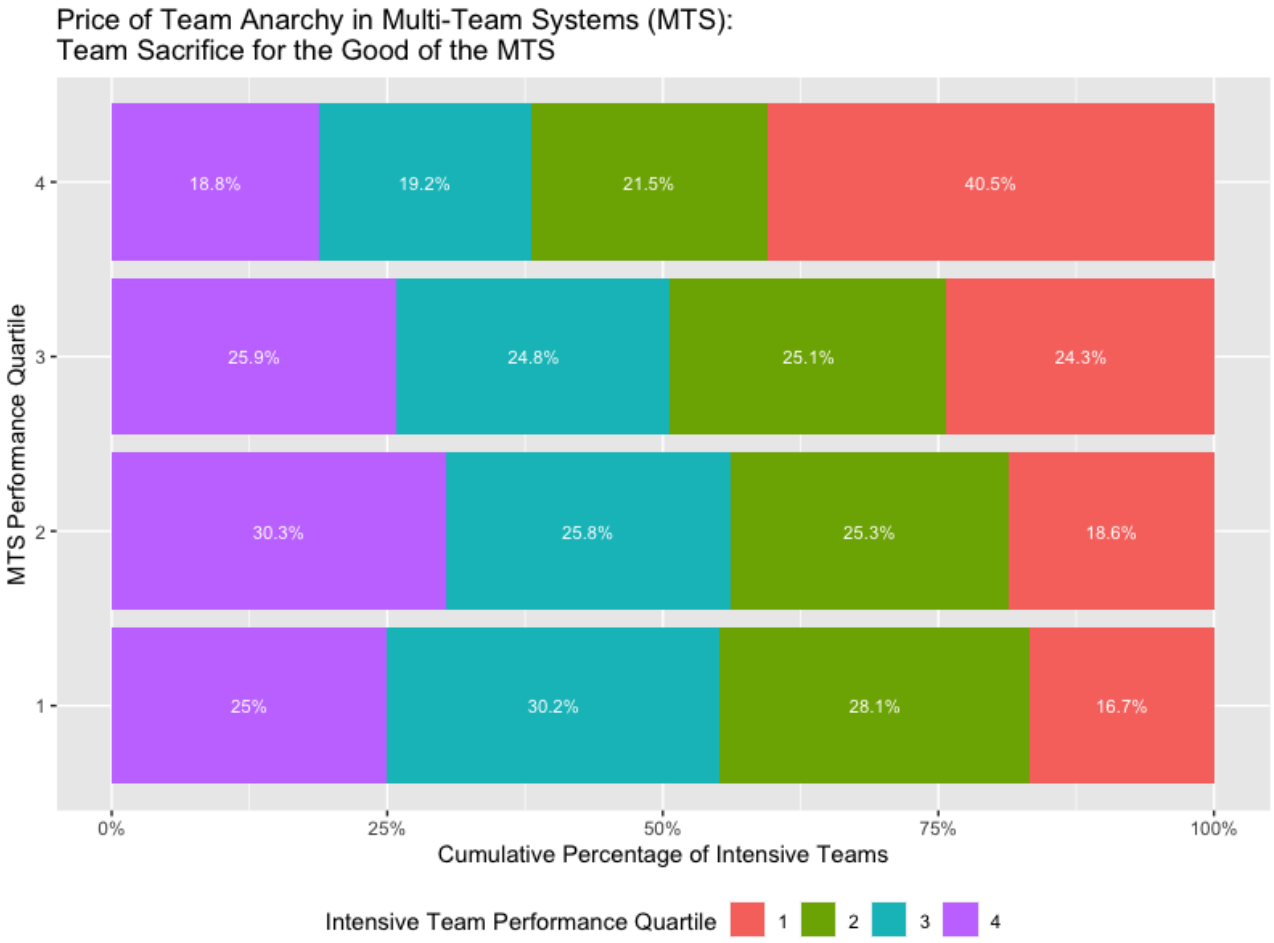

Figure 2: Illustrative results from MTS virtual experiment

2.2. Organizational Gender Stratification

Any large grouping of *Homo sapiens* faces the pernicious problem of social biases where, often times, happenstance favors particular sub-groups with respect to wealth, power, and treatment (Harari, 2015). Large, modern organizations face numerous such social biases favoring one sub-group of individuals over another. We highlight one such case. Solving these problems not only implies more equitable and fair treatment of employees in an organization, but, at the same time, more optimal organizational performance as a result of getting the best of organizational members. Organizational members addressing these problems stand to benefit as a collective.

Organizational gender stratification refers to the consistent and pernicious organizational phenomenon where men disproportionately hold the highest-level organizational positions and women seem to face a prohibitive ceiling (Martell, Lane, & Emrich, 1996). In the companies belonging to the *S&P 500* (i.e., 500 large companies based in the United States of America --- USA), the number of female chief executive officers hovered mostly near 0% through the mid-1990s. Today, the number of female chief executives in the *S&P 500* hovers around 5%, despite women composing around 45% of the workforce in these companies. Looking across the world, the percentage of women in senior management positions remains well under 50%, despite composing half of the workforce in some regions (e.g., European Union; Catalyst, 2019). Furthermore, empirical research suggests negligible differences between men and women in cognitive capabilities (Spelke, 2005). Given the cognitive nature of work in these referenced organizations, this data certainly makes one consider what mechanisms might prove responsible for the emergence of organizational gender stratification. Solving this problem would not only increase the equitable treatment of employees, but, as a consequence, it would improve organizational performance (Moscati, Zalewski, Crompvoets, Meyers, & Kuljanin, 2019).

To study this problem effectively, requires the use of people analytics tools including computational modeling and time series analysis (Samuelson, Levine, Barth, Wessel, & Grand, 2019). We might theorize several plausible mechanisms as drivers of organizational gender stratification such as bias in performance evaluations, individual career decision-making, and differences in work opportunities. Computational modeling can help us evaluate whether or not those mechanisms reproduce known empirical patterns (Grand, Braun, Kuljanin, Kozlowski, & Chao, 2016). For any mechanisms that in combination reproduce known empirical patterns, then we would look to investigate the signatures of these mechanisms empirically by observing ongoing work processes (e.g., organizational practices for performance evaluation measurement and promotional decision-making) and activities (e.g., individuals not seeking important opportunities) pertinent to those mechanisms inside organizations. This type of data-tracking would undoubtedly benefit from the use of time series analysis to determine whether proposed mechanisms do in fact play a role in organizational gender stratification, and, importantly, in expected signature ways. Eventually, this could lead to effective interventions to solve organizational gender stratification, and, thereby, identify employees who impact organizational performance more effectively.

As an illustrative example, we provide results from a virtual experiment utilizing a computational model built to study organizational gender stratification. Figure 3, on the left-hand side, highlights the average empirical pattern of the corporate pipeline in 2018 for small and large companies in the USA. On the right-hand side, Figure 3 highlights the results from a computational model simulating the emergence of organizational gender stratification in the presence of biased performance appraisals favoring men. We see a relatively close match between the empirical and simulated patterns suggesting the utility of the computational model to understand the processes that might underlie organizational gender stratification.

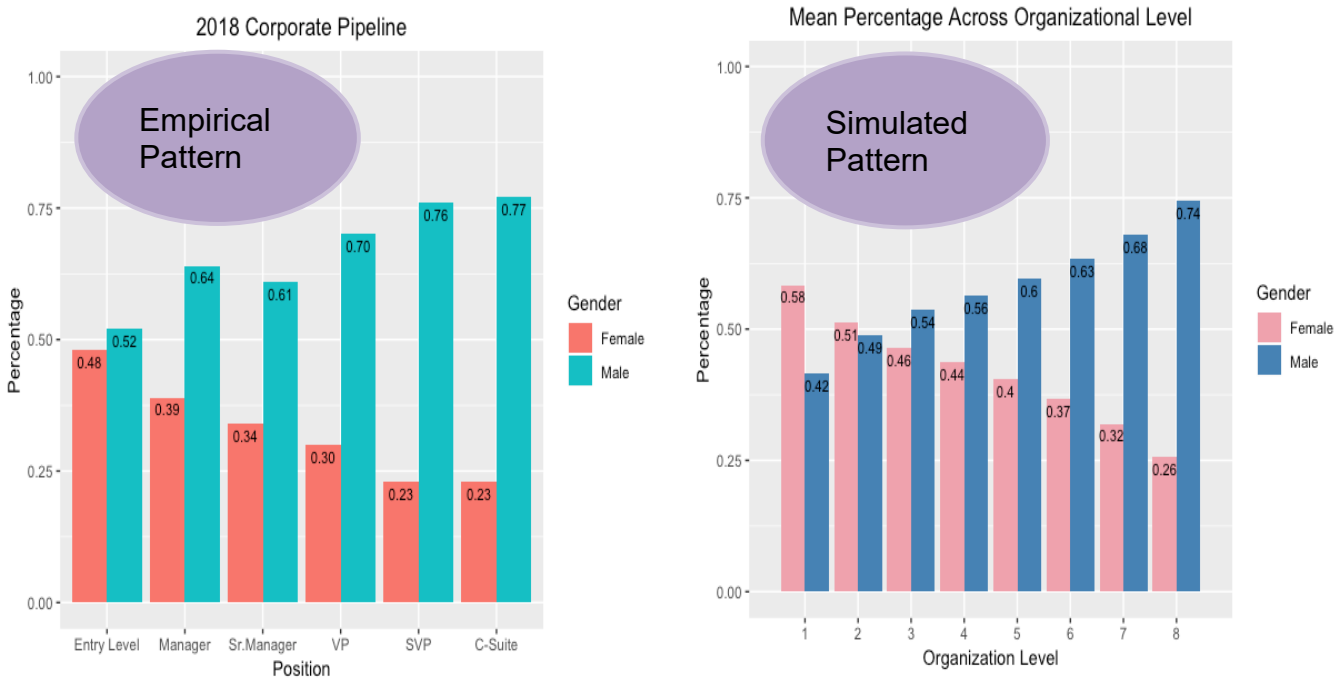

Figure 3: Comparing empirical and simulated organizational gender stratification

Fairness arguments may not necessarily convince organizations for a need to address organizational gender stratification. More convincing evidence might speak to the implications for organizational performance in the presence of organizational gender stratification. Figure 4 highlights these consequences. On the left-hand side, we see that the true performance capabilities of females at any level of the organization surpasses the true performance capabilities of males in this virtual experiment. Yet, men receive promotions at a higher rate than females (as highlighted in Figure 3 on the right-hand side) because the perceived performance of males surpasses the perceived performance of females as seen on the right-hand side of Figure 4. This ultimately implies the organization insufficiently promotes its best employees. Organizations who better allocate their personnel may generate competitive advantage over their competitors who fail to do so. In this case, organizations who solve organizational gender stratification may stand to benefit from a competitive advantage. Unfortunately, word constraints prohibit further elaboration. Importantly, this provides another example of how advanced people analytics may advance human resources management.

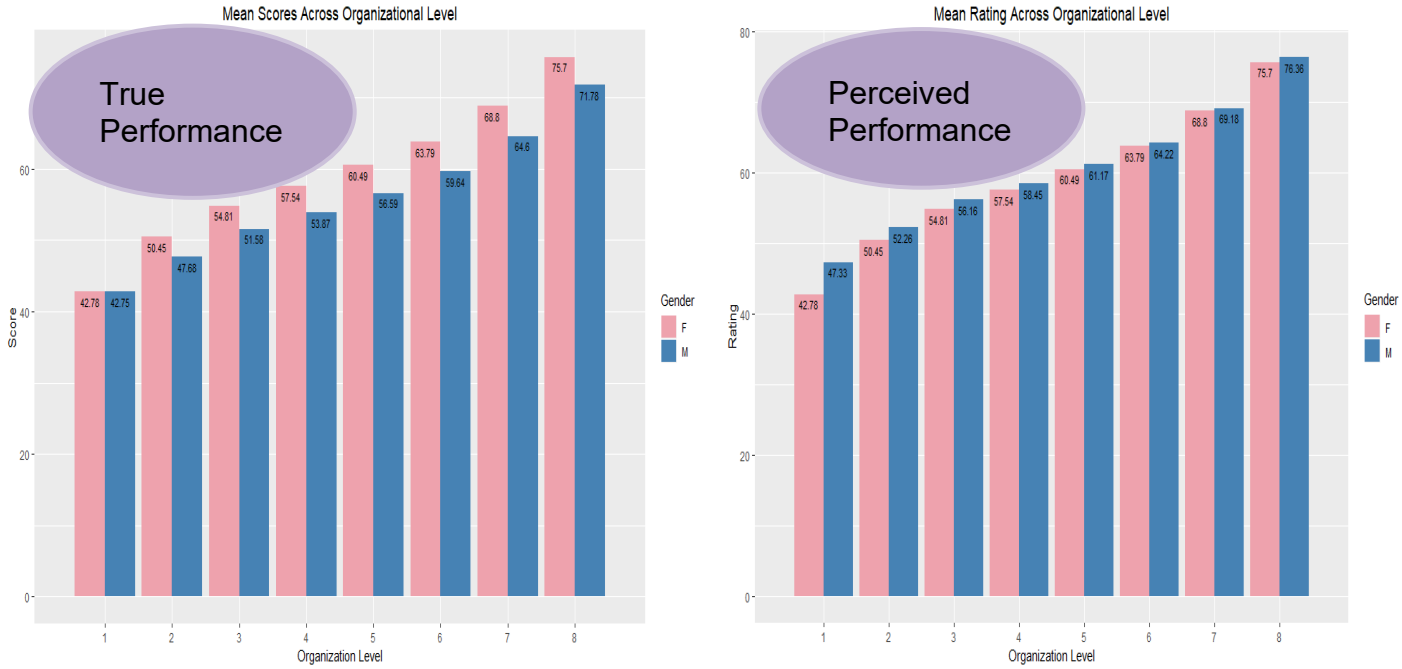

Figure 4: Consequence of organizational gender stratification for organizational performance

3. REQUISITE KNOWLEDGE AND SKILLS FOR PEOPLE ANALYTICS

The effective application of people analytics in organizational settings requires a set of knowledge and skills. In particular, it requires knowledge and skills in two broad categories present in the term *people analytics*. With respect to people, it requires knowledge of theories and practices and skills in implementing processes pertaining to human resources management and organizational behavior. With respect to analytics, it requires knowledge of and skills in statistics, mathematics, and data science. We focus on describing the typical stages of analytical work.

Most analytical work involves four stages: data wrangling, data visualization, data modeling, and data communication (Wickham & Grolemund, 2017). Data wrangling consists of the process of importing, tidying, and transforming data to prepare it for visualization, modeling, and communication. Data visualization consists of creating effective visual representations of data for building intuition, describing data, and highlighting modeling results. Data modeling consists of using formal mathematical and statistical models and algorithms to describe variable and unit relations and predict outcomes of interest. Data communication consists of reporting findings to stakeholders. Each of these stages comes with its own set of knowledge and skills.

To perform the tasks in the four analytical work stages, human resources professionals need to become familiar with one or more computer software useful for analytical work such as Numbers, Excel, Tableau, Power BI, Python, and R. Programs like Numbers and Excel help with basic data descriptions, analyses, and visualizations. Programs like Tableau and Power BI facilitate the familiarization with data via accessibility to quick visualizations and dashboards. Programs like Python and R help perform advanced data wrangling, modeling, visualization, and communication. While each program comes with its advantages and disadvantages, general-purpose programs like Python and R can take analytical work the furthest. Thus, we think strong familiarity with these types of programs proves most valuable, and, therefore, we encourage their use in people analytics education.

Data wrangling requires familiarity with importing, tidying, and transforming data (see Braun, Kuljanin, & DeShon, 2018). When it comes to importing data, human resources professionals need to become familiar with importing data from relational and graph databases (e.g., PostgreSQL, Neo4j), Application Programming Interfaces (e.g., Twitter API), websites (e.g., web scraping pertinent reports relevant to an organization), generic data files types (e.g., tab and comma separated values files), program specific data files (e.g., statistical software), and data files types convenient for transmission of data (e.g., Extensible Markup Language or JavaScript Object Notation data files). Tidying data involves becoming familiar with how to organize data to generate visualizations or models. In particular, this means becoming familiar with how to pivot data tables from wide and long formats as needed, separating and uniting variables, handling missing

values, and joining multiple data tables. Transforming data involves becoming familiar with calculating new variables from existing variables, aggregating units for computations on variables, creating sub data tables, and calculating data summaries across units or groups of units. Knowledge and skills in these areas prepare human resources professionals for data visualization and data modeling.

Data visualization requires familiarity with how to visualize data to better understand data and highlight insights from analytical work. Understanding data involves considering what the data reveal about the relationships between variables or the standing of units (e.g., employees) under study. Visualizations of data can help understand missing data patterns, distributions and covariation of variables, and the status of groups of units (e.g., units or teams in an organization). Similarly, data visualization helps an analyst prepare for and interpret results of data modeling work. In particular, data visualizations may point to particular variable relationships to investigate or particular groups of units similar on a set of measurements. When it comes to evaluating data modeling work, data visualizations help check model assumptions and predictive performance. Finally, data visualization prepares analysts to communicate their work.

Data modeling requires familiarity with mathematical and statistical models and algorithms to help make sense of data. In particular, this means becoming familiar with statistical distributions for different types of data (e.g., count, categorical, or continuous data), the generalized linear model (e.g., ordinary least-squares and logistic regression), dimensionality reduction (e.g., principal components analysis, t-distributed stochastic neighborhood embedding), unsupervised learning (e.g., cluster analysis), supervised learning (e.g., random forests, neural networks), network analysis (e.g., network indices, related events models), times series analysis (e.g., vector autoregressive models), and natural language processing (e.g., sentiment analysis), among other topics. Human resources professionals do not need to possess a complete mathematical and statistical understanding of various models and algorithms, but they do need to become familiar with applying them and interpreting their results. Generally speaking, the more mathematical and statistical methods human resources professionals know, the more types of organizational problems and questions they can address.

Data communication requires explaining data-based insights to stakeholders. For human resources professionals, this involves knowing how to effectively generate reports and presentations that describe analytical work combined with pertinent visualizations and tabulations, create dashboards that help stakeholders track pertinent processes and outcomes, and disseminate insights to particular groups of stakeholders (e.g., executives, middle managers, employees). Importantly, this implies human resources professionals need data story-telling skills. Stories move people to action. For human resources professionals, effective data communication proves vital for implementing evidence-based human resources management policies and guiding organizational strategic objectives.

4. POTENTIAL OF PEOPLE ANALYTICS FOR ORGANIZATIONS AND BEYOND

People analytics helps organizational members more effectively accomplish collective, organizational strategic objectives by helping them understand their most import resource, themselves. Indeed, people make organizations, and it seems obvious that organizational members would want to better understand their own work processes and activities. Yet, organizational members often neglect human resources management and prioritize the management of other resources (e.g., physical assets). Indeed, many organizational members view human resources management as an administrative function that mostly comes into action for compliance (Cappelli, 2015). They view it as a function which generally impedes the accomplishment of organizational objectives. Empirical data contradicts such sentiments (Yoshimoto & Frauenheim, 2018). Organizations that invest in people analytics tend to benefit in the long-term. People analytics provides an opportunity for organizations to accomplish their strategic objectives by advancing their human resources management.

We conclude with a thought that looks beyond business organizations. We described two examples of how people analytics can improve organizational life. We note the observation that organizations compose modern societies. Our two examples, in a general sense, reflect the kinds of collaborative and integrative challenges societies must solve. As an example, no single nation can solve climate change on their own. Solving climate change will require global cooperation where the best ideas come to the forefront (India Today Conclave 2018). This means that we want the very best individuals to rise to governmental decision-making positions (e.g., prime ministers, cabinet members, presidents, parliaments). In order to do so, societies need to address issues pertaining to social biases that prevent some of the best individuals (e.g., women) rising to top of organizations (including governments). Furthermore, nations, as a collective, will need to develop collaborative patterns to overcome pitfalls like competing to optimize their own standing to the detriment of the collective. It seems evident that people analytics holds insights beyond business

organizations. We hope business and governmental organizations apply insights from people analytics to the benefit of the collective.

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GAMIFIED ENGLISH LANGUAGE LEARNING AND TEACHING IN A UNIVERSITY CONTEXT

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Abstract: *The paper presents the authors' experience with employing Mentimeter, Kahoot! and Socrative, mobile applications with gamification elements, for improving students' learning experience and enhancing their engagement and motivation in two undergraduate English language courses. The main aim of the paper is to highlight the potential of these gamification tools and the benefits that they bring to mobile-assisted foreign language teaching in a university context. After briefly presenting the concepts of mobile-assisted language learning (MALL) and gamification in educational concepts, and providing a brief overview of gamification software used with relative frequency in foreign language teaching and learning, the authors focus on the three applications in question, describe the characteristics and the context of their use, and the benefits both the teachers and the students gained from employing them. The paper closes with indications of further research regarding the gamification concept in university language learning contexts, as well as the employment of even more gamification strategies and tools in future work.*

Keywords*: gamification, mobile-assisted language learning, Mentimeter, Kahoot!, Socrative*

1. INTRODUCTION

ICT has become ubiquitous in all aspects of life, including education. Foreign language learning and teaching are not an exception to this trend. In literature on applied linguistics and second language acquisition (SLA), several terms refer to language learning integrated with, or enabled by the use of technology, the most common ones being Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL), while newer ones include Technology Enhanced Language Learning (TELL), Network Based Language Teaching (NBLT), Web-Based Language Learning (WBLL), Internet-Based Language Teaching (IBLT), etc.

The application of technology in foreign language learning and teaching is not a novelty. The first language laboratories with audio and video tapes were introduced as far as in 1950s, and followed with film, radio, television and interactive video in language classrooms in the 1980s. The most radical move away from traditional approaches to language teaching and learning happened in the early 21st century, when modern technological applications and tools, mobile communications technologies, virtual learning environments (VLEs), learning management systems (LMSs), social networks, multimedia, intelligent tutoring systems, automated speech recognition (ASR), etc. started shaping the way foreign languages are learnt and taught. Today, computers are no longer seen as an add-on, but as inherent to language learning. The new technological innovations brought many benefits to foreign language instruction. According to Kannan and Munday (2018, p. 13-15), new technologies have allowed for language teaching and learning to be adaptable, cooperative, personalized and learner-centered, thus enabling learners to be more autonomous and motivated. The instructor-learner relationship has radically changed, since learners are now more empowered to be autonomous in their learning. The rise of the Web 2.0 and networked learning (NL) made it possible for learners to connect globally and not to limit their language learning to classroom settings only.

Mobile communications technology innovations provide exciting opportunities for improving teaching and learning experience. Because of the versatility and portability of mobile devices such as smartphones and tablets, easy Internet access and access to information and multimedia files (Nihat Sad et al., 2020, p. 2), they make learning unrestricted by time and place, possible both in formal and in informal settings, more flexible, personalized and collaborative (Wang et al., 2009, p. 674). MALL does not only refer to the use of mobile applications specifically designed for individual language learning (e.g. mobile app Duolingo), but also various other resources for in-class, distance and blended language learning, often not originally designed

for language instruction. Examples include social media tools (Facebook Groups, Twitter and Instagram), YouTube, visual dictionaries, digital games or apps and tools based on gamification, etc.

Faced with the challenge of engaging and motivating Generation Z to take active part in learning, since the traditional teaching methods seem inadequate for satisfying the needs and expectations, the authors have employed several gamification tools in their classroom. Gamification is believed to be one of the "most valuable methods of active learning", since it "offers the opportunity to combine content, teaching, digital literacy and 21st century learning skills" (Kingsley & Grabner-Hagen, 2015; Silva 2018, p. 16). Bearing this in mind, the aim of the paper is to introduce readers to the benefits of employing gamification in education, especially the potential of gamification tools in foreign language classroom by highlighting characteristics of these tools and sharing the experience of their application in mobile-assisted foreign language teaching in a university context.

2. GAMIFICATION CONCEPT

The term gamification was first used in 2003 by Nick Pelling, a game designer, to refer to the "implementation of game features into companies' products and services" with the purpose of attracting new customers (Fuchs et al.2014, p. 8). The most general definition of gamification is that it represents "the use of game design elements in non-game contexts" (Deterding et al., 2011, p. 2425). The main objectives of gamification are to motivate users and enhance their learning experience (Fitz-Walter et al., 2011, p.138) and problem-solving skills (de Sousa Borges et al., 2014, p. 216), to blur the boundaries between informal and formal learning (Lee & Hammer, 2011, p. 146), etc. Gamified situations reflect any other game: for example, in gamified situations, a player is faced with a task and is awarded a number of points for accomplishing the task; the score of each player is recorded on a leaderboard; the rating is shown for each player, which enables the player to measure their performance against other players. At the end of each level, the player is presented with a medal or other reward, which contributes to the player's sense of achievement, fulfillment and satisfaction, and the increase in motivation (Silva 2018, p. 238).

Gamification strategies and techniques are today increasingly used in diverse contexts, especially in business, marketing, corporate management and consultancy sectors (Fuchs et al., 2014, p. 8, Dicheva et al., 2015, p. 2), ecology and wellness (Dicheva et al., 2015, p. 2), and principally refers to using systems of rewards to attract and keep customers (Zichermann & Cunningham, 2011; Silva et al. 2018, p. 239). According to Jane McGonigal, a famous game designer, gamification can even be used to "approach social and political issues" (Fuchs, 2014, p. 9). The popularity of the gamification concept is proven by the number of publications, conferences such as the annual Gamification Summit held in San Francisco, series of TED talks and publications (Fuchs, 2014, p. 9), etc.

2.1. Gamification in Education

While gamification is commonly used in the business context, its application in education is still making its appearance (Dicheva et al. 2015, p. 1). Even though the potential of purposeful use of certain game properties has only recently been recognized by modern theories of learning, some authors observe that game and gamification have been present in teaching methodologies for a long time: the formal systems of education have always been based on "rewards and punishments, on merit and recognition" (da Silva et al., 2019, p. 11-12).

In the context of education, two similar concepts are being used: Game-Based Learning (GBL), the use of digital games as learning tools, and the concept of Gamification (defined above). While game-based learning, which implies the creation of instructional games, is difficult, expensive, time consuming (Kapp, 2012), and needs to be appropriately integrated with other methods, the use of gamification for educational purposes, i.e. game thinking and game elements, has great potential for improving students' learning experience, enhancing their motivation and engagement and encouraging the development of problem solving skills, skills of communication and collaboration among peers and between students and instructors (Dicheva et al., 2015, p. 1). According to Dicheva (2015, p. 3) most research papers dealing with gamification in the educational context present their application in blended learning courses at higher education institutions or in professional training.

Literature notes a diversity of elements that make up a game. A generally accepted classification of game elements, however, is missing (Dicheva et al., 2015, p. 3). According to Rego (2015), game elements especially important for the educational context are: goals, mechanics, aesthetics, game thinking, collaboration, reward and competition, feedback, progression in levels, and storytelling. The game mechanics are the game rules, i.e. the plan of points and rewards to be won, obstacles to be overcome, etc. The aesthetics of a game, i.e. appropriate visuals, attention to detail, colors, consistency, etc., greatly influence the overall game experience and consequently the participant's engagement. Game thinking,

according to Werbach and Hunter (2012) refers to the ability of instructors to identify opportunities for using gamification resources in order to motivate and engage their students. Collaboration, i.e. pair and groupwork, represents the exchange of experience with the peers; this increases commitment and promotes collective knowledge building (Rego, 2015, p. 6). Rewards in games (scores, rankings, leaderboards, badges etc.) encourage competition and increase learners' motivation to continue with the game. The rankings enable learners to monitor their own performance and thus promote their metacognitive skills (Rego 2015, p. 6). Games also offer constant feedback to their players, showing the players both the degree of success or error (informational feedback), and guidelines about the continuation of the game (educational feedback). During a game, players progress in levels for three reasons (Kapp, 2012; Rego 2015, p. 7): to help develop the game narrative and sustain player engagement, thus preventing the game from becoming boring and tiring; to strengthen and develop skills gained throughout different levels of the game, and to motivate players by providing them with small victories at the end of each level. Finally, the storytelling element of games refers to making the game more relevant for the student's context by creating a narrative, a story (with characters, stages, events, tension, solution, etc.) that will activate the player's imagination (Rego, 2015, p. 7).

A teacher creates a gamification strategy by utilizing certain game elements, such as, for example, the game mechanics, levels, or feedback (Lencastre, Bento, & Magalhães, 2016; Silva 2018, p. 15) and applying them to an activity, without linking the activity in question to any particular game. For learning to take place and be meaningful, challenging and engaging, introducing game elements and gamification strategies to the teaching process is not enough. The games' objectives need to be aligned with learning objectives. Gamification itself does not guarantee that learning will take place; the purpose of using gamification strategies is only to create the external conditions for learning.

3. GAMIFICATION TOOLS AND STRATEGIES IN FOREIGN LANGUAGE LEARNING AND TEACHING

Gamification tools and strategies are common in mobile applications intended for self-study of foreign languages. One of the most popular language learning apps, Duolingo, for example, successfully combines gamification strategies and traditional language teaching methods of translation and grammar drills in 28 languages. This freely available application contains several gamification elements (Rego 2015, p. 8-9): game mechanics (clear rules of the game), aesthetics (attractive and intuitive visual resources), immediate feedback after each exercise, and levels of progress (to pass one level, the learner has to submit all the exercises) The gamification elements not used in this app are lack of context (the element of storytelling) and collaboration among peers.

The use of gamification strategies in a traditional or a blended foreign language classroom has not been studied extensively, since its potential has been discovered only recently. Several authors report on the development of gamification tools specifically designed for the educational contexts (Landers & Callan, 2011; Hakulinen & Auvinen, 2014; Todor & Pitica, 2013).

The world wide web offers many possibilities for gamified teaching and learning experience. Online learning websites such as Quizlet.com can help users create their vocabulary word lists and use them collaboratively both in-class, at a distance or during self-study. After a user generates a database by entering certain words and their meanings, he or she can apply gamified techniques such as Flash Cards, Speller, Space Race and Scatter to learn them. VisuWords.com is a modern online visual dictionary and thesaurus and visualization tool that uses Princeton University's WordNet, an open source database, and helps students and teachers create visual representations of semantic relationships between words (DeHart 2016, p. 99), thus encouraging vocabulary acquisition. Even some technological tools and educational platforms, that were not originally developed for gamification, can be adjusted for this purpose. For example, Moodle learning management system has integration mechanism that enables software for supporting gamification to be employed as plugins or extensions, so that the teacher and learners engage in gamified activities (examples shown in Pirker, Riffnaller-Schiefer, & Gütl, 2014). LMS Moodle, however, does contain the game element of reward and competition, since students are ranked according to their achievement (score).

3.1 *Mentimeter*, *Kahoot!* and *Socrative* for Language Learning Purposes

Other examples of software convenient for gamifying the learning experience in a language classroom include *Mentimeter*, *Kahoot!* and *Socrative* (https://www.*Mentimeter*.com; https://kahoot.com; https://*Socrative*.com). These are online applications that enable students to participate in class activities by using their mobile phones with Internet connection to learn or revise a variety of subject matters (i.e. they are not intended for language learning only). In all three abovementioned online apps, the teacher creates a quiz before the actual class. To start the quiz in the classroom, a projection screen and good Internet connection are mandatory. After the teacher has selected the quiz to be played, students visit the application's website

and enter the quiz's PIN and their names or nicknames to begin. The teacher shows the first question on the projection screen and the students use their phones to answer. The correct answer is shown after everybody has answered or after the time has expired. Upon the completion of the quiz, the overall feedback is shown on the screen signifying the end of the game. The fundamental difference between these apps is the audience they are originally aimed at. While *Mentimeter* is essentially designed for engaging different types of audience, *Kahoot!* and *Socrative* are aimed for students learning different subjects, including languages. However, *Mentimeter* has proven to be an interesting language learning and teaching tool as well.

The main reasons behind the success of these software tools are the elements of game that they possess. Indeed, "of late, Internet-accessible digital tools have made gaming a mobile learning tool that can accommodate many participants in a single game, via a single platform" (Debbita et al., 2018, p. 569). Although the gaming element of these tools can potentially be misleading, the benefits of using them in the classroom must not be overlooked simply because they are game-based. In fact, it is placed as a challenge upon instructors to create a didactic model to incorporate these tools (Kannan & Munday, 2018, p. 18).

Mentimeter, *Kahoot!* and *Socrative* contain some of the eight game elements shared by most gamified applications, as determined by Denden et al. (2017, p. 1400). In some of these apps, Avatars are assigned to each participant, points are given for each correct answer and badges after successful quiz completion, leaderboard options are chosen for creating a competitive environment, progress bar is shown while playing a quiz, feedback is given and immediate engagement is allowed. Several game elements, however, are missing from these applications: the context, the storytelling element, and collaboration between peers (Rego, 2015, p. 7).

Additionally, these applications offer a free beginner account with basic features for generating quizzes. However, if a teacher needs any advanced features (which differ from app to app, but usually include larger number of participants and more question and quiz report options), an annual plan needs to be purchased. Furthermore, mobile phones with good Internet connection are a prerequisite for playing the quiz. Although students generally love using these apps, those who like to actively participate in traditional class activities and converse freely with the teacher might be frustrated by them (Moorhouse & Kohnke, 2020, p. 6). The team mode option available on *Kahoot!* and *Socrative* is not sufficient to account for the lack of communication. On the other hand, it is a perfect opportunity for students who are unconfident about their knowledge to fully participate in class activities.

Despite the positive and negative sides of these applications, they are easy to use, engaging and have proven to be excellent assets to traditional language teaching methods. Some other similarities and differences in characteristics that these apps offer are listed in the Table 1 below.

Table 1: Characteristics of apps

	Mentimeter	***Kahoot!***	***Socrative***
Various question types	+	-	+
Unlimited number of questions per quiz	-	+	+
Time limit on answers	+	+	-
Unlimited number of participants	+	-	-
Marked correct answer	+	+	+
Easily accessible	+	-	+
Student pace	-	-	+
Leaderboard	+	+	-
Easily exportable reports	-	+	+
Homework quiz	-	+	-
Team mode	-	+	+
Feedback	-	-	+
Extremely easy to play	+	-	+

4. GAMIFICATION IN HIGHER EDUCATION ENGLISH LANGUAGE CLASS: OUR EXPERIENCE

The current generation of university students belongs to Generation Z. This generation, in terms of their use of digital technologies in everyday life consists of digital innates, i.e. digitally proficient young people, for whom mobile communications technology represents an integral part of life. Generation Z represents, on the other hand, a challenge for their teachers and instructors since its members tend to have an attention deficit when confronted with classes that use the expository method of teaching. Therefore, traditional teaching

methodology has become entirely inappropriate for Generation Z students, who are prone to using their mobile phones whenever they feel even slightly bored. In connection to this, at the authors' teaching context, students attend large mixed-ability classes, which makes student engagement and motivation even more challenging for teachers. Taking all the above into consideration, in addition to the affection of new generations towards video games, the use of mobile applications that employ gamification strategies and exploit competition, i.e. *Mentimeter*, *Kahoot!* and *Socrative*, seemed to be a good choice for engaging students in large mixed-ability language classes.

The authors of this paper teach, inter alia, two English language courses to the first- and second-year undergraduate students at a business - oriented university. Both courses are two-semester long and focus on English for Specific Purposes (ESP), i.e. business and ICT, the two major fields of study at the faculty. The first course, ESP 1, is a general introduction into English for business and ICT, combined with grammar revision corresponding to B2 level (according to the Common European Framework of Reference for Languages (CEFR) - https://www.coe.int/en/web/common-european-framework-reference-languages). The second-year course, ESP 2, focuses primarily on English technical vocabulary and terminology extension for the fields of management and ICT. While teaching the two courses, three major issues affecting student engagement and motivation have been detected: attending large mixed-ability classes, traditional expository method of teaching with the teacher in the spotlight and drill-based and inefficient exercises that do not cater for students' individual learning styles.

Gamification tools *Kahoot!*, *Mentimeter* and *Socrative* were recognized as a means to try to solve these issues. Another name for these tools is Student Response Systems (SRS), i.e. "digital alternatives to response cards" (Moorhouse & Kohnke, 2020, p. 2). We found their application in revising grammar and vocabulary units, in the classroom, after the formal teaching through expository method has taken place. Whether we use them for revising grammar or vocabulary depends on the type of exercise we want to create, matched with question type options available in each app. Namely, *Mentimeter* and *Socrative* have open ended questions that we found suitable for the grammatical revision of tenses and conditional sentences (FIGURE 1), and vocabulary revision of word formation.

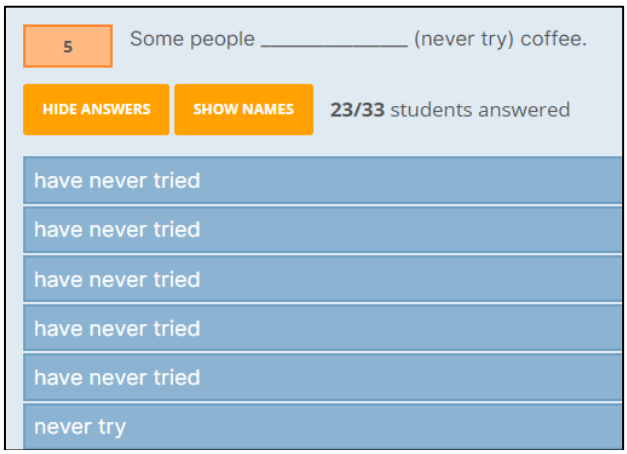

Figure 1: Open ended question (*Socrative*)

All three applications offer multiple choice questions that are appropriate for revising articles, prepositions and confusable words (FIGURE 2), but also for checking the understanding of technical concepts and definitions. An even better solution for revising definitions is true or false question type offered in *Kahoot!*. Having chosen the unit of revision, we create a quiz that consists of maximum ten questions regarding the most important aspects of the lesson. The quiz creation process is quite simple, enjoyable and not the least frustrating. The quiz is always presented towards the end of the lesson, because of its game and competition elements that make students enthusiastic and difficult to manage. Teacher pace option, when teacher is in charge of the game tempo, is repeatedly used. However, whenever student autonomy should be brought forward, student pace in Socrative app is used, when each student dictates their own game tempo. Time restriction comes in handy when running out of time and having to wrap up quickly. To ensure student engagement during the entire quiz, we add a leaderboard in Mentimeter, or assign points to each question in Kahoot!. This leads to students being more careful when submitting their answers. Sometimes two apps are implemented during one class, especially in cases when one app cannot provide for all question types needed. This turns out well if some time is allowed between the use of the two apps; if used successively, students tend to express frustration for having to enter codes and join quizzes two times, even though they

maintain interest in the quiz itself. Another cause of frustration is poor Internet connection that further causes the interruption of the game and impossibility of returning to the game when the connection is re-established.

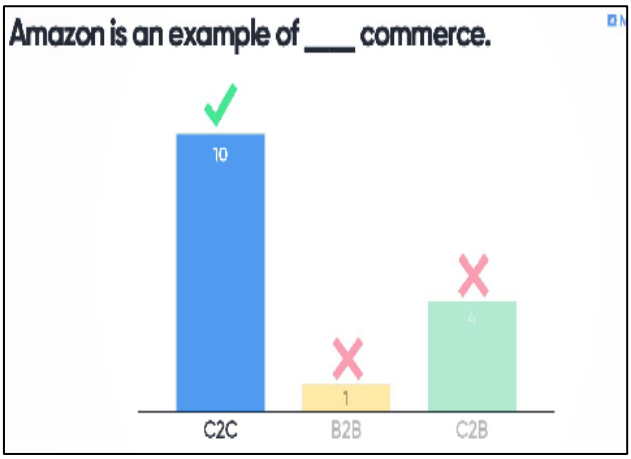

Figure 2: multiple choice question (*Mentimeter*)

Informal discussions with students revealed that the most favorite application is *Mentimeter,* predominantly because of the leaderboard that shows the winner of the game i.e. the player who submitted most correct answers in the shortest time. Moreover, it is not entirely game-like and puerile in the sense of *Kahoot!*, nor completely formal and educational like *Socrative*. As another advantage in favor of *Mentimeter* they listed the ease of joining and playing the quiz, which is not the case with the other two apps. *Socrative* requires three-step login that students find confusing and unnecessary, so they reported it to be their least favorite app. On the other hand, they deem *Kahoot!* more likeable than *Socrative*, but feel puzzled when playing it for the first time due to a bit unusual way of answering questions. Every answer has a symbol in front of it (triangle, circle, square or rhombus). Namely, to answer a question, players need to look at the projection screen to see the question and the available answers, and then to look back at their phones and choose the symbol next to the answer they believe to be correct.

From teachers' perspective, one final advantage of *Mentimeter* is the feeling of satisfaction gained from relaxed, pleasant and, above all, learning atmosphere that follows from the use of the app. Two main disadvantages are the limited number of questions (six) per quiz and the lack of options for exporting quiz reports in the free version of this app. In case of *Kahoot!*, the positive sides include the unlimited number of questions and the homework quiz option, but the negative sides often prevail: the number of players per game is restricted to 50 and the free version offers only two possible question types – multiple choice and true / false. Finally, although being the most academic among the presented applications, *Socrative* is the least engaging. Students often complain about not being able to see either the correct answer or the feedback about the wrong answer, which is available only in this app. With reference to this, the authors are under the impression that this application is an online adaptation of traditional assessment tests, since it offers the possibility of uploading your test / set of questions and downloading it to distribute to students on paper.

5. DISCUSSION AND CONCLUSION

This paper shares the authors' experience with the use of mobile *apps Mentimeter, Socrative and Kahoot!* in two undergraduate English language courses during the winter semester of academic year 2019/20, introduced with the intention of diversifying the teaching methodology, engaging and motivating students, enabling them to participate more despite attending large mixed ability classes, and eventually contributing to better learning and knowledge gained.

Our experience shows that student engagement and motivation in learning foreign languages in a university context can be enhanced by employing gamification strategies in mobile learning. A prerequisite to employing these strategies, apart from good internet connection, are digital literacy and a smartphone that can support the applications in question. Since the classrooms in the higher educational institution where the authors are employed are fully equipped with computers, projection screens and good Internet connection, the usage of these applications in their everyday teaching is significantly facilitated.

Encouraged by the positive feedback and the overall satisfaction regarding the use of the tools, the intention for future work is to test the influence of these tools on students' performance, for example, in mid-term and

final exams, by comparing the students' achievements before (through a pre-test) and after (through a post-test) the application of these gamification tools. Thus, we would learn about the effectiveness of these apps on students' acquisition of learning materials. The main idea is to choose two groups of second-year students, one comprising IT and the other Management students. They would be given a pre-test to check their knowledge before attending the course. This test would also serve as a means of comparing students' pre-course with their after-course knowledge. Upon course completion, students would be given the post-test to check how much they have acquired, which would be a direct indicator of the appropriateness of using gamification tools for teaching a foreign language. Since gamification appeals to Generation Z and show great potential for English language learning, another intention of the authors is to employ other tools and strategies more often for blended learning. Tools like Quizlet and VisuWords were recommended to students for self-study, but they are also appropriate for in-class use.

Despite the major advantages that gamification tools and strategies offer, the exclusive usage of these tools in classrooms is not suggested: rather, we suggest their moderate usage as a support to and in combination with face-to-face, traditional learning. As indicated by Kannan and Munday (2018, p. 24-5), "human teachers and social interactions beyond the digital environment are still essential for mastering a second language."

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STUDENTS PERCEPTION TOWARDS ONLINE LEARNING IN THE TIME OF COVID-19: CASE OF SERBIA

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Abstract: *Universities all over the world wanted to react quickly to COVID-19 pandemic situation in order to provide students with continuity in learning. They have switched to online mode, but without sufficient preparation in most cases. The research was conducted in order to assess students' readiness for online learning during COVID-19 crisis by assessing their prior experience in use of digital platforms, their attitudes toward e-learning and their motivation to learn. 547 students from University of Belgrade, Faculty of Organizational Sciences (Serbia) filled the questionnaire. Research results revealed that our students had prior experience in using digital platforms, especially for learning, that they expressed positive attitudes towards online learning and that they were moderately motivated, mostly intrinsically. Although the situation was specific, it could be concluded that students' readiness for online learning was on satisfactory level and that that made a good basis for them to be successful in learning process.*

Keywords*: online learning, emergency remote teaching, COVID-19, higher education, e-readiness*

1. INTRODUCTION

As a result of coronavirus (COVID-19) pandemic most of the counties worldwide decided to close Universities in order to prevent virus spread. This was a demanding challenge for Higher education institutions to almost instantly switch from face-to-face learning to some form of online learning. Online learning is a growing phenomenon in the higher education context (Fredericksen, 2017) that involves an entirely virtual learning experience provided by institutions where learning occurs using web-based technology without the learner's physical presence on campus (Broadbent, 2017). Lot of questions had to be answered at that moment, mostly regarding student's readiness, teacher's readiness and readiness of the institution to move all their activities online. It was not a case of classical distance education, meaning that the courses were not designed in advance as an online learning courses and students and teachers did not chose to learn/teach online. Students readiness for e-leaning is a broad concept studied in lot of research (Smith et al., 2003; Bernard et al., 2004; Pillay et al., 2007; Yu, 2018; Yeh et al., 2019; Joosten & Cusatis, 2020) but for this specific situation, we perceive that it could refer to their digital competencies in terms of their eligibility to study online, on one hand, and on the other, to their desire to learn in an electronic environment in this specific situation, as the most important ones. The readiness of teachers for online teaching, in addition to the necessary digital skills, also refers to the readiness for additional engagement and adaptation of syllabus and teaching content to the particulars of the new environment. Specifically, in this case, one more important dimension occurs: prioritizing while working from home. And, very important, readiness of the institution, refers to the technical and technological readiness for a fast transition into the online environment.

As the whole world, the Faculty of organizational Sciences had to respond to the new circumstances. All courses were transferred online, at all study levels (undergraduate, master and PhD) in second semester. As we have perceived that it would be very beneficial to learn from this experience, we have conducted this research. The aim was to find out to what extend students were ready to move to online learning and were they satisfied with the outcome. Since, majority of students were at the level of undergraduate studies, we have decided to target them as respondents. Electronic questionnaire was prepared and disseminated.

2. LEARNING IN THE TIME OF COVID-19

On May 24, 2020, UNESCO (2020) reported that there have been 1,198,530,172 affected learners which makes 68,5% of total enrolled learners and 153 countries worldwide where Universities are closed for all levels of learning. It seems that situation is slightly getting better, since the peak was at the beginning of April with 91,3% of total enrolled learners in 195 countries. Different solutions were applied by Universities all over the

world. Some went completely online, with all their teaching and non-teaching activities, while some chose the option of so-called blended learning, a combination of traditional and online learning.

Hodges et al. (2020) interestingly emphasize, with which the authors of this paper agree, is that scientists and researchers in the field of online learning, educational technology and instructional design, have identified clear differences between terms: distance learning, distributed learning, blended learning, online learning, mobile learning and that it would not be precise to include this teaching in the time of ČOVID-19 in one of the mentioned categories, and their suggestion is to use the term “emergency remote teaching”. The main idea goes into favor that quality online education is well planned and carefully designed process and that, in most cases, learning in the time of COVID-19 was a shift from the in-class learning to online. Emergency remote teaching refers to a temporary solution, as an alternative way of conducting classes, fully remote, in order to be able to provide a temporary approach, and to return to the original way of learning after the emergency.

Research results show that in countries that are considered in the category of developed economies (Australia, Germany, Italy, Republic of Ireland, United Kingdom and United States of America) all the countries except USA have reported campus closures and moved to online teaching. The situation is significantly different in developing economies considered (Brazil, China, Chile, Egypt, Hong Kong, India, Indonesia, Jordan, Malaysia, Nigeria, Republic of Korea, Singapore, South Africa and United Arab Emirates) where most of them reported campus closures, but just three of them reported complete shift to online learning (Crawford et al., 2020).

At the beginning of March Serbia was affected as well. Based on the decision of the Government of the Republic of Serbia on declaring an emergency state caused by the COVID-19 virus situation, the Faculty of Organizational Sciences (University of Belgrade) makes a decision to suspend all its activities and announces closure starting from March 15. Consequently, very quickly, Faculty transfers all its activities online. The situation required a quick reaction, there was not enough time for detailed and comprehensive preparation as we would have wanted. From March 23, 2020, the teaching process through the Microsoft Teams platform began. The decision was made for this platform because it was necessary to react quickly, and the system with all students in it has already been implemented to some extent at the Faculty level. Classes are performed in the form of online (live) lectures and exercises. Teachers taught live and prepared and provided students with many additional resources that they could use for learning, such as quizzes, presentations, various documents, a joint notebook.

3. THE IMPORTANCE OF E-LEARNING READINESS IN THE TIME OF COVID-19

A it was stated previously, when readiness for e-learning is in question, it should be considered from different perspectives, especially from the perspective of students, teachers and institutions.

Insufficient research is done in a relation to how the crises caused by COVID-19 influenced educational systems all over the world (Toquero, 2020; Bao,2020) There are opposite results over the learning experience. For example, Alpiro (2020) investigated students’ readiness for e-learning in Philippines (less economically developed country) in order to be able to prepare to the possible shift to fully online learning. The results show that most of the respondents (out of 880) answered ‘No’ in all e-learning readiness items and that they are not ready for e-learning. Consequently, Toquero (2020) argued that most of the teachers were not ready for online learning, as well. In Philippines after three days from moving to online learning, lot of students and teachers appealed against online education and Commission of Higher Education suspended all activities. Bao (2020) presented a case study of Peking University in which she suggested six instructional strategies to ensure the effectiveness of online learning and smooth transition from traditional, face-to-face, in-class learning. The idea is to prevent students’ negative attitudes towards e-learning and strengthen their concentrations and engagement in online learning environment. Harsha and Bai (2020) states that students in India have embraced online learning and that they are really satisfied with the efforts that Higher Education Institutions (HEIs) are making in order to keep education going and curriculum on track.

Pillay et al. (2007) argued that students readiness for e-learning can be tested with four subscales: ‘Technical skills’, ‘Computer self-efficacy’, ‘Learner preferences’ and ‘Attitudes towards computers’. Smith et al. (2003) identified two factors "Comfort with e-learning" and "Self-management of learning" underlying readiness for e-learning. Yu (2018) estimated student online learning readiness through evaluation of social competencies, communication competencies, and technical competencies in online learning. Joosten and Cusatis (2020) examined online learning readiness with six measures: online work skills, social technology familiarity, online learning efficacy, self-directedness, organization skills and socialization. Yeh et al. (2019) investigated how motivational factors and students’ actions during learning are influencing academic outcome in online learning environment.

Special attention must be paid to evaluation of this online learning (emergency remote learning). Hodges at al. (2020) emphasize that in this specific case, it makes no sense to compare online and face-to-face learning, and also it cannot be evaluated as a specifically design online course. So, the student success in relation to learning outcomes should not be traditionally evaluated but their interest, motivation and attitudes as well as their ability to use learning platform could be of extreme importance for their success in learning (Hodges et al., 2020). In this paper we will focus on student readiness for online learning in this emergency remote teaching process, but in the specific time of COVID-19. Students readiness will be assessed according to their experience in online learning using digital platforms, their attitudes towards online learning and their motivation in this time of crises.

4. RESEARCH METHODOLOGY

This research is a part of a larger research on students perception on learning in the time of COVID-19 through three parts: e-readiness (their experience, attitudes and motivation to learn in the time of crises), their satisfaction about course design and teachers delivery and the influence of e-learning on the development on their digital skills. In this paper, the first part of the research that describes the current students` capacity to learn online will be presented.

4.1. Research method

For the purpose of investigating students readiness for online learning in the time of COVID-19 questionnaire was developed. There was tree set of questions: first, regarding their prior experience in use of digital platforms for learning, second, regarding their attitude toward learning platforms and third, investigating their reasons and motivation to learn. Besides, there were a few general questions about their year of birth, gender, year of study and field of study. For the questions where they were asked to assess the level of agreement five degree Likert scale was used (1- completely disagree, 2 - mainly disagree, 3 - Moderately agree, 4- Mainly agree, 5- completely agree).

4.2. Research sample

The questionnaire was prepared using Google forms and it was made available to all students that followed the lectures using MS Teams platform. All students that were following lectures were adequate for our sample, but since it was noticed that a certain number of students did not follow actively, and that the number of students presence decreased from week to week, we have waited with questionnaire dissemination until the last teaching week and then forwarded the questionnaire. We have assumed that the ones who are persistent and eager to learn will last. It was forwarded through the compulsory courses in each year of study, by placing a link to the course page on the Teams platform and the teachers, with an explanation, asked the students to fill it out. Data collection lasted for two teaching weeks.

We have collected answers from 547 students. Most of them were females (68,5%). There are two general field of study at FOS, Information systems and technology (IT) and Management (MN), and the majority was from the IT (61,1%). Looking from the perspective of year of study, it was almost equally distributed: first year 20.5%, second 29.3%, third 27.7% and fourth 22.5%.

5. FINDINGS

The results will be presented trough following parts. In first part students prior experience in use of digital platforms for communication, collaboration and for learning will be presented. Second part will show students attitudes toward learning using different platforms and third will give us some insights regarding their motivation to learn in the time of this specific crises.

5.1. Students experience in using digital platforms

In relation to their previous experience, the results show that most students either rarely or sometimes use some of the platforms for communication, collaboration and/or learning (65,23%), When it comes to how much experience they have had in using different platforms specifically for learning, 33.94% of them have never used it before, while very few of them have done so on a daily basis (1.6%). Majority had some experience. It is interesting that out of those who did have some experience in using some of the platforms, huge majority did use it for learning (Figure 1). When it comes to the experience in using specifically MS Teams platform, the situation is not significantly different, as there are 34.92% who have never used this platform before, while the massive majority had some experience in using it. Of those students who had experience in learning through the MS Teams platform, 52% of them answered that they were mainly satisfied and 27,18% that they were very satisfied, which makes significant part of the sample.

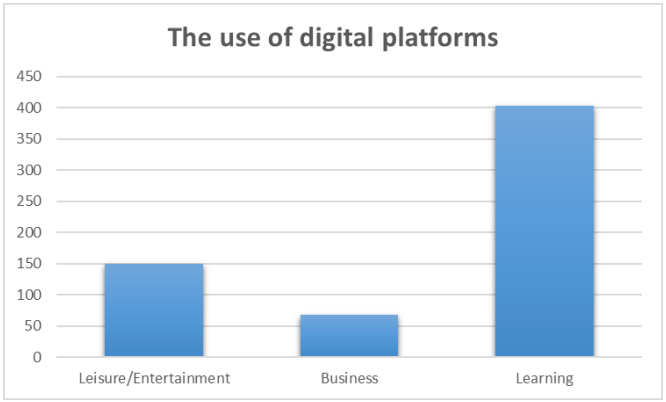

Figure 1: The purpose of using digital platforms

5.2. Students attitudes towards learning with different digital platforms

At the Figure 2, different statements representing students 'attitudes toward learning via digital platforms, are ordered according to the average values. It is shown that majority of students perceive that learning trough digital platforms is more flexible and proper way for collaboration, not only for the current situation. Therefore, it could be concluded that their attitudes toward online learning are mainly positive. Following, it is shown that they see that learning is much easier and has more potential than learning in traditional way (in-class), and above all they strongly disagreed that it is could be considered as necessary evil. With the claim that learning with digital platforms is a necessary evil, 44.7% responded completely disagreed and 26.64% mainly disagreed, which makes up the significant majority of the observed sample. This could be explained as they are probably aware that the application of technology in education is inevitable, that it brings change, and that the question is no longer whether IT will be applied to learning, but to what extent. Will it be about computer-based learning or a complete transition to online learning, so even the translon to completely online in this situation was not so unexpected. Furthermore, it may be interesting that students who are of the opinion that nothing can replace classical teaching and learning, most of the respondents have answered that they mainly (24.81%) or completely (26.64%) agree, so for them it is good that this was just the way that faculty coped with this specific situation and they will go back to traditional in-class teaching and learning as soon as possible.

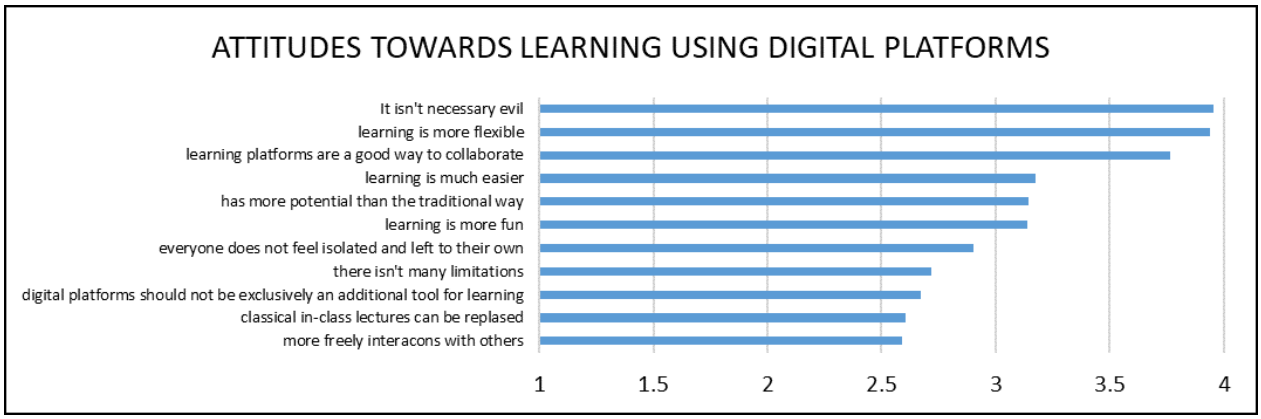

Figure 2: Students attitudes towards learning using different digital platforms

5.3. Students motivation for learning in the time of COVID-19

In general, it is shown that student's motivation for learning during the time of COVID-19 was at the level M=2.95 (at the scale 1 to 5; SD=1,27). It seems that most important motive for them was learning itself, in terms of that they have perceived continuation of their studies (37% mainly agree and 57,66% totally agree). and learning in any circumstances as most important ones (Figure 3). Looking at the obtained results in more detail, it is interesting to investigate which factors more influence the motivation of an individual in this specific situation, extrinsic or intrinsic. The results show that our students were more intrinsically motivated, as it is presented in the Figure 4. It seems that these results should not relate specifically with the crises situation, for example Rovai et al. (2007) showed that students' intrinsic motivation in e-learning courses is greater than intrinsic motivation of in-class students. Indicators of intrinsic motivation for learning is represented here by the items representing the interest in the studies, enjoyment and fining it challenging. On the other side, extrinsic aspects are seen in the statements considering the learning modality being convenient or providing some meaning, comfort and escape from the current situation.

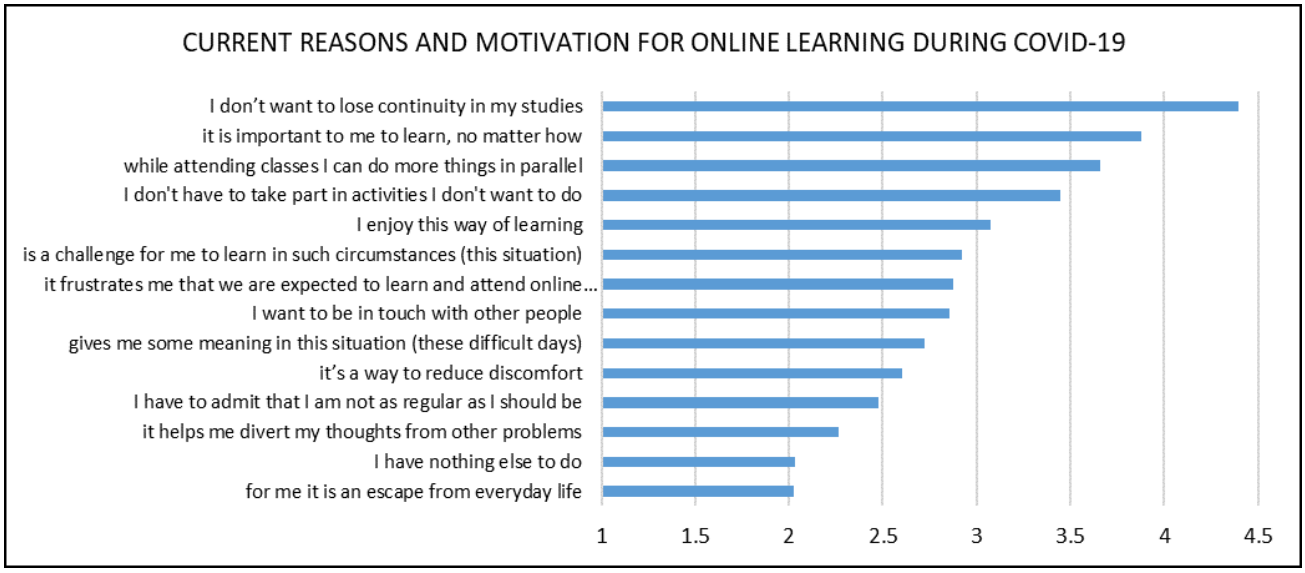

Figure 3: Motivation for online learning during COVID-19

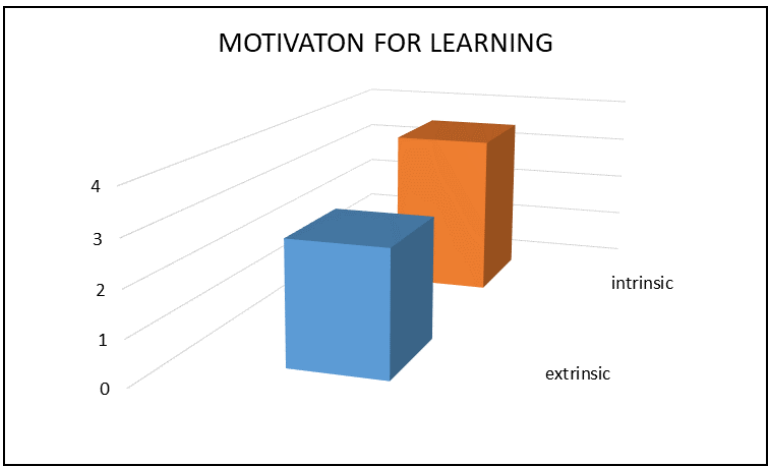

Figure 4: Intrinsic and extrinsic motivation for learning

We have considered reason that could be correlated with learning in this specific situation and could possibly influence their learning motivation with two questions directly: 1. Did they perceive learning as a challenge in those situations and did they felt frustrated about their student obligations as nothing is happening. Interestingly, students' opinions are equally distributed between the ones that perceived that it was a challenge for them to learn in this specific situation and the that could perceive it as an obstacle. Their frustration with what was expected of them when it came to learning during COVID-19 was moderate, 29% of them did not felt frustrated at all.

Additionally, it could be important to comment students answers on questions that were specifically related to online learning, i.e. learning with digital platform – MS Teams. It seems that what mostly motivates them to learn online is that they could do more things simultaneously (M=3,66; SD=1,27), which could raise question about their focus and concentration on learning process. Also, it was highly ranked that they enjoy this way of learning.

6. CONCLUSION

In this research it is shown that although the situation caused by COVID-19 required quick reaction of HEI and almost immediate transfer from traditional in-class learning and teaching to fully online, we could conclude that readiness for online learning of our students was on satisfactory level. This means that they had prior experience in using digital platforms, especially for learning. Importantly their attitudes toward online learning

using digital platform were positive and they were moderately motivated. They were mostly intrinsically motivated, which could be important considering research results from Lin at al. (2003) were they have shown that higher levels of intrinsic motivation are positively related to grades.

Still, it is important to emphasize that in order for the process of online learning to be successful, teacher's readiness and readiness of the institution should be considered as well. For the first time, some teachers had the opportunity to teach in this way. Lin et al. (2003) concluded that teachers training and motivation for the incorporating technologies in the classroom with pedagogical and didactic principles is essential. Additional challenge was working from home. When a person is in situation to leverage between needs of a family (especially kids) and job while working at home it is hard to priorities. This would be interesting to examine further.

And, once again, it should be emphasized that this was not an online learning that was planned and designed in advance. The planned learning process does not involve a simple content reproduction in terms of information transmission, but planning and designing the process in relation to many dimensions in order to be able to support different learning needs. Online learning should be an approach where learning is recognized as social and cognitive process (Hodges et al, 2020).

We could recommend that it would be useful to test the readiness of students for online learning at the beginning of the process and, in relation to the obtained results, try to adapt as much as possible. In case it turns out that with enough previous experience in using digital platforms, the focus should be on additional trainings for its use and general development of their digital skills. For example, among other, Alpiro (2020) concludes that in order to prepare students for online learning they should prepare programs for their digital skills development. Considering their attitudes and motivation for learning we can emphasize that this situation was specific and that maybe something that seem important now would not be in other circumstances. Bao (2020) states that the basic challenge for students during self-isolation is not of a technological nature, and does not relate to their technical skills, but relates to a lack of self-discipline, adequate learning materials and proper learning environment. Additionally, it is important for HEI to make available mental health-related services and to rearrange curriculums to be responsive (Toquero, 2020), in order to be prepared for eventual similar situations.

We perceive that these results should be considered as a specific case in the time of COVID-19 and that we should learn from the experience of countries all over the world and that sharing those experience and research results should be encouraged.

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THE IMPORTANCE OF THE DEVELOPMENT OF ADVANCED SKILLS FOR EMPLOYEES IN THE HOSPITALITY INDUSTRY

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Abstract: *The aim of this paper is to emphasize the importance and significance of possessing and nurturing advanced skills for securing personal professional performance, considering the general value of these skills. In the methodological research, a primary research based on a qualitative approach was carried out, which main theme was the perception of students and employers about advanced skills as relevant employment skills. The aim of this research problem was to establish a solution that will help students to develop relevant soft skills for business hotel and tourism positions at the initial level. Understanding how to prepare graduates to enter the labor market is a concern for human resources directors and managers in various countries, including Serbia. There is considerable potential that the outcome of this research eventually result in an action plan aimed at faculties to better prepare students with soft skills. Students who are well equipped with advanced skills are expected to be promoted communicators, to work more efficiently together, to have more meaningful careers and to be more efficient and competent employees who can contribute to the growth of the organization and economy of a country.*

Keywords*: soft skills, labor market, employment, professional development, hospitality management*

1. HARD SKILLS AND SOFT SKILLS

The contemporary business surroundings is characterized by continuous dynamics, so the organizations more and more tend to recognize the power of human capital as the determinant of competitive advantage compared to competition. The transfer from the industrial economics to the information society and a business oriented economics assumes that many jobs presently performed place accent on integrity, communication and flexibility of the employee within the organization.

Historically seen, academic and technical skills, known as the formal skills, have been the only and decisive skills needed for employment and they have been called ***hard skills*** (James & James, 2004, p. 40). The contemporary working environment, where organizations continuously adjust their size and systematization of the work places to strategies of cost reduction, constant growth and development, as well as contemporary trends, it is indicated that technical skills are no longer sufficient for the employee to retain his/her workplace. Actually, the employers are more and more taking into consideration the personal characteristics, abilities and talents of the individuals during employment, sticking to the generally accepted attitude that the adequate pool of employee skills shall have a positive effect onto the results of the organization`s business. Such pool of personal skills, social and emotional intelligence as well as positive nature gives the advantage and differentiates the person from other individuals who might have the similar level of academic education, technical competences and business experience. Precisely the previously stated skills are defined as the combination of abilities, attitudes, behavior and personal qualities, as well as opinions which individuals use in order to be successful in different situations at work and in life in general (Robles, 2012, p. 454). From the business perspective, ***soft skills*** encompass non-technical skills and competences which are needed to perform work, such as communication skills, interpersonal skills, the skills of teamwork, critical thinking, leadership, negotiation, motivation, managing conflicts and many others, which are necessary on all levels of the organization (Robles, 2012, p. 454). These skills have been identified as crucial, since they stress the action of every individual and become of vital importance for every person in today`s business context. Flexible, adaptive persons with the mixture of strong and advanced skills are globally recognized by business organizations as a constitutive part of their growth process.

Hotel management is one of the most significant service economy branches with a business firstly relying human resources which using their efficiency secure the outstanding delivery of services with the end goals of satisfying clients or guests. Precisely that is where the great importance and need for advanced, soft skills of employees from this industry lays. These skills are of vital importance for productive performance within the hotel industry. The students of hotel management entering the labor market of the 21st century must obtain non-technical soft skills along with the technical and academic competences, i.e. hard skills, in order to adequately respond to the market needs and to secure the personal business success. The complex labor market has experienced reconstruction due to the diversity of business world within the 21st century, whereas organizations keep demanding more and more multitalented individuals who possess high professional standards, even for the work places of beginners` positions (Rivera et al., 2009, p. 354). Although technical skills are a part of many excellent educational programs, the advanced, soft skills need significant integration into the university teaching programs, in order for the pupils and students to get to know the importance of these skills before starting their own business career. Regardless of the expert qualification gained through academic circles and the knowledge and experience within a certain area, today`s employees simply must have a high degree of usage of advanced skills in order to succeed and survive in today competitive era.

The subject of this paper is the analysis of importance of soft skills development, firstly among students, in order to be more suitable for the labor market of the 21st century, but also among employees, in order to identify segments of personal characteristics which could be improved in order to be more efficient in performing business activities.

2. THE IMPORTANCE OF SOFT SKILLS

Hard skills refer to technical skills need for performing tasks or getting the job done, and are acquired through education or training. This type of skills represents the needed but not sufficient condition for employment (James & James, 2004, p. 40). Work places which demand high performance require more than technical knowledge in order to develop the career and efficiently perform work tasks (Glenn, 2003, p. 10). The employees are expected more and more to have orientation and an attitude about work which is beyond what is called performing work tasks.

The development of technology and the appearance of globalization within the business surroundings where the employees from the 21st century function, also dictates new trends while defining the employee competences (Timm, 2005, p. 56). The technology development, globalization and the decrease of organizational hierarchy are the most important factors which have influenced the change of traditional criteria while recruiting and employing (Kilcoyne & Redmann, 2006, p. 66). The digitalization has influenced novelties within the global economy and the needs for adjusting to the new trends and forming demands for the new employee competences (Timm, 2005, p. 56). The employers express concerns more and more regarding the inadequate employee skills and the fact that traditional, hard skills which were needed for the yesterday`s employee for efficiently performing work tasks are not adequate for the today`s employee (Kilcoyne & Redmann, 2006, p. 66). In one research concerning the training priorities performed by highly competitive experts for prequalification and additional trainings of employees carried out by Training Magazine it was stated that the soft skills training was the key challenge in modern business (Hall, 2003, p. 38). The American National Association for Business Education has pointed out that technical competence is simple not enough anymore for today`s employees. Besides, the new generation of employees not only has to be aware that possessing soft skills can improve their careers and private lives, but they also must be ready to use these skills in performing business processes (Robles, 2012, p. 455). The employers who offer the best working conditions seek employees who possess a high level of soft skills (Hemby & Crews, 2005, p.4). Therefore, it is important for the graduates entering the labor market to know what employers are seeking for. They must possess the skills which shall be compatible with skills needed by the employees. The averageness which was a dominant characteristic while employing during the previous period shall no longer be acceptable for engaging workers within highly paid workplaces in today`s business environment (Timm, 2005, p. 56). What is more, without the possession of soft skills which differentiate the individual from the average employees, it can be difficult for him/her to enable oneself a financially stable life. In the past, the employees used to earn the salaries based on their ability to finish their obligations using formal, hard skills, with little or no interaction with others. However, the change of business paradigm of the 21st century has influenced the need to develop and use soft skills (Ganzel, 2001, p. 57). Students which have soft skills can expect to obtain a good job and to advance within their career (Evenson, 1999, p.30).

Employers of the contemporary business surroundings are primarily focused on developing soft skills with their employees. Hard skills have become the assumed set of skills and a precondition for the development of soft skills which have the highest value for the working engagement (Towner, 2002, p.30).

3. THE METHODOLOGY OF THE EMPIRICAL RESEARCH

The empirical research within this paper has been carried out as a primary research based on qualitative approach with the subject concerning the student and employee perception on soft skills which are relevant for employment within hotel management. The aim of researching this issue was to determine the difference in the perception of students and hotel managers about soft skills while employing. The aim was to use the research in order to define the framework solution which shall help students to improve their relevant soft skills for the initial employment within hotel management. The sample encompassed twenty students (ten students from the final years of undergraduate studies and ten students from the final years of graduate studies of tourism and hotel management) as well as ten employees from the hotel sector. The research has been carried out in Serbia, using an open-interview form. The data after the interview have been systematized in order to perform a detailed analysis. The analysis of data has been descriptively shown.

The process of gathering data has been performed by semi-structured individual interviews with respondents. Two separate interview protocols have been used as an instrument for gathering data: one protocol has been devised for students and one for employers. Every instrument included open form questions. The role of the researcher was to identify the connections, to understand the observed and new concepts concerning the problem which is researched during the process of data analysis. The software for qualitative data analysis MAXQDA 2018 (VERBI GmbH) was used to process results and it is recognized to be suitable for this kind of research (Creswell, 2018, p. 26).

4. THE RESEARCH RESULTS ON THE IMPORTANCE OF SOFT SKILLS IN HOTEL MANAGEMENT

The process of qualitative research used several research questions with the aim to determine the perception of students and hotel managers regarding (1) the most important soft skills and (2) the types of soft skills where there is a significant difference in the perception of their importance among employers and students. In order to carry out the qualitative research discussion themes with students and employers have been used which are shown within Table 1. Every theme used a sub-theme which is also demonstrated within Table 1.

Table 1: Themes and sub-themes for determining importance of soft skills by hotel management and students

Theme	Sub-theme
Possession of soft skills	Gaining a job
	Performing a job
Using soft skills	Cooperation with others
	Time management
	Attitude towards work
	Facing challenges
Not-using soft skills	Soft skills at the beginners level
	The nature of the job description
Criteria for determining soft skills	Employment
	The nature of business of hotel industry
The scale of importance of soft skills	Interaction with others
	Avoiding micromanagement
	Problem identification
	The least significant advanced, soft skills
Acquired soft skills	Student perception on communication
	Determining priorities and time management
	Perception of employers on professionalism and working attitudes
	Perception of employers on self-confidence
	Capability of teamwork
Soft skills which are need to be improved	The problem of communication
	Self-confidence
	The challenges of critical thinking
	Capability to negotiate
The efficiency of courses on soft skills	The integration of advanced skills within particular courses
	Seminars for professional development
Recommendations for development of advanced skills at the beginners level	Courses, workshops and seminars for professional development
	The activities of simulation and practical tasks
	Mentorship and/or training programs
	Inclusion of faculties
	Improvement of existing courses

In the process of data analysis, interview transcripts have been read several times in order to completely understand the thoughts of the respondents. The data were codified and based on that themes from the repetitive perspective were identified and formed. The qualitative codified answers have been processed within the software MAXQDA 2018 (VERBI GmbH) in order to determine the rank of importance of different soft skills. Besides, the narrative descriptions have been used to strengthen validity and credibility of the participant perception.

Table 2 shows the rank of importance of 10 different soft skills which have been identified as the most significant with students and hotel managers.

Table 2: The rank of importance of soft skills for hotel managers and students

The rank of importance	Employer perception	Student perception
1	Communication	Communication
2	Self-management	Work ethics
3	Problem solving	Problem solving
4	Interpersonal skills	Teamwork
5	Work ethics	Critical thinking
6	Teamwork	Self-confidence
7	Critical thinking	Interpersonal skills
8	Decision making	Self-management
9	Self-confidence	Decision making
10	Negotiating skills	Negotiating skills

Key: Grades 1–10; 1 is the most important soft skill, while 10 is the least important soft skill

Based on the results presentation within Table 2 it can be observed that the greatest difference in the rank of importance exists with the following soft skills: Work ethics (students ranked it as second, while hotel managers ranked it as fifth), Interpersonal skills (students ranked it as seventh, while hotel managers ranked it as fourth) and Self-management (students ranked it as eighth, while hotel managers ranked it as second).

5. CONCLUSIONS

The results of the qualitative study have shown that both students and hotel managers consider soft skills to be important for employment. The employers consider soft skills to be difficult to estimate during the process of employment. They use a serial type of questions during candidate interviewing in order to determine to which extent the candidates possess soft skills.

Both students and hotel managers have ranked communication skills as the most important soft skill which new employees should possess. In a similar manner, negotiating skills have been ranked both by the students and employers as the least wanted soft skills. There was a difference between the student and employer perception regarding soft skills which students consider to possess, i.e. to have obtained during their academic studies. Actually, while students believed to have mastered the communication skills, employers stated communication, especially the written format, as one of the areas where students are weak and where additional improvement was needed.

Several recommendations have been identified which higher education institutions from hotel management should carry out in order to improve the soft skills of their students. Some of the employers have concluded that particular students have a problem with demonstrating certain soft skills, since their life experiences and cultural backgrounds have limited the possibility of gaining soft skills. Therefore, one of the conclusions is that the level of not-knowing relevant soft skills derives from the socio-economic and educational background of the students. Some of the recommendations of the employers were that soft skills needed to be intensively developed with students, and not in a subtle way.

Hotel managers recommended as necessary the training for professional development. In this case, student should be subjected to formal, compulsory course of training which is adjusted to promoting the development of soft skills. Student should also be assigned with practical tasks and simulations of business activities which reflect the tasks from work places and from the business surroundings. One other recommendation from the hotel managers was to introduce the mentorships or programs of practical training during studies within hotels. In that manner, students would respect the same values taught by teachers, but would also be in the position to gain soft skills which are important for employers.

Students have especially recommended the higher inclusion of faculties as a good strategy which would promote the development of soft skills. Once the students talk with the lecturers on soft skills and once they

start regarding lecturers which model their behavior according to the concept of soft skills, there is tendency that students shall adopt such attitudes and learn by role-model. One other concept that students have stated as a recommendation for solving shortcomings in the development of soft skills is the improvement of existing courses which have the aim to develop soft skills, for example, the course of personal professional career development. Within the teaching subjects from the area of hotel management there is a greater focus needed on practical activities which are directed towards helping students to master their soft skills.

Bearing in mind the stated research results, there is a clear necessity to revise and renew the existing curriculum with a greater emphasize on practical knowledge from the wide area of soft skills. Actually, the education institutions and organizations hold great responsibility to implement as effectively as possible the term soft skills in the education plans and programs, where the positive effects would be multiple: the employees would secure the desired career development, the hotels would finally have quality staff, and institutions and employment services would have available a great number of young, qualified labor force ready to enter the labor market within the area of hotel management.

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PREDICTING OF CITIZENS' WELL-BEING IN LARGE CITIES

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Abstract: *The well-being of citizens in large cities is an important issue due to potential gaps between needs and capacities for providing health care. That became particularly visible during the Covid pandemic. Thus identifying factors of citizens' well-being in large cities and based on that developing a model of its improvement is of high significance. In the paper six relevant sub-domains of well-being were identified: Evaluative, Emotional, Functional, Vitality, Community, and Supportive. Three of them: Emotional well-being, Evaluative well-being, and Functioning appeared to be highly correlated with each other. The three of the most predictive features of well-being proved to be the presence of anxiety or depression feelings (Anxiety/depression), the presence of pain or discomfort (Pain/discomfort), and the general self-evaluation of health status in the day the participants respond (Health scale). The results of this research may serve local self-governments to get insights into citizens' well-being and to predict changes in the future.*

Keywords*: well-being, wearable trackers data, prediction, physical activity, health*

1. INTRODUCTION

The world is faced with a very intense process of urbanization. It is foreseen that in 2050, 68% of the population will live in the cities. Nowadays, cities generate 75% of the carbon emission, which means the urban population is highly exposed to pollutants (United Nations Development Programme, 2020). The World Health Organization (WHO) estimates that 63% of global mortality (about 36 million deaths per year) is the result of non-communicable diseases (e.g., cardiovascular disease, cancer, diabetes, and lung disease) that are attributable to the increased exposure to air pollution concentration and an inactive lifestyle (World Health Organization, 2016). Elder citizens are particularly vulnerable to those negative factors.

Demographic trends in EU countries are characterized by a growing share of older adults. Increasing needs of elder citizens' care created pressure on local governments' resources. The stress was even more visible in emergency situations such as the COVID pandemic. For that reason, it is necessary to improve the management of healthcare system resources in order to meet increasing demand in particular in highly populated large cities. In this sense, smart cities may be the new concept that would help EU countries to respond to the needs of their changing population, increasing the efficiency of the resources, while improves the quality of life of citizens (Pierce, 2017). This is especially important for aging syndromes, such as frailty, in which prompt detection can prevent, even reverse, this condition, improving life expectancies of the affected individuals (Abril-Jiménez, 2019).

Frailty may be considered as a vulnerable status, which can precede the onset of overt disability. Structured exercise programs are effective in contrasting the progression of frailty, but a healthy and active lifestyle may be sufficient for delaying the onset of disability (Abate, 2007). Recent researches confirmed that active individuals have been related to lower rates of developing frailty (McPhee, 2016).The situation has driven to consider as a priority the need to create tools, guidelines, and recommendations to enable healthier, climate-friendly, and resilient lifestyles within urban environments (World Health Organization, 2019).

The European funded project PULSE (Participatory Urban Living for Sustainable Environments) aims to study the relationship between well-being and its predictors under a quantitative point of view, so a feature assumed as a possible predictor must be transformed into a well-identified and measurable concept. Under this quantitative approach, the main interest of the study is intended to be the detection of features that significantly affect well-being (PULSE, 2020).

Most of the identified predictors are related to the habits of participants about food, self-care, relationships with other people, physical activity, and their health status both at a physical and psychological level. The tools used to collect data were:

- Self-compiled questionnaires: Profile, Basic socio-demographics, Neighborhood environment, Health behaviors and habits, Physical activity IPAQ-Short, EuroQol-5d, Generalized anxiety disorder, Patient health questionnaire-9.
- Wearable trackers (Fitbit, ASUS, and Garmin) that allowed the recording of some biometric variables mainly regarding sleep quality and physical activity.

In this paper, the data collected by the above-mentioned sources will be explained from the raw information they provide, up to the way in which this information has been transformed and used in the fitting of machine learning models. The machine learning models that have been used in the paper are introduced and subsequently, the results of the analysis are presented.

2. QUESTIONNARIES DATA

In this research, the Well-being and the European Social Survey (WES) questionnaire has been used in an adjusted version to obtain an assessment of well-being status of participants. This questionnaire provides a direct measure of the general well-being status of participants, based on their feelings and perceptions, and it is reasonable to think that it is one of the most effective methods for measuring of the actual state of well-being (European Social Survey, 2020). However, it is worth considering that it does not represent an absolute and objective measure, since the individual responses to the questionnaire are, by rule, characterized by a subjective bias.

WES questionnaire is made up of 15 items monitoring 6 different dimensions of well-being (European Social Survey, 2020):

- **Evaluative well-being :**
  I'm satisfied with life as a whole
  I'm happy with my life
- **Emotional well-being:**
  I enjoy my life
  I feel calm and peaceful
- **Functioning:**
  I can decide how to live my life
  I have a sense of accomplishment in my life
  I'm optimistic about my future
  I have idea of how my life would be in the future
- **Vitality:**
  I sleep well
  In general, I have lots of energy
- **Community well-being:**
  People in my neighborhood are kind and helpful
  I have friends in my local area
- **Supportive relationships:**
  I feel appreciated by my friends and family
  I receive help and support when I need it
  I trust people in my neighborhood

The possible responses to each item of the WES questionnaire are in a 5 levels scale expressing how much the individual agrees with a statement (in particular, categories are: "Agree strongly", "Agree", "Neither agree nor disagree", "Disagree", "Disagree strongly").

The computation of the 6 dimensions of well-being (and the one referred to overall well-being) is the result of the following steps:

- Conversion to numerical scores as Agree strongly - 4, Agree - 3, Neither agree nor disagree - 2, Disagree - 1 and Disagree strongly - 0.
- Standardization of individual scores (s_{ij}):

$$\bar{s_{ij}} = \frac{s_{ij} - \bar{s_j}}{\sigma_{s_j}} \tag{2}$$

where:

s_{ij} is a subject-specific measure, that is the score obtained for the i-th individual in the j-th item, $\bar{s}_j$ is the mean score for the j-th item of WES questionnaire. It has the same value for each subject that responded to the j-th item. $\bar{s}_j$ is obtained as follows, where n_j is the number of subjects that responded to the j-th item.

$$\bar{s}_j = \frac{\sum_{i=1}^{n_j} s_{ij}}{n_j} \tag{3}$$

where:

σ_{s_j} is the standard deviation of all scores obtained for the j-th item. It has the same value for each subject that responded to the j-th item and it is obtained as follows:

$$\sigma_{s_j} = \sqrt{\frac{\sum_{i=1}^{n_j} (s_{ij} - \bar{s}_j)^2}{n_j}} \tag{4}$$

Assessment of the individual scores for each dimension of interest, using a mean of standardized scores of each item that is included in that dimension.

The concept of well-being that is developed in this research includes above mentioned 6 dimensions and the overall well-being measure. Therefore, the models will be evaluated both for each of the six dimensions and for a more general measure of well-being, given by the mean of the scores obtained on the six dimensions. Table 1 shows summary statistics of the scores obtained for each dimension and their mean in the whole set of collected data.

Table1: Summary of observed scores for well-being dimensions

	Min.	1st Qu	Median	Mean	3rd Qu	Max	Std. Dev.
Evaluative	-3.57	-0.04	-0.03	0	1.13	1.14	0.97
Emotional	-3.07	-0.83	0.23	0	0.80	1.33	0.86
Functioning	-2.99	-0.55	0.01	0	0.54	1.36	0.81
Vitality	-2.44	-0.48	0.04	0	0.50	1.49	0.84
Community	-2.72	-0.57	-0.02	0	0.50	1.58	0.90
Supportive	-3.81	-0.31	0.06	0	0.52	1.34	0.79
Overall	-3.10	-0.37	0.04	0	0.36	1.37	0.66

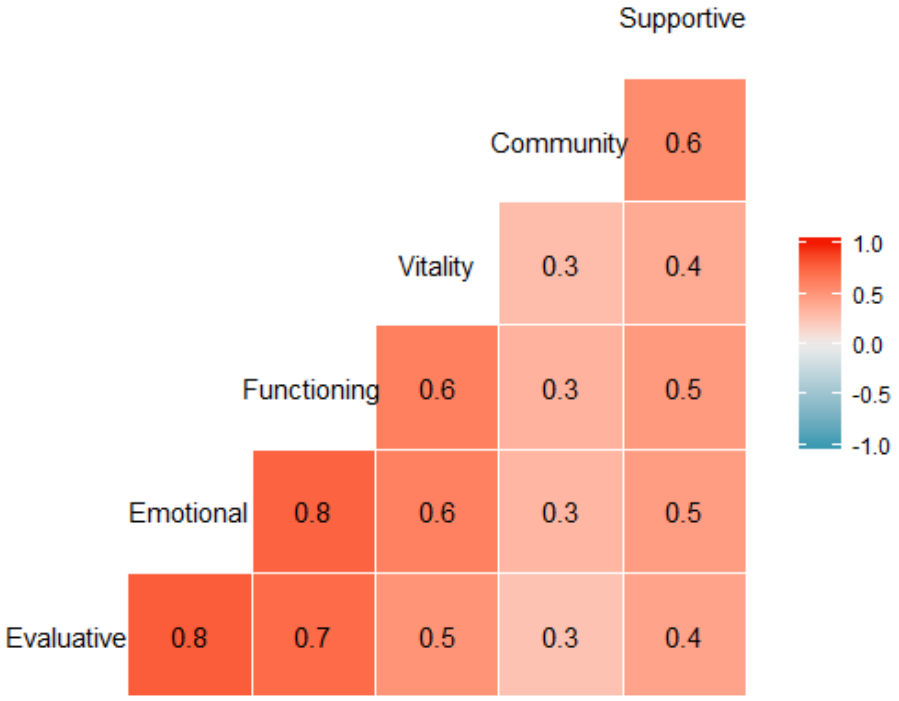

Figure 1: Correlations between well-being dimensions

Figure 1 shows how much the dimensions obtained are correlated to each other, with a darker cell color indicating stronger correlation between the two dimensions. In particular, the dimensions “Emotional well-being”, “Evaluative well-being” and “Functioning” are highly mutually correlated. Although it is difficult to clearly identify why this happens, it could be due to the nature of items that take part to their construction. That is, while other dimensions mostly regard “concrete” aspects of individual life (sleep, friends, trust and support from other people), functioning, emotional and evaluative well-being regard individual feelings about his/her overall life (satisfaction, joy, optimism and accomplishment). In the next section, the statistical tools used to identify the best predictors for each well-being dimension will be presented. Based on them, prediction of the well-being would be possible to be done.

3. PREDICTORS OF WELL-BEING

The second set of variables included in machine learning models were data related to health that were recorded by wearable trackers. The variables covered subjects’ level of physical activity and the quality of their sleep. According to the study of the World Health Organization (WHO), physical inactivity is a leading risk factor for premature death from non-communicable diseases. Conversely, regular physical activity is associated with reduced risks of heart disease, stroke, diabetes, breast and colon cancer, and improved mental health and quality of life (World Health Organization, 2019).

Walking and cycling are key means of transportation enabling people to engage in regular daily physical activity. Sport is an underutilized yet important contributor to physical activity. Physical and health literacy are preconditions for a lifelong healthy, active lifestyle and prevention of non-communicable diseases. World Health Organization considers that policy action on walking, cycling, active recreation, sport and play contribute directly to achieving many of the Sustainable Development Goals.

Unlike physical predictors, quality of sleep is a psychical one. Due to several reasons like frailty, illness, and simply due to their age, among other reasons, older people are at disproportionately higher risk of suffering from mental health problems. What is further noteworthy for all age groups, but especially so for the older adults, is that physical health has an impact on mental health just like mental health has an impact on physical health. Therefore, along with a continued focus on extending their life expectancy, it is also necessary to understand the strategies to maintain the sound mental health of older adults (Kadariya, 2019). Researches confirm that overall better health condition results in a better quality of sleep among other indicators of mental health (Garatachea et al., 2009). And vice versa, inadequate sleep duration may cause severe health problems such as diabetes type 2 for example (Shan et al., 2015).

The data for this research were collected by several types of health and fitness wearable tracker devices manufactured by Fitbit, Garmin and ASUS, monitoring physical and walking activity, sleep and heart/cardio parameters, for over 300 recruited citizens participating in the study in 7 global tested cities (Barcelona, Birmingham, New York, Paris, Pavia (Italy), Singapore, and Keelung/Taipei), selected by the Project PULSE (Urošević et al., 2020).

In recording physical activity, each subject used a wearable tracker. The variables of interest have been recorded daily, for a period of different length for each individual. However, only the recordings temporally close to the data of the first compilation of WES questionnaires have been kept, thus also making the number of observations as homogeneous as possible among subjects. Variables recorded through the wearable tracker devices are all numeric and regarding the health status of participants.

Table 2: Summary of principal component analysis from wearable trackers data

Variable name	Min	Median	Mean	Max	Std. Dev.
Sleep 1	-2.37	1.01	0	3.01	3.27
Sleep 2	-0.74	-0.74	0	3.21	1.21
Sleep 3	-0.10	-0.08	0	2.97	1.10
Sleep 4	-0.25	0.04	0	2.62	0.95
Sleep 5	-0.07	-0.07	0	2.87	0.89
Sleep 6	-0.31	-0.01	0	2.57	0.83
Sleep 7	-0.13	0.03	0	2.08	0.76
Physical activity 1	-3.07	-1.16	0	5.20	3.26
Physical activity 2	-0.93	0.47	0	2.16	1.35
Physical activity 3	-0.49	-0.02	0	2.12	1.16
Physical activity 4	-0.70	0.06	0	2.46	1.00
Physical activity 5	-0.73	0.23	0	2.35	0.96
Physical activity 6	-0.93	0.33	0	2.16	0.91

With the data recorded, 7 principal components have been individuated for the first group (sleep quality) and 6 principal components have been used to summarize information about physical activity, with 75% of variance explained by the principal components in both cases. Some summary measures for the individual components are reported in Table 2.

4. LINEAR REGRESSION MODELS

Linear regression model is a useful tool for prediction of well-being status providing an estimated coefficient for every predictor included in the model. A typical linear model is shown below.

$$\mathrm{Y} = \alpha + \beta_1 \mathrm{Predictor1} + \beta_2 Predictor2 + \cdots \quad (5)$$

Where Y is any of the 7 dimensions of well-being to be predicted, predictor 1 and predictor 2 are some of the input variables deriving from questionnaires, wearable trackers recordings, and β_1, β_2 are the respective coefficients expressing how much the input variable and the output Y are related and in which direction. However, the large number of variables required the use of some shrinkage tool in order to reduce the variance of the estimated coefficients, in the face of a slight increase in their bias. In this context, Lasso tool has been used.

According to lasso shrinkage, the p coefficients, β_j are estimated like in a generic linear model, with the addition of the following constraint:

$$\sum_{j=1}^{p-1} |\beta_j| \leq \lambda \quad (6)$$

Here, *p* is the number of variables included in the model and λ is the element that determines how strong is the constraint, being stronger with a lower λ value. For this reason, it is considered the regularization parameters of lasso penalization. The choice of the best value of λ, for each model referred to a certain dimension of well-being, starts with the detection of a set of possible values for λ.

The transformation performed by lasso is the same for every coefficient, in fact, it could be intended as a translation of coefficients of a certain constant. In addition, lower coefficients are truncated to 0, thus obtaining an effective selection of variables, since in a linear model setting, when the coefficient of a certain variable is close to 0, it means that it does not give any contribution to the model (James et al., 2013).

5. BEST PREDICTORS

One of the significant outputs of the linear regression model with lasso shrinkage was estimated value of its coefficients β that expressed both the strength of the correlation between the input variable to which it was referred and the output Y as well as the direction of this correlation. In particular, the higher is the absolute value of β, the stronger is the linear correlation between the output (the dimension of well-being to which the model is referred) and the input feature to which β is referred.

The three most predictive features among considered dimensions are: 1) the presence of some anxiety or depression feelings (Anxiety/depression), 2) the presence of some pain or discomfort (Pain/discomfort) and 3) the general self-evaluation of health status in the day the participants respond (Health scale). In particular, Anxiety/depression and Pain/discomfort are negatively correlated with all dimensions, which means that high status of Anxiety/depression or Pain/discomfort usually occurs together with low levels of well-being. At the same time, Health scale coefficient is positive which means that high values of Health scale indicates high levels of well-being.

The aim of this paper is to detect the features that are the best predictors of the well-being in a general sense. For that reason we will focus on the relationships between particular predictors on one side and the overall well-being on the other. As we pointed out, Anxiety/depression, Pain/Discomfort and Health scale were identified as the best predictors with average coefficients β respectively equal to -0.30, -0.13, and 0.22.

The results expressed above are summarized in the following formula, including the average estimates of the 10 best predictors for overall well-being:

$$\hat{\mathrm{Y}} = -0.30\mathrm{AD} + 0.22\mathrm{HS} - 0.13\mathrm{Pdis} + 0.08\mathrm{Mar} - 0.07\mathrm{GrGroc} + 0.06\mathrm{UsAct} + 0.05\mathrm{More6} + +0.05\mathrm{Sleep} + 0.05\mathrm{PASMod} + 0.04\mathrm{FreeTP} + \cdots \quad (7)$$

where:

$\hat{Y}$= Predicted value for Overall well-being

AD= Anxiety/Depression

HS= Health scale

Pdis= Pain/Discomfort

Mar= Marital Status Married

GrGroc= Green Groceries Availability

UsAct= Usual Activities

Mora 6= More than 6 drinks per night

Sleep= Sleep hours per night

PAS Mod= Class PAS Moderate

FreeTP= Free time parks

The figures below show the relations between the overall well-being and the values of all ten predictors considered.

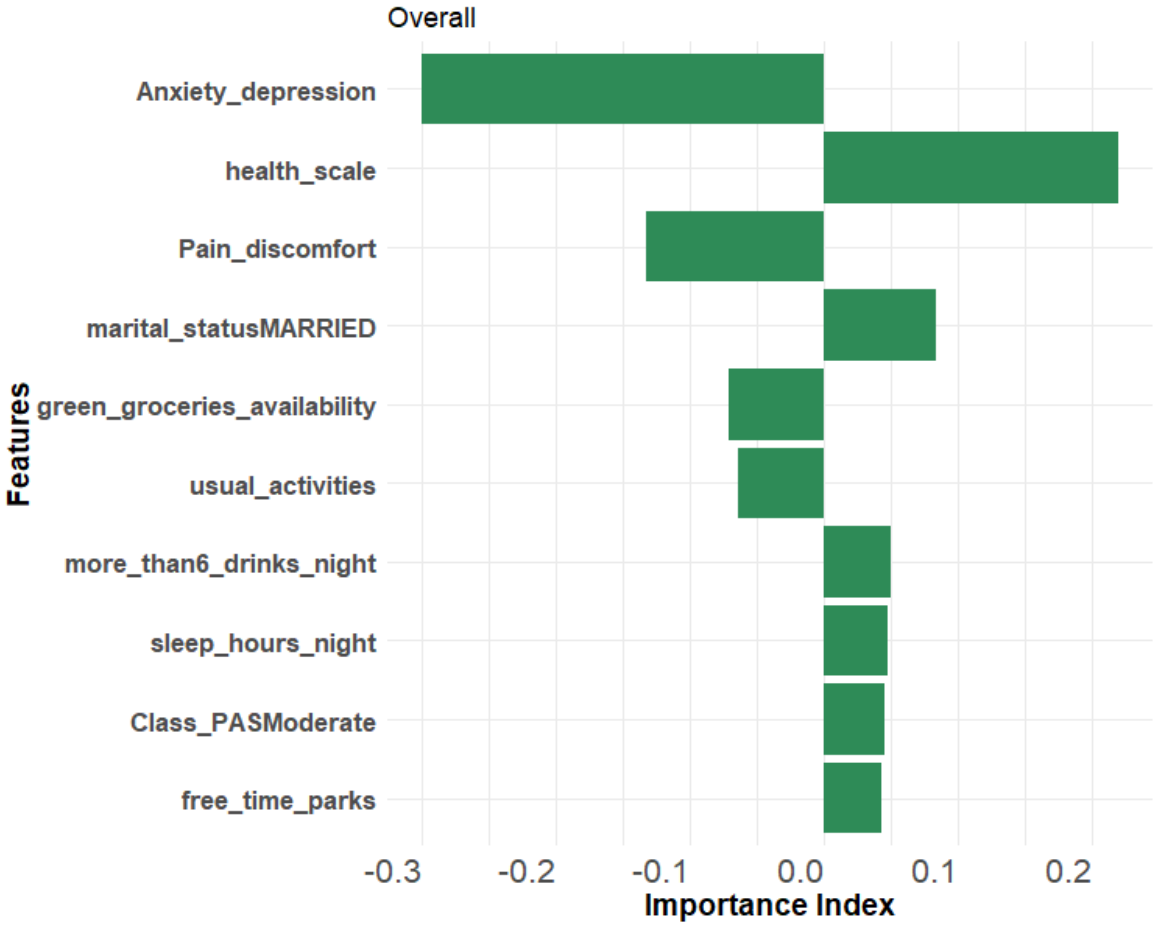

Figure 2: 10 best predictors for overall well-being

The figures below show the relations between the observed overall well-being and the observed values of, respectively, Anxiety/Depression Pain/Discomfort and Health scale. It can be observed that these features appear correlated with overall well-being in the same direction of their respective estimated coefficients. However, it is worth considering that the following figures show the marginal relation with the overall well-being, while the estimated coefficients express the same relationship net of all other variables included in the model.

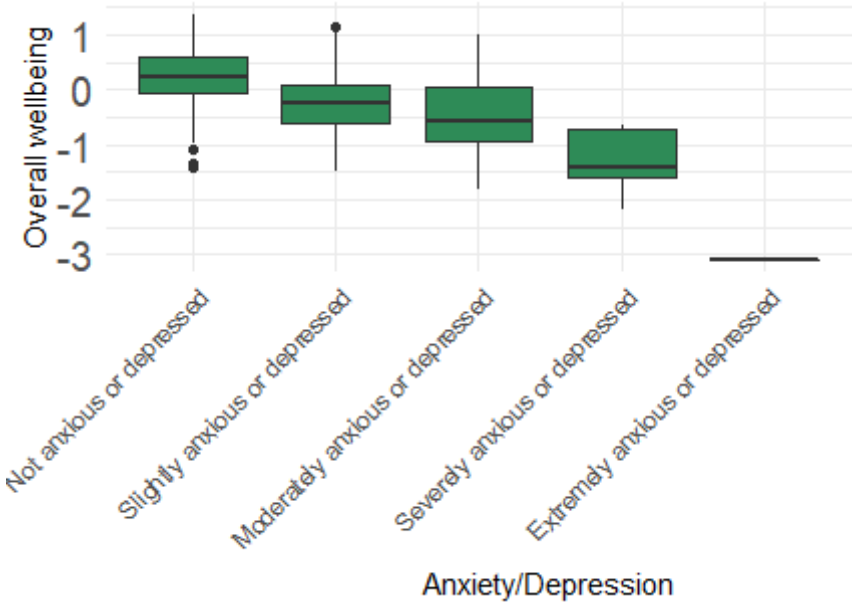

Figure 3: Anxiety/Depression vs Overall well-being on observed data

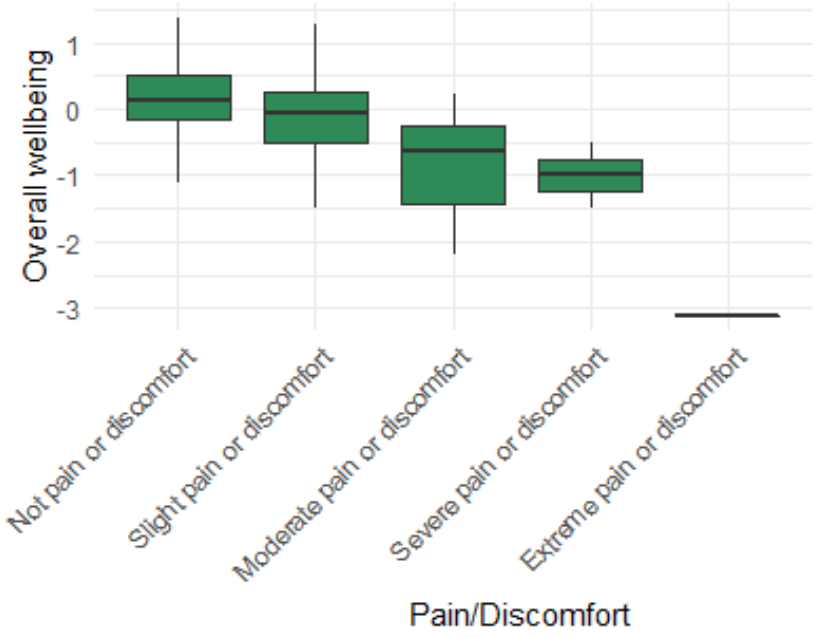

Figure 4: Pain/Discomfort vs Overall well-being on observed data

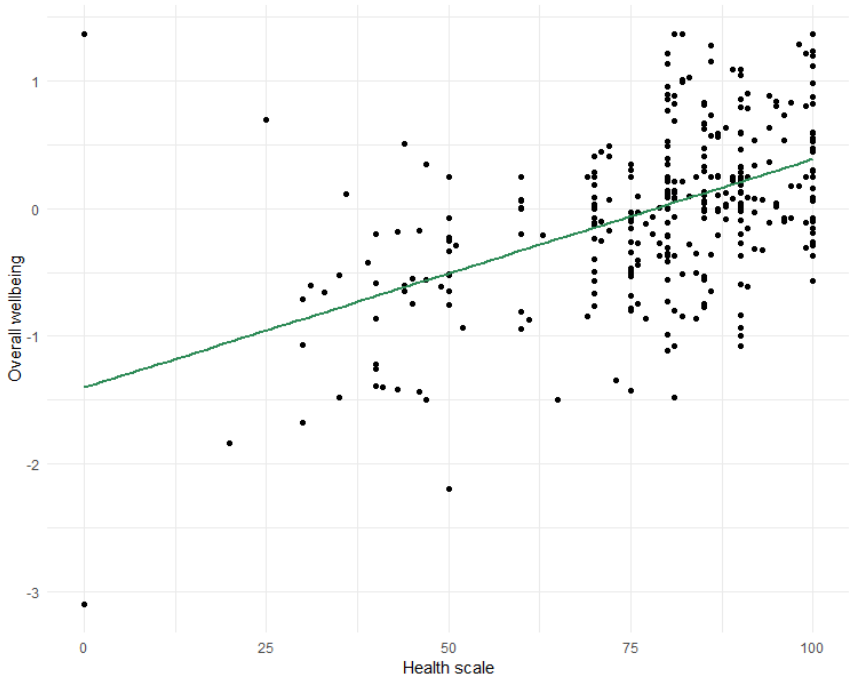

Figure 5: Health scale vs Overall well-being on observed data

6. CONCLUSION

In this paper, the authors tried to detect significant factors of well-being and based on them to develop a prediction model of well-being improvement. This has been done by recording and analyzing of key features of the individual daily life habits of citizens in large cities.

Since well-being is a broad and complex issue, the authors selected six sub-domains: Evaluative, Emotional, Functional, Vitality, Community, and Supportive well-being for the purpose of this research. The prediction model of the six sub-domains confirmed their overall relevance. Moreover, the dimensions Emotional well-being, Evaluative well-being and Functioning were highly correlated with each other.

The three of the most predictive features of well-being proved to be the presence of anxiety or depression feelings (Anxiety/depression), the presence of pain or discomfort (Pain/discomfort), and the general self-evaluation of health status in the day the participants respond (Health scale). In particular, Anxiety/depression and Pain/discomfort are negatively correlated with all dimensions, which means that high status of Anxiety/depression or Pain/discomfort usually occurs together with low levels of well-being. On the contrary, high value of Health scale go hand in hand with a high level of well-being.

The results of this research may serve to local governments to provide composite pictures (i.e. the six scales) of the well-being of the population of the cities. However, it is important to be aware that the relationships detected between well-being on one side and the predicting features on the other have no direct, causal character. In spite of that, the presented model may well serve as monitoring and predictive tools of the well-being, both at a community and at the individual level.

ACKNOWLEDGMENTS

This paper was written as part of the 2020 Research Program of the Institute of Social Sciences with the support of the Ministry of Education, Science and Technological Development of the Republic of Serbia

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ENTREPRENEURSHIP,

INNOVATION

AND

SUSTAINABLE DEVELOPMENT

CONTENT

IDEA MANAGEMENT SYSTEMS

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Abstract: *The aim of this paper is to present the main elements of the idea management systems. These systems represent a web-based software for idea management directed towards gathering, organizing, selecting and managing innovative ideas provided by large communities. Communities can come from both inside and outside the company – it depends on the company's innovation strategy. Of big importance is to emphasize the role of the creativity, not only as necessity for new idea generation, but, also, as the backbone of the idea management systems. Idea management systems represent a tool that creates such an environment that makes employees comfortable enough to propose ideas; that nurture and inspire proactive creativity aiming at encouraging the individuals who are driven by internal motivators and who actively search for problems by themselves, to freely propose the ideas. In addition, the paper presents the application of one of the idea management software solutions, known as Innovation Cloud.*

Keywords: *Idea management system, Ideation, Creativity, Idea lifecycle, Innovation Cloud*

1. INTRODUCTION

It is widely recognized that innovation is one of the most important ways for company to survive and to make progress (Milutinović, Stošić, Čudanov, & Štavljanin, 2018). Companies are constantly under the pressure to create new or improved products or services in order to sustain their attractiveness to customers. This has shaped the approach companies take in regard of implementing new concepts and methods to make the innovation process more efficient. As the demand for innovative solutions kept on rising and time to implement new idea shortened, companies needed to find a way to collect as much innovative opportunities as they could. Therefore, the systems for managing that process have been accepted extensively. Those systems are made by using the logic of traditional approaches to generating ideas that are implemented in web-based software. Actually, idea management systems are developed as a way to empower customers to participate directly in the design of products and services. They connect innovation community and shape the interactions within it by using elements of the game in a non-game context, with the idea of achieving higher goals in the direction of solving certain problems. These systems have shown success in many companies, which is the reason of theirs increasing use.

2. IDEATION LEADING TO INNOVATION

For centuries, human civilization has been trying to adapt the nature to fulfill its physiological and existential needs and make everyday life easier. What allowed people to make this possible is human predisposition of logical and creative thinking, which gave us an opportunity to recognize problems and their context and then act upon them. Generating solutions or at least ideas of potential solutions, is the result of this process. This is how the basic concept of ideation has been created. Ideation is defined as "the process of creating, developing and communicating ideas" … as "visual, concrete or abstract base elements of a thought" (Medium, 2018). Ideas can be observed as the antecedents to innovation (Malik, 2014) so innovation can be observed as implemented ideas.

The starting point of the development of innovation concept has begun with the thought of J. Schumpeter who believed that the innovation is the main initiator of technological progress and economic development. Many years after, companies have come to realization that being innovative is a key driver of competitiveness since it assumes creating value by solving problems and challenges. This means constantly developing value proposition is important both for attracting new clients and not losing current ones (Westerski, Iglesias, & Nagle, 2011). Innovations are not only good for maintaining customer satisfaction and competitiveness in today's fast paced market, but also an essential part of company's existence and growth. Starting from the beginning, ideas happen to be vital for organizations since they are the first step to innovation process representing the incredibly important source of competitive advantage (Dorow, Dávila, Varvakis, & Vallejos, 2015).

2.1. Creativity as an imperative of ideation

Herring, Jones & Bailey (2009) considered ideation to be the activity directly linked to creative problem solving. In other words, creativity is the precondition, input and inevitable element of innovation. There are many approaches to creativity process, where the most comprehensible is that of generation of new and useful ideas. Therefore, the concept of ideation is closely connected to the creativity that is immanent to everyone.

Creativity, as a part of our everyday life, occurs in everything we do, including different areas of business and science. Organizations that take creativity process seriously are more likely to succeed in creating successful innovations. Moreover, creativity is identified as one of the most important skills today's employees should have (WEF, 2018). As O'Sullivan (2011) has stated, creativity is "a learning habit that requires skill as well as specific understanding of the contexts in which creativity is being applied." Kampylis & Berki (2014) claim that everyone has creative thinking skills, especially children as they are not fully aware of logic principles which makes them more open, inventive and playful. What children lack in relation to adults is the knowledge and expertise in particular area. It is the combination of both creativity and knowledge that turns creative ideas into real life innovations.

Taking from Unsworth (2001), intelligence is not the only factor that influences the creative process. In fact, the same author believes that there are four types of creativity based on the two aspects: problem type and driver for engagement (Figure 1). Regarding the type of the problem, Unsworth differentiate whether the problem is given or recognized by the individual or group. As for the drivers, the author recognizes the internal and external motivation.

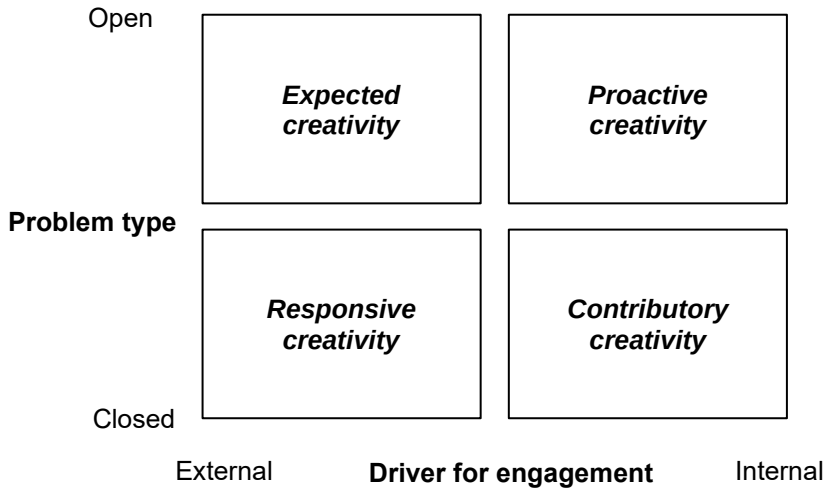

Figure 1: Creativity typology (adapted from (Unsworth, 2001))

Expected creativity is often seen through process of creating an artwork. This type of creativity implies that it is in someone's job description to be creative – moreover, the expectations are external and problems are self-discovered. Responsive type of creativity concerns the individual or a group that answer to the requirements of the given problem. This type of creativity requires the least amount of creativity. Contributory creativity is often explained in voluntarily scenarios, when the problem is known, while the individual's creativity to bring the solution is driven internally. The last type of creativity is labeled as proactive creativity. It is inherent to the individuals who are driven by internal motivators and who actively search for problems by themselves.

When it comes to the creative process flow, Herring, Jones & Bailey (2009) have noted that creative process can be divided into four distinct phases of Preparation, Incubation, Illumination and Verification (identified much earlier, with the beginning of the previous century). The preparation comes for knowledge gathering and problem understanding. Incubation means thinking about the problem without special focus. Illumination happens together with the solution discovery, figuratively speaking as a sudden flash of light. The final phase, verification, assume the evaluation of the proposed new idea.

2.2. The basic concepts of idea management

As Girotra, Terwiesch & Ulrich (2010), and many others, discussed, basically all innovation processes start with new ideas generating followed by evaluation and selection of the best ones. They claim that the success of this part of the innovation process is led by the quality of the identified opportunity. Idea generation can be

defined as a systematic process of creating and capturing ideas consistent with the organization's strategy, including elements related to creativity and details of the organizational structure to support the process (Dorow, Dávila, Varvakis, & Vallejos, 2014). Again, authors Girotra, Terwiesch, & Ulrich (2010) emphasize that, in the context of innovation, the goal is not always to maximize the number of ideas or to maximize the average quality of ideas, but to maximize the quality of the best idea. This can be seen as that companies tend to „generate one incredibly good idea and 99 terrible ideas rather than generating 100 merely decent ideas." It is desirable to generate as many ideas as possible, but when it overgrows into a large batch of ideas, it certainly becomes useless for the companies.

It is also important to note the way of managing ideas through innovation process often depends on differences that exist between the introverted and extroverted individuals, as their ability to solve problems can differ tremendously. Boeddrich (2004) claims that every employee has some portion of one of the following archetypes and that no one can completely fit in with these extreme types:

- *Emotional Perceiver* – very good listener that prefers creative problem-solving and hesitates to publish his own ideas.
- *Reserved Scientist* – needs leadership and prefers linear-analytical problem-solving, wants for his work to be appreciated, but doesn't like criticism, consequently, hesitates to publish his idea.
- *Open Communicator* – communicates his ideas anywhere at any time and is excellent in convincing others. He enjoys solving problem more creatively.
- *Dominant Entrepreneur* – great at delegating work, even though he prefers linear-analytic problem-solving, he will accept creative problem-solving if the other method seems to be exhausted.

A particular problem can often be resolved by generating ideas from the employees that are directly involved with the problem. Yet companies tend to question the ability of their employees to bring an innovative solution, which can be a limiting factor to make the most of human capital. This is the problem that many managers are not aware of, which can lead to a massive waste of key competencies. Certainly, a lot of situations and problems can be best managed by encouraging ideas from employees in the front line. Companies need to nurture the philosophy that encourages employees and to create an appropriate environment for employees to be comfortable enough to propose ideas. This is the reason the first concept of idea management systems has emerged.

3. THE CONCEPT OF IDEA MANAGEMENT SYSTEMS

As globalization brought large scale competitiveness among market participants, the question was no longer why but how to innovate successfully. The need to find a better way to create innovative solutions has increased. That itself was already hard enough to achieve, as the time range for maintaining competitive advantage by developing innovations, has reduced to minimum. Companies didn't have enough capabilities to bring up new solutions in such a short time and to respond to the demands of the market. One of the attempts to support innovation processes is the application of the idea management systems that employ and combine information technology and crowdsourcing principals (Westerski, Dalamagas, & Iglesias, 2012).

These systems are particularly made to reinforce innovation process with the help of communities gathered inside and outside the company. The main characteristic of idea management systems is the use of web-based technologies which facilitates collecting ideas from particular community. This community can either be internal including employees of the company, which improves bottom-up communication, or external recruiting company's customers (but, also, suppliers, distributors, organizations, etc.). The use of idea management systems has been increased as they made easier to oversee submitted ideas and select the best concepts for implementation and deployment. The application of these systems enables resolving a problem of large redundancy and quantities of trivial ideas, as the community could cherry-pick the most relevant ones (Westerski, Dalamagas, & Iglesias, 2012). Another great thing about those systems is that they allow interactions in between community which essentially represent the basic idea of co-creating innovative solutions, as the best idea doesn't only come from one individual's perspective. The best idea is usually made by being inspired by others and implementing portion of their ideas into one of their own. Idea management systems often use the game design elements such as points, likes, comments, badges, and leader-boards, as it brings more positive effects on individuals. The goal of this principle is to enhance participation in the ideation process by improving motivation to submit best idea and earn community recognition.

3.1. Development of Idea Management Systems

The term of idea management in a form of platforms that allowed companies to track ideas generated, as it is known today, has emerged in late 1990s (Westerski, Iglesias, & Nagle, 2011). Since then the systems are being continuously evolved by embedding different methods, tools and approaches. Historically, the pioneers

of idea management systems were suggestion boxes used as a way to coordinate and manage creativity (Sandstrom & Bjork, 2010). Some companies still use the suggestion boxes as the way for collecting the ideas. However, this traditional approach did not have the advantages of a use of modern technologies that enhance collecting and capturing large amount of ideas. With the appearance of these advantages (the abilities to store, display and organize the submitted ideas), also arose the opportunity for the development of idea management systems (Westerski, Iglesias, & Nagle, 2011).

At first, many people were sceptic about idea management systems claiming that they are practical only for small, incremental innovations. Precisely, these systems were aimed at improving organizational efficiency, competitiveness, and certain practices and procedures. But, as the time has passing and technology performances have improved, the idea management systems have become more sophisticated. They started implementing IT tools which enabled efficient systematic handling of ideas. It is certain that by using the advantages of the Web 2.0 techniques (Westerski, Iglesias, & Nagle, 2011), idea management systems advanced from creating small, incremental improvements, to the development of radical innovations (for example, Shell GameChanger). For sure, with the appearance of new technologies the systems will be even better and practical. Generally, it can be said that idea management system represents a management tool used to give a structure to fuzzy front end of innovation project, and to connect these early phases with the later phases of development.

3.2. The basic steps of an Idea Management Systems

Idea management systems is closely connected to idea lifecycle and follows the innovation process through its stages of evolution. Generally, it can be noted that a couple of stages are recognized starting from idea generation over idea improvement, idea selection, idea implementation to idea deployment (Westerski, Iglesias, & Nagle, 2011; Innovation Cloud, 2020):

- Idea generation is the first phase of innovation process, and could be seen as the most significant one. It represents the starting point of discovering opportunities, which later can lead to innovation. This phase includes collecting ideas from the community or particular group of people. Ideas can be captured in two ways (Westerski, Iglesias, & Nagle, 2011):
  - push methods, company explicitly asks employees or others to propose ideas on a given topic.
  - pull methods, company extract ideas from some user ideas are extracted or inferred from some content.
- Idea improvement refers to the opportunity of participants to interact and collaborate with each other in a way to improve proposed idea. As soon as the ideas are submitted, they are shared to the community for potential improvements before they are assessed by the defined evaluators within the company. The improvements are made through comments, emoticons and other game mechanics (Burke, 2014). Although this type of improvement is hard to analyze when it reaches a certain size, idea management systems has found a way to facilitate this problem with additional tools, such as simple up/down ranking, buying and selling idea shares, idea games, and hybrid ranking systems.
- Idea selection enables that the best idea is selected and sent to the next stage of implementation. This stage is about ranking of ideas so it may use different techniques (for example, idea assessment, filtering and clustering). Whether it is assessed by human or machine algorithm, both produce a number of characteristics of idea by which the idea database could be examined and specific ideas could be prioritized. Idea assessment can rely on more than one level of assessment (usually qualitative and quantitative) (Innovation Cloud, 2020).
- Idea implementation is used for transformation of ideas into new products, services, processes, business models, etc. It starts with the idea's positive review and its acceptance to be set on implementation. In this stage, idea management systems serve as a support for project management given the allocation of resources, defining tasks and requirements, and reporting. Frequently, this is accomplished through different modules in the system. Through the idea implementation phase, ideas are associated data concerning status and progress update, resources allocated, iterations of the product cycle, problems encountered and financial data.
- Idea deployment is the final stage of innovation evolution that shows the success of ideas after they have been delivered to the stakeholders in the form of new product, service, process, etc. This step includes gathering information about the deployment process based on various metrics (KPIs) such as client satisfaction, return of investment, brand impact, or revenue growth.

3.3. The Idea Management Systems typology

Ideas can be generated from various sides – employees, customers, suppliers, distributors, etc. Depending on the community that is targeted in this process, three types of systems for idea management can be distinguished (Erasmus University Rotterdam, n.d.):

- HR (human resource) idea management systems,

- R&D (research and development) idea management systems,
- Marketing idea management systems.

Usually, the HR idea management systems are managed by the HR department. The role of the systems in this context is not necessarily to initiate gathering the ideas from employees, but rather to increase employees' satisfaction by giving them voice and a possibility to put forth their ideas. The ideas submitted in HR idea management systems are often small and incremental, but what is important, the systems might spark employees to think more entrepreneurial, as they need to pitch their idea and argue about the advantages they offer. One of the examples of this system actually is *Innovation Cloud*. R&D idea management systems are very much about the ideas that people submit. The goal of these systems concerns bringing radical, breakthrough ideas that have the power to change the company from the root. In R&D idea management systems the starting point is collecting ideas from employees and then addressing to the outside stakeholders. One good example of successful application of R&D system is *Shell GameChanger*. The third type of idea management system is managed by the marketing department. These systems are focused on reaching out to its customers and trying to engage with them. These systems are intended to create a dialogue between customers and to make them more loyal and committed to the company (for example *My Starbucks Idea*). What is common to all these systems is the fact that they enable the path for all stakeholders that are proactively creative and that voluntarily notice the problems and propose the solutions to the problems (Erasmus University Rotterdam, n.d.).

4. THE INNOVATION CLOUD SOFTWARE OVIERVIEW

As development of a successful innovation has become the best indicator of organizational agility, the companies have to find a way to upgrade the management of innovation processes across each phase of innovation lifecycle. Innovation cloud is one of solutions that levels up company's innovation efforts, facilitating the entire process from ideation to realization. It allows companies to harness the creativity of its community and select the most promising ideas that will be developed in a form for launching, as well as adapted based on the customer's feedback. Innovation Cloud software engages the community to cocreate high-quality ideas and invites them to share their views and feedback for the purpose of addressing key problems faster and cheaper. This software allows companies to connect with customers regarding their thoughts about companies' ideas before an investment was made (Innovation Cloud, 2020).

The first step in using the software is gathering innovation community, which can be easily done by inviting new members over the email. These systems have a role-based access control meaning that the permissions of the participants are based on the assigned role – challenge access, idea approver, idea scorer, idea reviewer, project access and many more. Ideas go through the process of submission, revision, scoring and approval (Innovation Cloud, 2020). Idea submission (Figure 2) is done by defining the title, description of idea, the access (public, private, shared), the owner of the idea, as well as additional details on idea which can be customized in consultation with the administrator.

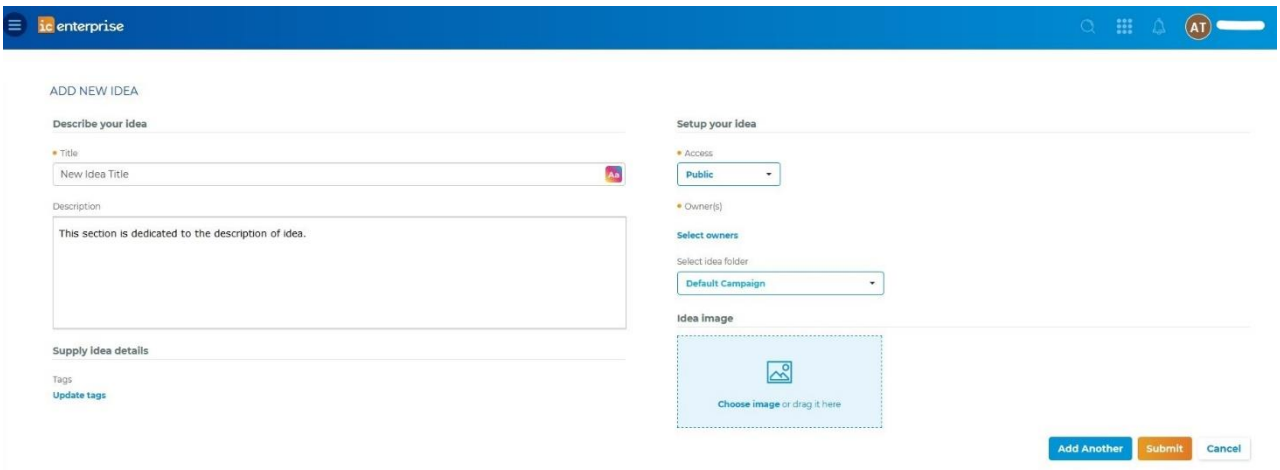

Figure 2: Adding new idea in the Innovation Cloud software

After the idea is submitted and improved through collaboration of other participants (Figure 3), the Idea Owner will send the idea to the revision by clicking the option *Send idea to review* in *ACTION* section. Throughout each phase, this section will contain all relevant and important action buttons that needs to be taken at that point. In the revision phase, the Idea Reviewer will be asked to give his professional feedback on submitted ideas and decide whether the idea is ready to be sent to scoring phase.

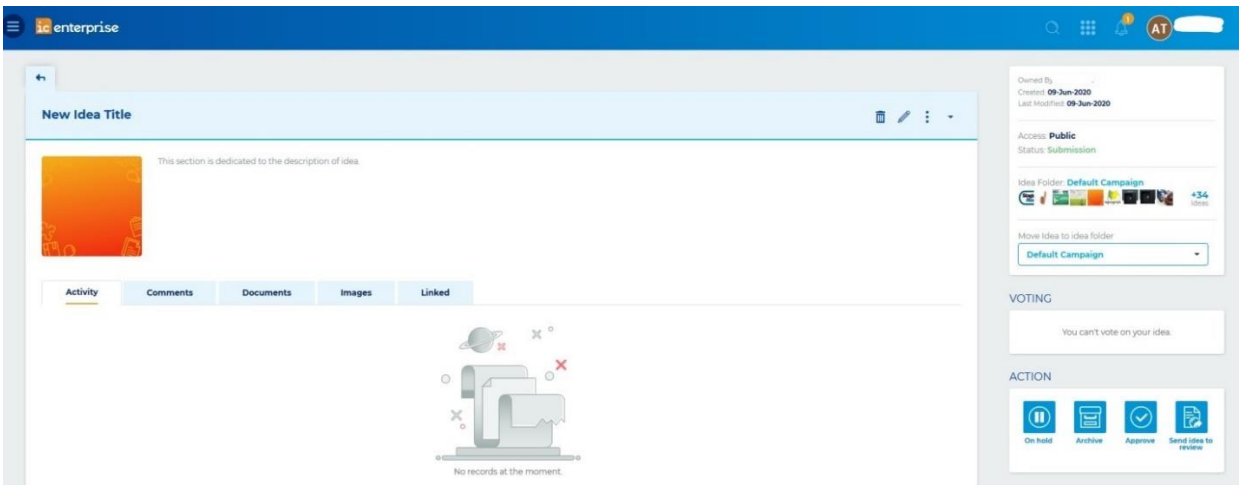

Figure 3: The collaboration space in the Innovation Cloud software

In the scoring phase, the Scorer evaluates the ideas based on the predefined criteria, such as strategy fit, feasibility, competitive advantage, etc. (Figure 4). This scorecard can be customized according to the specific business the system is applied. Based on scoring results, the Approver makes the final decision about the most relevant and promising ideas.

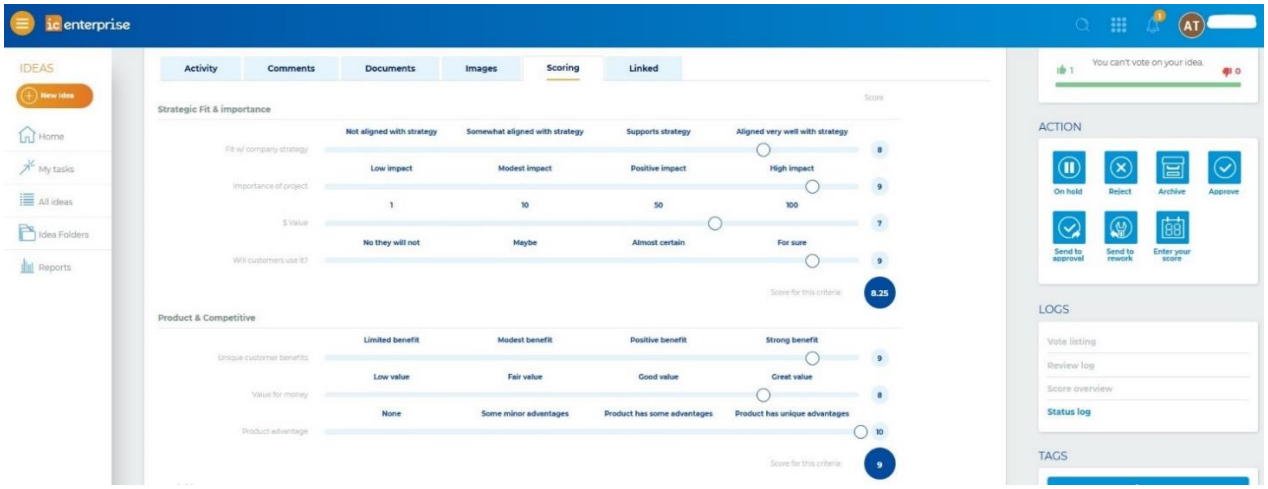

Figure 4: Scoring phase in the Innovation Cloud software

Once the scoring phase is completed, the Approver will decide whether to put idea *on hold* – more time is needed for the decision, *reject* – the idea does not meet the company's requirements, *archive* - the idea is saved in database for the later usage, or *approve* – the idea is send to implementation. If the Approver assesses that idea needs additional improvement, there is an option to send idea to *rework*, which will also be available throughout every phase mentioned above. After all the steps are done, the idea will be sent straight away to development, and users are now able to work on the innovation outcome. Innovation cloud software, also, provides users with advanced reports (Figure 5). These reports deal with the data for each activity of the community as well as the data that is important for the business reports.

The previously described approach is known as the *bottom-up approach* of idea management and it particularly targets the development of one idea. This approach explains the path that begins with the specific idea and moves more to the focused development of such idea. Another approach, provided by the software, is treated as the *top-down approach* or innovation challenge. Innovation challenge is structured in a way to bring everyone on board to work together on the predefined problem/challenge. Usually, at the end, the winning idea will be rewarded (rewards depend on the company's policy). The rewards, for sure, may represent a factor for attracting attention of the community.

Both bottom-up and top-down approaches nurture the proactive creativity in people by providing them the tool that gives them voice and facilitates the participation in the ideation process. This as a result brings more satisfaction among employees, boosts their confidence, makes them think more towards problem solving and improves their work performance. The system enables employees to see themselves as more than just workers.

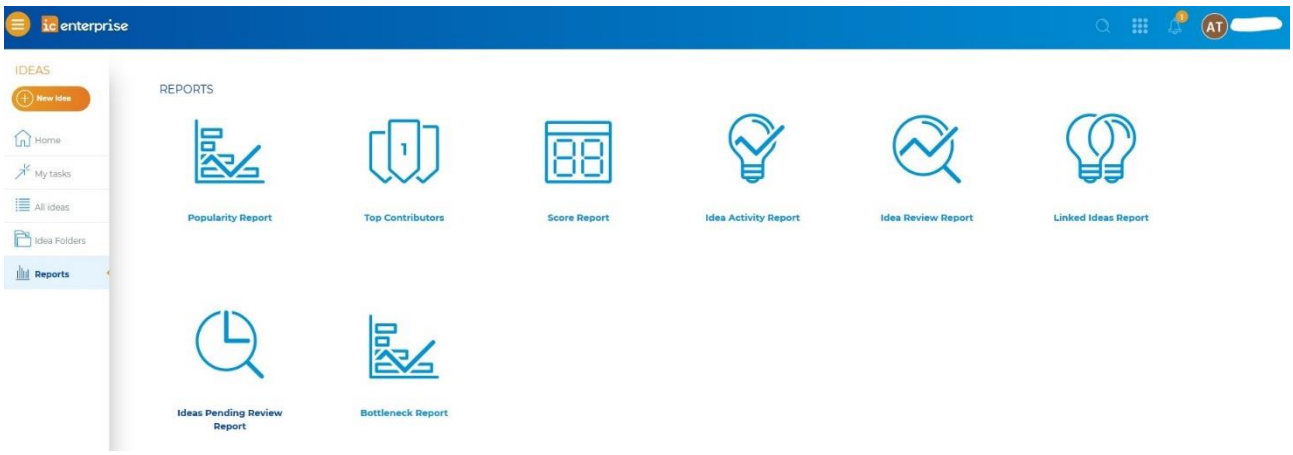

Figure 5: Reports in the Innovation Cloud software

5. CONCLUSION

Innovation has rapidly become a strategic priority in high-demand markets. Initially, companies used various methods for solving this issue. This meant finding an idea that will make a promising attempt in the market. Therefore, companies have applied many methods and tools for generating ideas, such as well-known brainstorming, lateral thinking, TRIZ, and many others. The need for ideas leads companies to application of more contemporary approaches and methods that of co-creation, crowdsourcing and gamification. Exactly these tools and methods are deeply incorporated in systems for managing ideas, which in today's literature refer to a software for collecting innovative ideas from large communities. These systems have found application in lot of companies and have shown as a good tool for collecting a large number of ideas.

Over the years a number of different solutions has appeared and many of them are SaaS (Software as a Service) solutions. One of the examples of such a system is the aforementioned software Innovation Cloud. It represents a modular end-to-end innovation management software which first module is dedicated to idea management. The other two modules ensure the complete lifecycle of innovation. Second module develops the most promising ideas, selected from the previous module, into real innovative product, service, process, etc. using proven methodology (in this case Stage-Gate model). It monitors the ongoing alignment of the innovation project against predefined targets and, if needed, it provides data and insights for adaptation of the overall innovation strategy. The last module examines the market impact on the developed innovation. It is used to keep tracking of the innovative solution by comparing predictions made in project with the real-life situation. This module is used for improvement of the future innovations.

Idea management systems increasingly become an imperative for companies as they allow them to overcome the gap between perceived importance of innovations and the way innovations are supported and accelerated. These solutions are expected to improve even more over time as well as their approach to the essential data related to business itself.

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THE IMPACT OF DIGITALIZATION ON THE APPLICATION OF CIRCULAR ECONOMY WITHIN THE FOURTH INDUSTRIAL REVOLUTION

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Abstract: *Rapid industrialization of the world, as well as the growing lack of natural resources as well as their efficiency, have seriously questioned future activities, threatening the survival on Earth. The changes that should be undertaken, within the society, business, industry, are not easy at all, but with the application of circular economy and solutions it offers, the transition process itself would be more accessible. This should be undertaken as soon as possible seeing as more developed countries have already introduced into their business spheres. The paper will present areas such as circular economy, digital technologies, as well as the development of the fourth industrial revolution. The aim of this paper is to give an overview, a concept of synergy of these three concepts and their mutual influence, as well as their action - advantages of interconnection used in the right way. The idea of this paper is to identify different ways in which these three areas are related by presenting and analyzing each concept individually. Their interrelationship can generally contribute to the development of countries, societies, communities, companies, but also present a competitive weapon for supply chains and business'.*

Keywords: *digitalization, circular economy; industry 4.0.*

1. INTRODUCTION

Industrialization, economic growth, the trend of increasing population growth, increasing urbanization, all of this creates enormous amounts of waste all over the world, creating a serious problem for the planet. The progress of society inevitably entails the accelerated development of modern technologies, leading to greater production and use of various products, without which everyday life is unthinkable. Changes within the global or local industry, which have taken place in recent years, have led to the development and advancement of various technologies, the development of the IT sector, the development of digitalization, the manner and speed of use of existing technologies and much more. In short, they led to the emergence of the Fourth Industrial Revolution or Industry 4.0. "The era we are currently in is the era of the Fourth Industrial Revolution, and this era represents the era of information technology and telecommunications" (Perez, 2018). In contrast, the current model of unlimited depletion of natural resources, unlimited production, unlimited consumption, or a linear model of the economy, which involves only the use and rejection of any product, ignoring the consequences of such behavior, must be discontinued. One of the solutions to this behavior is circular economy, which uses everything that is "discarded" in the current system, as a value or entry into another system. "The transition to circular economy will affect different sectors of the economy and at different levels" (Milanović, Petković & Jovanović, 2019). Also, the challenges posed by the Fourth Industrial Revolution will require fast, efficient solutions, which together with circular economy can meet the ever-increasing and faster demands of today's society. Organizations should base their work on adopting the latest solutions and applications, as well as developing their own digital solutions and tools, which would make them more competitive and successful in their business compared to other companies (Sillanpää & Ncibi, 2019). Hereinafter, each term will be explained separately. The nuances and interactions between these three areas are presented as well as their mutual synergy.

1.1. Defining circular economy

Today, circular economy is receiving increasing attention, since it presents an approach to dealing with huge amounts of waste, volatile resources and pressures on the environment. Different sectors of the economy, industries at different levels, through different technologies will need to network and connect in order for circular economy to get the right application (Milanović, Petković, & Jovanović, 2019). Circular economy can be defined in several ways. “Circular economy is widely known as a way to implement and achieve sustainability, mainly because of its contribution to the separation of biological and technical nutrients under cyclical industrial metabolism “(Ávila-Gutiérrez et al., 2019). Circular economy involves the form of transactions and exchanges. For an efficient economy cycle, data and knowledge of sources and markets are needed. Many times, suppliers and users of various products within supply chains of circular economies can come from different industries and regions (Kouhizadeh, Sarkis & Zhu, 2019). Safety, efficiency, speed, and ultimately the circularity of a particular system, are achieved by gradually incorporating the principles of the circular economy into the value chain links of different sectors of the economy (Ávila-Gutiérrez et al., 2019). Circular economy implies an expanded vision of sustainable production under the assumption that sustainability is achieved thanks to the cyclical nature of the ecosystem. For this reason, it is necessary for industrial systems to be designed so as to establish not only mutual interactions between systems, but also to establish interactions with the natural environment (Milanovic, Petrovic & Cirovic, 2019). This directly refers to the adaptation of the development of Industry 4.0, because the application of the circular economy should be in line with industrial change and development. Circular economy also implies a way of thinking, that at every possible moment, the value of the material is maintained at the highest possible level (Linder, 2017; Lahti et al., 2018). This refers to the fact that each product or material is used and applied, even for other purposes, until their complete value is lost. The point is that products and materials are reused for as long as possible, even after recycling and disposal, when it is thought that they cannot be reused (Lahti et al., 2018).

1.2. Industry 4.0

In recent years, we have realized that in addition to increasing urbanization, rapid economic growth, increased population growth and faster development of technologies, companies and individuals need to be actively involved in broader initiatives and monitoring changes in business technologies in order to remain competitive and contribute to encouraging faster development. According to various scientists, “this new industrial revolution is completely reconstructing the most basic system” (Larsson & Lindfred, 2019). This refers to the fact that due to these changes, the system itself must be changed quickly and efficiently. Outdated technologies no longer have a place in application, due to the fact that so many new digital solutions and technologies are emerging, which are affordable to use. Achieving a higher level of automation, productivity, operational efficiency would be some of the goals of Industry 4.0 (Thames & Schaefer, 2016). “The fourth industrial revolution, or as it is otherwise called, Industry 4.0, is usually defined as a combination of new technologies, including artificial intelligence, machine learning, natural programming language, robotics, sensors, cloud computing, nanotechnology, IoT (lot of things) and 3D printing” (Schwab, 2016). The benefits and opportunities it provides are great. It provides manufacturers with the opportunity to adopt flexible, intelligent, automated production processes, which will gain an advantage in product differentiation, and to provide the necessary competitiveness and advantage in the market (Okorie et al., 2018). Many countries have taken initiatives and taken the first steps to adapt to the changes brought about by the Fourth Industrial Revolution. Germany was among the first countries to adopt Industry 4.0 through the implementation of its “High-Tech Strategy 2020 Action Plan” (Hunt et al., 2018; Okorie et al., 2018), while others countries followed, such as China, Japan, the United Kingdom, Brazil, France, and South Korea (Liao et al., 2017; Okorie et al., 2018). It is also necessary to note that support in education and further development in this area is necessary in all its fields, and in the following text its importance will be explained, especially through their relationship.

1.3. Digital technologies

Most organizations, institutions and countries, today, use digital technologies in response to the increasingly rapid development of industry (Larsson & Lindfred, 2019). It can be said that research in the field of business models and platforms through digital technologies, devices or techniques contributes to various life and business fields. However, balancing the advantages and disadvantages of digital technologies will be essential to promote inclusive economic growth (Preston & Lehne, 2017). This is especially true where the exchange of digital solutions is not a problem in developed countries. The problem occurs in developing countries. According to the World Bank (2016), "sixty percent of the world's population still does not have access to the Internet, and as many as two billion people do not own a mobile phone". Also, in Africa, for example, only 12 percent of women and 18 percent of men own or use digital technologies or telephones (World Bank, 2016; Preston & Lehne, 2017). The benefits of digital solutions and technologies are manifold. They refer to the improvement, but also the possibility of simplifying the entire economy, infrastructure, business in any industry, organization, company or business venture - modern technologies are becoming deeply integrated into every business segment. Innovative and transformational technologies such as digital, combined with the principles

of the circular economy, are the main drivers of current global change in a number of strategic economic sectors (Sillanpää & Ncibi, 2019). Those companies that invest in digital solutions expect to achieve annual growth and cost efficiencies of 5-10% or more in the next 3-5 years (Catlin et al., 2015; Kotarba, 2017). The emergence and development of new technologies and digital solutions is becoming increasingly important, with increasing connectivity between countries (Kouhizadeh, Sarkis, & Zhu, 2019).

2. DIGITAL SOLUTIONS FOR CIRCULAR ECONOMY

The digitalization of organizations and their interrelationships, represent today, one of the strongest trends that is reshaping the global economy of today. Digitization processes encourage the achievement of greater overall organizational performance and equal building of competitive advantages, which are necessary for the survival and growth of organizations (Peppard, 2016). Digitization is an important tool for enabling and facilitating the circular economy. "Many ideas about the circular economy, which have been discussed for decades, are possible today with the help of the digital revolution" (Preston & Lehne, 2017). According to most experts, digitalization is one of the main drivers of the application of the circular economy, because it allows visibility, traceability and monitoring of locations and conditions of resources and products in real time, as well as the availability of assets (Sillanpää & Ncibi, 2019). Also, many circular economic principles are possible with the help of digitalization (Larsson & Lindfred, 2019).Thus, pairing the digital revolution with the circular economy can transform the economy's relationship to materials and finite resources, creating added value and positive outcomes, separating the creation of economic value from resource consumption (Sillanpää & Ncibi, 2019). The transition to use of resources will only progress if digitization is maximized, which involves understanding the links and exploiting synergies between digital and circular economy programs (Larsson & Lindfred, 2019).

2.1. Challenges of digitization

The benefits of digitization and digital solutions, by switching and establishing a circular economy are enormous. But, on the other hand, there are also some challenges that must be solved, so that the circular economy can be fully implemented, with the maximum use of the effects of digital technologies. Overall, these barriers can be divided into (Sillanpää & Ncibi, 2019):

- Financial barriers;
- Mathematical and computer optimization models to provide support during the decision-making process;
- Analysis based on operational data;
- Extensive data analysis.

The speed and scope of digital transformation is affecting almost all industries, resulting in more and more new IT companies that need to enable the application of technologies at all levels. Innovations are happening at a high speed and in the next few years, digitalization will affect the development of many areas. The digitization process will ensure that industrial production is fully automated (Milanovic et al., 2018).

Table 1: Challenges / barriers to overcome (Sillanpää & Ncibi, 2019).

Number	Challenges / barriers	Explanation
1.	Financial barriers.	Financial barriers, such as measuring financial benefits, financial profitability, etc.
2.	Mathematical and computer optimization models to provide support during the decision-making process.	The goal of these models is to optimize industry-related industrial activities, such as industrial symbioses, and to enable designers to optimize their environmental, economic, or employment goals.
3.	Analysis based on operational data.	This refers to the obstacle that may arise in terms of creating information within the supply and industrial networks, and thus to optimize the use of resources especially for industrial symbioses in eco-industrial parks.
4.	Extensive data analysis.	Using extensive data analysis to determine mutual trust, corporate culture, sustainable consumption, or corporate behavior within industrial networks to increase industrial viability can pose a serious challenge or barrier to managing so many different data.

3. OVERVIEW OF THE RELATIONSHIP BETWEEN SYNERGIES OF CIRCULAR ECONOMY, INDUSTRY 4.0 AND DIGITAL TECHNOLOGIES

These three terms are linked together multiple times as well as individually Topics, such as circular economy and Industry 4.0, are receiving increasing attention, both separately and on interpersonal relationships. "Industry 4.0 is widely accepted as the driving force behind the circular economy model "(Lopes de Sousa

Jabbour et al., 2018). The inclusion of an increasing number of applications and the use of technology is what actually represents the development of this Revolution (Hunt, 2018). Using technology to change the future and the opportunity to create a "more sustainable and circular society" that will, with its help, have multiple benefits, both in business and in everyday life, is the main purpose of Industry 4.0 (Perez, 2018). “Industry 4.0 is an industrial system that works through the integration of production operating systems as information, as well as communication technologies“ (Wang et al., 2015; Dalenogare et al., 2018). Mutual relationship is shown in Figure 1, where it can be seen that it is digital technologies that connect these two concepts.

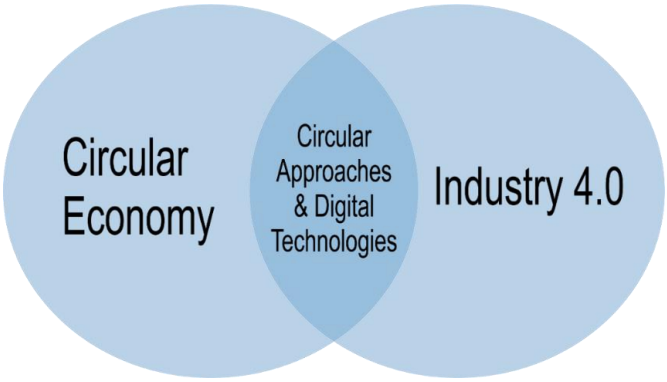

Figure 1: Mutual relationrelationship (Okorie et al., 2018)

Development with technological progress has greatly contributed to the emergence of Industry 4 (Hunt, 2018; Okorie et al., 2018). Furthermore, the synergistic and integrated relationship is reflected in the fact that together, circular economy and Industry 4.0, influence companies to reduce their business strategies and models, because both of these strategies are complementary and synergistic effects can be established between them (Ávila-Gutiérrez et al., 2019). This refers to the reduction of duplication or more different models, which do not necessarily exist, because they would only represent an additional obligation and cost for companies.

Further connection or relationship between the circular economy and Industry 4.0 is reflected in the field of waste management, i.e. in finding innovative ways of achieving sustainable waste management and thus creating opportunities to close the circular loop of the economy. The “4Rs“ (reduction, reuse, recycling and recovery) have always been at the forefront of sustainable waste management. With the advent of Industry 4.0 technology, adding another R to the “redesign" of products and processes makes sense. The possibilities are endless. For example, the use of big data and artificial intelligence can help produce products that are more durable. While machine learning and robotics can much more effectively help recover and recycle material and thus make waste reuse economically viable (ISWA, 2019).

The challenge is how to simultaneously build a sustainable Industry 4.0 and use Industry 4.0 to build sustainability. In other words, society should (Knudsen & Kaivo-Oja, 2018):

- Ensure that sustainability and circular economy are a feature in the ecosystem of technologies that enable Industry 4.0; as much as possible
- Explore and harness the potential of Industry 4.0 to build a more sustainable business model and manufacturing systems. These challenges are shown in Figure 2.

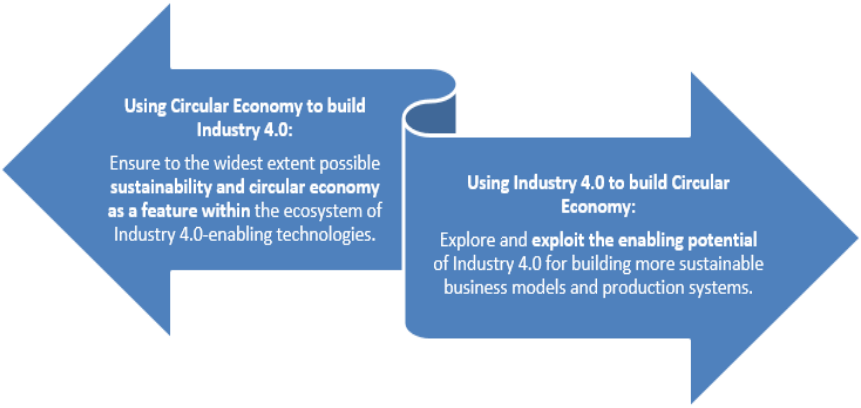

Figure 2: Circular Economy for Industry 4.0 and Industry 4.0 for Circular Economy (Knudsen & Kaivo-Oja, 2018).

4. CONCLUSION

Until a couple of years ago circular economy would not have been applicable due to the fact that technology has not advanced enough, for the reason that it could not support the ideas that are being developed by the application of circular economy. Even today, most products are not biodegradable or are difficult to biodegrade, and those that can be recycled are recycled only a limited number of times, usually with significant consumption of additional energy. Greater investment in research and development, as well as the development of technologies will lead to potential opportunities that will facilitate the circular economy and its implementation. A reliable set of information is needed to understand the potential values of circular materials, products, and systems. Companies that want to keep up with all the changes that come with accelerated industrialization must focus on investing in technology, must develop and use a variety of digital solutions that will support their business and operating models. Circular economy, as well as Industry 4.0 are topics focused on sustainability, i.e. building a more sustainable model and business system, while bringing unimaginable opportunities for energy and resource efficiency, all through and with the help of digital technologies. The idea included in this paper allows us to draw a conclusion, which can be useful for further research, and that is that the interconnectedness and integration of these three concepts, lead to technological advances that can provide prosperity, better living conditions, better business and a more sustainable world. It is necessary to work on providing support in education, related to all three topics, for both the staff in companies and young people, because this new industrial revolution would help highlight talents and ideas, as well as provide the opportunity for future further training. It can be concluded that these three areas are compatible and that complementary, they can achieve excellent effects, as well as that with the help of various digital technologies and digital solutions, they can potentially accelerate the application of circular economy, and at the same time follow in the right way all the changes that Industry 4.0 brings with it.

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INNOVATION AND ENTREPRENEURSHIP ECOSYSTEM IN SERBIA: PERFORMANCE AND ACTORS

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Abstract: *Theory and practice have offered evidence that innovation and entrepreneurship are the engines of growth both in developing and developed economies. The ecosystem approach is a useful tool in assessing different aspects of a process in which innovative entrepreneurship contributes to the competitiveness and economic growth. The aim of this paper is to examine the performance and actors in Serbian innovation and entrepreneurship ecosystem (IEE). In particular, this paper focuses on exploring different domains of the IEE on the basis of selected components of the Global Competitiveness Index. The actors in Serbian IEE are explored from the perspective of establishing an innovative company in order to give an overview of the type and activities of different stakeholders. The research offers pathways that may activate changes in the infrastructures and processes affecting innovative and entrepreneurial activities in Serbia.*

Keywords*: innovation, entrepreneurship, ecosystem approach, performance, actors.*

1. INTRODUCTION

Innovation generation and entrepreneurial spirit have been widely acknowledged as depending on a complex set of economic, social and cultural factors. Exploring the framework for innovation and entrepreneurship can be done through the innovation and entrepreneurship ecosystem (IEE) framework.

The IEE concept is based on a premise that developing supportive environment is a key factor in nurturing innovation and entrepreneurial activities. The concept has become very popular among academics and policy makers focused on national and local economic development. Successful innovation and entrepreneurship ecosystem enables different actors (entrepreneurs, companies, universities, research organisations, investors and government) to interact effectively and maximise the economic impact and potential of their activities. They include combination of various economic, political, social and cultural elements which support innovative start-ups and encourage entrepreneurship. Efficient IEE enables increasing country output, increase of employment and exploiting technological breakthroughs.

Monitoring performance, actors and networks of the innovation and entrepreneurship ecosystem is an important activity for every national economy due to its effects on economic development. Results of this process give valuable information for decision makers in the area of economic and scientific and technology policy. Analysis of innovation, technology and entrepreneurship is relevant for planning, implementation and evaluation of policies and programs in these fields. Moreover, indicators of innovation and entrepreneurship are beneficial for companies or industry sectors when making decisions related to funds allocation, selection of areas for innovation or creating innovative strategies.

The paper is structured as follows. Section 2 explains evolution of the innovation and entrepreneurship ecosystem concept and it introduces different IEE models. Performance of Serbian innovation and entrepreneurship ecosystem is explored in the third section through the selected components of the Global Competitiveness index. The fourth section presents actors in Serbian IEE from the perspective of innovative company, i.e. in each phase in establishing innovative company. Final sections include concluding remarks and reference list.

2. CONCEPT AND MODELS OF INNOVATION AND ENTREPRENEURSHIP ECOSYSTEM

There are different theoretical and practical approaches in explaining the environment in which innovation and entrepreneurial activity is taking place. Some of them are: national innovation system, innovation

system, Triple/Quadruple Helix model, innovation ecosystem, entrepreneurship ecosystem. These approaches include different stakeholders and their relationships in the processes of research, development and innovation. One of the most comprehensive concepts is innovation and entrepreneurship ecosystem.

The term “ecosystem” is used in innovation studies in order to capture the interconnected nature of different actors and processes in academic, government and business sector. The ecosystem approach emerged in the 1990s when the concept of “business ecosystem” was developed. Business ecosystem is used to explain interactions between companies from different industries in the process of cooperative work and developing innovative products (Moore, 1993).

Innovation ecosystem is a framework used to encompass different participants, resources and their relationships in enabling technology development and innovation. Participants in the innovation ecosystem are researchers, entrepreneurs, investors, providers of business development, technical services or skills training. Each of these actors plays a significant role in creating value, enabling flow of information and resources, and launching new solutions which increase human well-being.

The first use of the innovation ecosystem concept emerged in 2006 when it was described in Harvard Business Review as “the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution“ (Adner, 2006, p. 2). One of the broadest definitions of the innovation ecosystem explains it as “the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors” (Granstrand & Holgersoon, 2020, p. 3).

The entrepreneurial ecosystem concept includes different elements that affect the entrepreneurial activity. It can be defined as a set of interacting factors which moderate the effect of entrepreneurial activity on economic growth (Bruns, Bosma, Sanders & Schramm, 2017) or which enable productive entrepreneurship on a certain territory (Stam & Spigel, 2016). The entrepreneurship ecosystem offers not only the networking propensity, but also regional “communities of practice” and interactive learning from the ecosystem actors (Cooke, 2016). The comprehensive definition of the innovation and entrepreneurship ecosystem describes it as a set of interconnected entrepreneurial actors and processes in the three most important parts of the entrepreneurship: creating opportunity, innovation and organizations, and bearing responsibilities in developing policies, measures, instruments for connecting, mediating and governing the performance within the local innovation and entrepreneurial environment (Levi-Jakšić, Rakićević & Jaško, 2018).

An important challenge in innovation and entrepreneurial ecosystem analysis is a conceptual ambiguity, due to its close resemblance to other network or system-level concepts (Ritala & Gustafsson, 2018). There are approaches similar to the entrepreneurship ecosystem, such as clusters, industrial districts of regional innovation systems. These approaches emphasise the importance of social, cultural and economic context of the entrepreneurial process, but they have different focal points. The focus of the entrepreneurship ecosystem is the individual entrepreneur or a start-up, rather than established companies or SMEs. The output of the entrepreneurial ecosystem is entrepreneurial activity based on creating opportunities for innovation. The innovation will bring new value to the society and it is the ultimate outcome of the entrepreneurial ecosystem (Stam & Spigel, 2016)

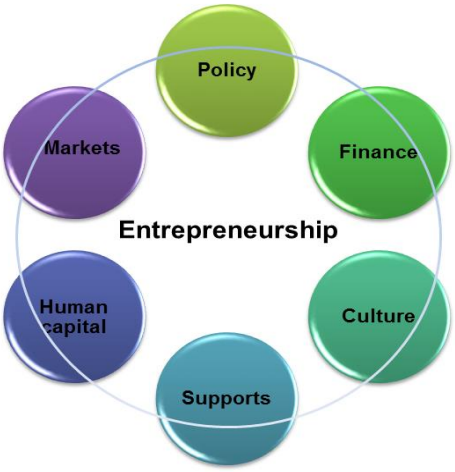

Figure 1: Domains of the entrepreneurship ecosystem (Source: Isenberg, 2011)

Entrepreneurship ecosystem includes six domains: policy, markets, finance, human capital, culture and support organisations. These domains interact in different ways and their analysis shows if the entrepreneurship is self-sustaining or not (Isenberg, 2011). Aspects of the entrepreneurship ecosystem are presented in Figure 1.

The World Economic Forum, in cooperation with Stanford University, Ernst & Young and Endeavor created an entrepreneurial ecosystem model in order to understand how companies conquer new markets and become successful. They surveyed more than 1,000 entrepreneurs from early-stage companies and after evaluating their answers the model was developed. The advantage of this methodology is the fact that it is developed on the basis of the opinions from all over the world. The model is shown in Figure 2. The research has shown that the three most crucial domains for entrepreneurs are accessible markets, funding & finance and human capital.

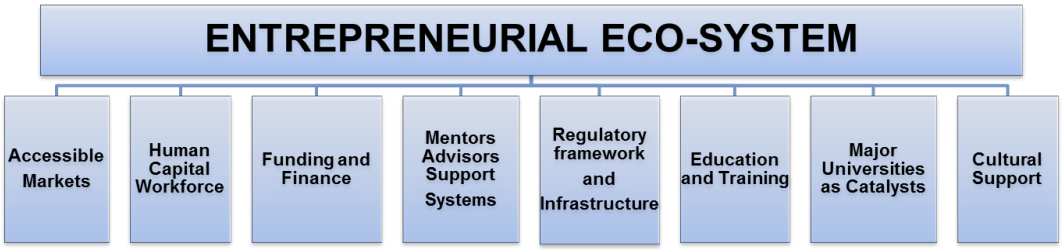

Figure 2: WEF Entrepreneurial Ecosystem (Source: World Economic Forum, 2013)

The relational model of the entrepreneurial ecosystem is starting from the premise that it is necessary to include relations between different elements. The entrepreneurial ecosystem is dynamic since there are different relations between cultural, social and material attributes. These characteristics of the entrepreneurial ecosystem determine the level of entrepreneurial activity as the output of the entrepreneurial ecosystem (Spigel, 2015). Cultural attributes include supportive culture and history of entrepreneurship, while social attributes are talent of workers, capital, networks or role models. Material attributes encompass support centres, infrastructure, public policy, universities, etc. An ecosystem's attributes are created and reproduced through their relationships with other attributes. This approach is presented in Figure 3.

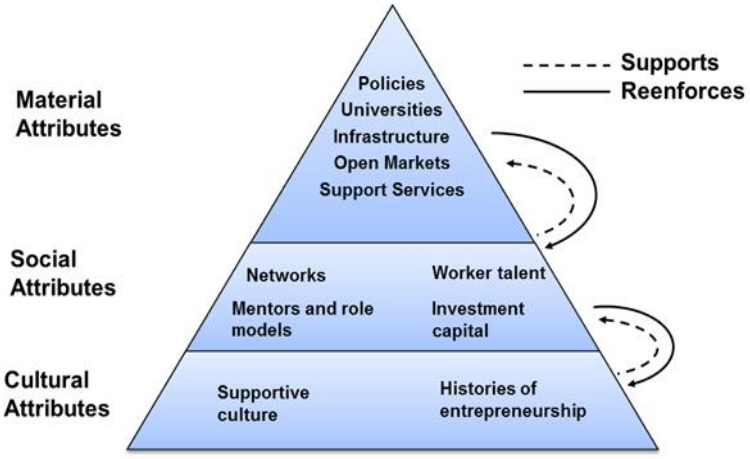

Figure 3: Relational approach to the entrepreneurial ecosystem model (Source: Spigel, 2015)

There are different theoretical and practical disadvantages of the innovation and entrepreneurship ecosystem concept. The ecosystems are defined in very different ways, on different levels and with different research methodology and data. The discussion regarding the entrepreneurial ecosystems is mainly focused on its elements, while ignoring the processes of their combination and sustainability (Malecki, 2018). Previous investigations are also missing case studies showing the evolution of concrete entrepreneurship ecosystems. This is a huge challenge since it requires tracing history of certain area backward for a few decades (Motoyama & Watkins, 2014). Important shortcoming of the existing IEE studies is the fact that they are often focused on the entrepreneurship ecosystem in single regions or clusters, but lack a comparative and multi-scalar perspective (Alvedalen & Boschma, 2017). There are also approaches which highlight the necessity to make difference between quality and quantity in the entrepreneurship activity while assessing the IEE outcomes (Szerb, Lafuente, Horváth & Páger, 2019).

3. PERFORMANCE OF SERBIAN IEE

There are different indicators, methodologies and standards for measuring performance of innovation and entrepreneurship system. They can be classified into three broad categories: innovation and entrepreneurship surveys; individual indicators and composite indicators. It is very difficult to focus on only one indicator when assessing the results in certain field especially having in mind the fact that majority of indicators represent indirect measure of innovation or entrepreneurship performance.

Individual indicators of scientific or economic development are used to create composite indices which enable comprehensive consideration of the national position. There are different international initiatives for developing aggregate indices. Some of them are: European Innovation Scoreboard, Knowledge Assessment Methodology, Global Innovation Index, Global Competitiveness Index, Competitive Industrial Performance Index. For the purpose of this research, the evaluation of Serbian innovation and entrepreneurship ecosystem will be based on the Global Competitiveness Index and its components.

The Global Competitiveness Index (GCI) is developed by the World Economic Forum (WEF) and it is published every year in the Global Competitiveness Report. It is one of the broadest and most popular indicators for measuring overall performance of the economy. The World Economic Forum defines competitiveness as a set of institutions, policies and factors which determine the productivity level of the economy, which in turn determines the level of prosperity (World Economic Forum, 2016). The WEF methodology is being improved almost every year and in 2018 the Global Competitiveness Index 4.0 was developed. The GCI 4.0 is calculated on the basis of 103 individual indicators (combination of data from international organizations) and results of the World Economic Forum's Executive Opinion Survey (World Economic Forum, 2019). WEF Executive Opinion Survey is distributed to the business leaders around the globe and serves for getting answers in areas lacking official statistics or in cases when official statistics does not offer comparability between different countries. In the current WEF report, indicators are organized into twelve pillars: Institutions; Infrastructure; ICT adoption; Macroeconomic stability; Health; Skills; Product market; Labour market; Financial system; Market size; Business dynamism and Innovation capability.

The Table 1 summarizes components of the Global Competitiveness Index for the Republic of Serbia sorted by the different domains of the innovation and entrepreneurship ecosystem. Each component is described by its value, score and rank among 141 countries. Scores are indicated on a scale from 0 to 100, where 100 represents the optimal solution or "frontier". Each score is followed by the arrow indicating the direction of change in comparison with the previous period.

According to the Global Competitive Index for 2019, Serbia is the 72th most competitive nation in the world among 141 countries covered in the research (World Economic Forum, 2019). This is a fall from 65th position it held in 2018.

In the area of human capital Serbia has the worst position in the extent of staff training, while finding skilled employees has the most favourable rank. GCI components related to the market competition and dominance have the most unfavourable ranks in comparison with other IEE domains. Extent of market dominance is ranked 110th, competition in services 85th and distortive effect of taxes and subsidies on competition is 81st. These data undoubtedly reveal the fields for improvement. Financial system indicators show improvement related to financing of SMEs and venture capital availability. Domestic credit to private sector is ranked 81st and considered as less favourable than in the previous period.

Indicators of business dynamic explain the administrative, cultural and innovative environment. The business registration procedure in Serbia lasts 5 days and Serbia is ranked 27th in this field. Costs of starting a business are also low in comparison with other world economies. On the other hand, Serbia has very unfavourable rank when it comes to attitudes towards entrepreneurial risk (107th), willingness to delegate authority (82th), growth of innovative companies (83rd), companies embracing disruptive ideas (80th). These indicators show low level of innovative and entrepreneurial culture in the country.

Innovation capabilities domain of the IEE includes different indicators affecting various elements of the innovation process. Serbia has the worst results in the area of cluster development and multi-stakeholder collaboration. It is interesting to notice that although R&D expenditure in Serbia is only 0.9% of GDP, it is ranked 38th. Numbers of scientific publications, international co-inventions and patent applications take above average position among observed countries. For example, there are 1.08 international co-inventions per million population in Serbia which ranks it 43rd among 141 countries.

Table 1: Global Competitiveness Index components (Republic of Serbia, 2019).

IEE domain	GCI Component	Value	Score	Rank/141
Human capital	Extent of staff training 1-7 (best)	3.6	43.6↓	104
	Skillset of graduates 1-7 (best)	4.1	51.9↓	65
	Digital skills among active population 1-7 (best)	4.1	51.5↓	77
	Ease of finding skilled employees 1-7 (best)	4.4	57.3↑	51
Markets	Distortive effect of taxes and subsidies on competition 1-7 (best)	3.6	43.3↑	81
	Extent of market dominance 1-7 (best)	3.2	37.4↓	110
	Competition in services 1-7 (best)	4.7	62.3↓	85
Financial system	Domestic credit to private sector (% GDP)	43.3	45.5↓	81
	Financing of SMEs 1–7 (best)	3.9	49.1↑	65
	Venture capital availability 1-7 (best)	3.2	35.9↑	69
Business dynamic	Cost of starting a business (% of GNI per capita)	2.2	98.9↑	45
	Time to start a business (days)	5.5	95.0 =	27
	Attitudes towards entrepreneurial risk 1-7 (best)	3.7	44.9↑	107
	Willingness to delegate authority 1-7 (best)	4.2	53.1↑	82
	Growth of innovative companies 1-7 (best)	4.0	49.2↑	83
	Companies embracing disruptive ideas 1-7 (best)	3.5	42.3↑	80
Innovation capabilities	Diversity of workforce 1-7 (best)	4.7	62.0↑	48
	State of cluster development 1-7 (best)	3.4	40.0↓	104
	International co-inventions (per mil. pop.)	1.08	22.4↓	43
	Multi-stakeholder collaboration 1-7 (best)	3.6	42.9↑	87
	Scientific publications (score)	180.3	77.0↑	61
	Patent applications (per mil. pop.)	2.49	22.9↓	54
	R&D expenditures (% of GDP)	0.9	31.0↑	38
	Research institutions prominence 0-100 (best)	0.02	4.2↑	60

Source: World Economic Forum, 2019.

4. ACTORS IN SERBIAN IEE FROM THE PERSPECTIVE OF INNOVATIVE COMPANIES

Serbian innovation and entrepreneurship ecosystem includes actors from different sectors: academic, governmental and private. In this research, for each phase in establishing innovative company are presented IEE actors including their activities, type and concrete example. Of course, the phases in establishing innovative company are introduced with the assumption that innovation are based on R&D and technology transfer. In real conditions, there are non-technological innovations and those developed without research efforts. For example, innovation may happen as a result of individual intellectual work.

As illustrated in Table 2, the first phase in establishing innovative company includes research and development. This embraces generating ideas, conducting concrete R&D types and financing these activities. Actors involved in this phase are universities, research institutes, innovation centres, ministries and R&D funding agencies. R&D performers are universities and R&D institutes. They are funded by the Ministry of the Education, Science and Technological Development, Science Fund and different international programs, projects and organisations.

Conveying results of scientific research into market or wider community requires help of technology transfer and intellectual property rights (IPR) professionals. There are technology transfer offices established at the public universities in Belgrade, Novi Sad, Kragujevac and Niš. Intellectual Property Office offers consulting related to the IPR. Researchers and SMEs can also get preliminary IPR consulting and technology transfer help from the Enterprise Europe Network Advisers.

In the phase of establishing innovative company, IEE actors offer different services: creating business models; renting office space; business, legal and marketing consulting; staff training; networking and mentoring. There are many support organisations offering these services – Science & Technology parks, business incubators, clusters, associations, chambers of commerce, development agencies, etc. Serbia has four S&T parks, several business incubators, and many clusters and specialised organisation supporting innovative start-up companies. Chamber of commerce and Development Agency also have different programmes for supporting entrepreneurships and innovators. A recent study exploring facilities providing business development services in Serbia highlighted the importance of improving and standardizing their offer in order to move from co-working and property-based services to high-value services. Smart

specialization strategy is identified as a tool for transforming business incubators into network hubs and areas of innovation (EUBID project, 2019).

Table 2: IEE actors per phases in establishing innovative company

Phase in establishing innovative company	Activities	Type of IEE actor	Example
Research & Development	- Generating ideas - Basic research - Applied research - Experimental development - Financing R&D	- Universities, research institutes and innovation centres - Ministries - Agencies for funding R&D - International programmes and organisations	- Accredited universities: University of Belgrade, University of Novi Sad, University of Kragujevac, University of Niš, etc. - R&D institutes: Institute "Mihajlo Pupin", Institute of physics, Vinča Institute of Nuclear Sciences, etc. - Ministry of education, science and technological development - Science Fund - Innovation Fund
Technology transfer and IP protection	- Advising in the area of technology transfer and IPR	- TT offices - IP offices - Professionals, specialized projects	- Center for technology transfer, University of Belgrade - Danube Center for Technology Transfer, University of Novi Sad - Knowledge Transfer Center, University of Kragujevac - Center for technology transfer, University of Niš - Intellectual Property Office of the Republic of Serbia - Enterprise Europe Network Advisers
Establishing a company	- Creating business models - Office space - Business and legal consulting - Networking, mentoring, marketing and promotion - Professional trainings	- S&T parks - Business incubators - Chambers of commerce - Development agencies - Clusters and associations	- Science and Technology Parks: Belgrade, Novi Sad, Niš and Čačak - Business & Technology Incubator of technical faculties Belgrade - Business incubators in Novi Sad, Subotica, Kagujevac, Kruševac, Pirot, etc. - StartIT, ICT Hub, Impact Hub, Nova iskra - Chamber of Commerce and Industry of Serbia - Development Agency of Serbia - Clusters: Vojvodina ICT cluster, Fashion apparel cluster Serbia, Agro Cluster of Serbia, etc.
Seed financing	- Seed money grants - Crowdfunding initiatives	- Ministries and funding agencies - Individual investors - Angel investors - Venture capital funds - Crowdfunding platforms	- Innovation Fund - Ministry of education, science and technological development - Crowdfunding platforms: kickstarter.com, indiegogo.com, etc.
Financing in the phase of maturity	- Initial public offering - Loans - Government programmes for fostering entrepreneurship	- Individual investors - Companies - Financial institutions - State institutions	- Commercial banks - Ministry of economy - Development Fund of the Republic of Serbia

Source: Prepared by the authors.

Acquisition of the seed financing for new business ideas is usually the most difficult phase which requires tremendous networking and effort. Actors in this phase include relevant ministries, funding agencies, individual and angel investors, venture capital funds and crowdfunding platforms. Seed money for starting innovative business in Serbia is provided by the Ministry of Education, Science and Technological Development and Innovation Fund. Also, there are different networks of investors and crowdfunding campaigns available.

In the phase of maturity, innovative companies can obtain funds through initial public offerings, loans or government programmes for supporting entrepreneurship. This includes engaging individual investors,

financial and state institutions. In Serbia, there are frequently opened public calls for fostering entrepreneurship published by the Ministry of economy and the Development fund.

5. CONCLUSION

The innovation and entrepreneurship ecosystem concept represents a very useful framework for assessing the external environment determining micro and macro aspects of national competitiveness. Analysis of different actors, domains, networks and relationships in the IEE enables identifying bottlenecks and areas for improvement.

According to the components of the Global Competitiveness Index grouped per IEE domains, Serbian IEE has potential for improving in all selected areas: human capital, markets, financial system, business dynamic and innovation capabilities. Ranks and scores of the GCI suggest that the most disadvantaged position of the innovation and entrepreneurship ecosystem in Serbia are related to the market dominance, attitudes towards entrepreneurial risk, cluster development, staff training and multi-stakeholder collaboration.

Analysis of the actors in Serbian IEE indicates that there are diverse organisations and institutions performing relevant activities in each phase of establishing an innovative company. It is especially developed a network of supporting organisations offering services of business and legal consulting, creating business models, networking, mentoring and professional trainings. This analysis should be considered as a preliminary mapping of these organisations. In order to understand their activities and impact, a more detailed assessment is required.

The research presented in this paper offers insights of Serbian IEE relevant for policy makers, entrepreneurs and researchers. Policy makers could find relevant information and methodology necessary for knowledge-based decision making in the area of scientific and technological development. Innovators and entrepreneurs are offered a range of stakeholders in the IEE which could help them in implementing their business ideas. The paper is also valuable for researchers since it offers a solid base for future investigation in this area.

ACKNOWLEDGEMENT

The research described in this paper was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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HOW GREEN IS GREEN ENTREPRENEURSHIP? THE PATHS AND PATHWAYS OF ECO-MODERNIZATION IN THE CASE OF THE AUTOMOTIVE INDUSTRY

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Abstract : *Environmental and social crises have put humans at the forefront of their entire developmental dilemma. How to survive on a limited planet with a growing population and declining livelihoods? The current neoliberal policy has not met people's expectations, neither on a social level or on an environmental level. Inequality in society is increasing, environmental problems continue and escalate and human-human conflicts and their nature deepen. Finding solutions to emerging problems for space is becoming a necessity for all living things on the planet. If we adopted the concept of sustainable development in the mid-1980s, we can summarize today that we have not reduced the problems but further deepened them. Just as in the case of sustainability, where there is ambiguity in the interpretation of the concept and precisely because of this realization of its goals in space, the concepts of green entrepreneurship and green capitalism must be considered constructively critical. The very concept of "green" does not yet mean a truly environmentally and socially successful transformation which will be presented below.*

Keywords*: environmental crises, neoliberal policy, sustainable development, green entrepreneurship*

1. INTRODUCTION

The concept of Green Entrepreneurship began to emerge in the so-called era of eco-capitalism when neoliberalism began to integrate the environment into its concepts due to the growing social crises caused by negative environmental impact (negative environmental influences can be defined as direct, occurring in space and indirect, and both as consequences of human anthropogenic influences).

The beginning of sustainable development can be considered the middle of the 1980s, when the concept of sustainable development was adopted in the Brundland Commission, and which in the political field (UN) advocated a more careful attitude towards the environment and society, also in the future.

But the problem arose with different interpretations of sustainable development. Sustainable development is interpreted differently by neoliberal theoretical economists and eco economists, than environmentalists. Economists as a continuation of consumerism, economists as a continuation of growth, and environmentalists as a reducing pressure on the environment, which in relation to the first two (economists) is a contradictory concept. Sustainable development for the first two actors is ultimately a continuation of growth and thus a burden on space and pressure on resources, for environmentalists it is the opposite, sustainable and extreme careful exploitation of natural resources and their exploitation, which should not exceed the self-renewal capacity of nature and the environment.

Despite many positive effects on society and the environment, the idea of sustainable development is not actually implemented in practice in a way that would reduce the pressure on the environment and society due to different interpretations of social actors. The fact that there is no single concept of sustainable development, where economists interpret it as a continuation of sustainable growth and thus pressures on the environment and the environment, on the contrary, reducing consumption and protecting the environment, has led to the failure to implement the idea it was not so successful. A step in the right direction is a comprehensive treatment of all segments and all factors in space, in a way where the environment and nature represent an equal factor with man. And not like now that nature appears and with it resources in a subordinate position.

Today, the green economy could be a step in the right direction, linking it to the idea of a circular economy, which is currently a fundamental focus in reducing the impact of greenhouse gases and developing carbon-free in the future in the economies of developed EU countries. Green economies formed in this way can represent not only the potential for green, more socially and environmentally sustainable development, but also the potential for reducing social and environmental conflicts. A precondition for a successful green transformation of the neoliberal, economic and social mentality is a comprehensive consideration of the positive and negative effects of measures to restructure the economy in practice.

The example of the automotive industry shows that for a real green breakthrough, all segments in the development of electric cars need to be addressed. From the resources for building batteries, technological systems and energy used to convert substances into elements needed to build batteries, to aggregates, charging stations and the production of green energy for charging stations, to the restructuring and transformation of jobs lost by replacement jobs to power units in the classic diesel and petrol sector. For true green production, the following areas and activities need to be considered in the automotive industry:

- Environmental impacts due to the extraction of (lithium) ore
- Base metal production for battery production, resources consumed, and conversion time
- Construction of batteries and their decomposition after use
- Installation of additional power grids for charging electric batteries and their impact in space
- Efficiency of e cars in terms of greenhouse gas production compared to conventional units
- Generation of electricity from RES for the purposes of mobility
- Transformation of jobs to move to e-mobility (job loss)
- Exploitation of (human) resources in the production of base metals for batteries and the impact of multinationals on the exploitation of cheap labor (Žnidarič, 2018).

2. COMPOSITION

2.1. Environmental impacts from lithium ore excavation.

Given that by 2030, between 15 and 25 percent of cars will use electric propulsion and 75 to 90 percent will use lithium-ion batteries. This means that by the year 2030, between 65,000 and 145,000 tones of lithium carbonate will be need to be obtained to meet lithium requirements (Co Not, 2011). Lithium production itself is not yet a critical process. Mining and transportation potential being the main problem while intermediate chemical processes due to refining and lithium production do not pose any major risks for environmental impacts. Cobalt production, which is an indispensable element in battery production is extremely environmentally controversial. The problem is in the refining materials and refining of the ore (cobalt) itself where in addition to various acids (sulfuric and hydrochloric) chlorine, ammonia, hydrogen sulfide, sodium hydrogen sulfide, lime and the use of a lot of energy.

2.2. Base metal production for battery production, resources consumed, and conversion time

For 1 ton of lithium, we need 750 tones of lithium brine and 24 months to prepare (Battery UN, 2018). Recycling 20 t of lithium-ion batteries yields 1 t of lithium for further use, or 5.3 t of lithium carbonate for 1 t of lithium (121 Group). How much lithium is in individual batteries depends on the chemical structure and of course the size of the battery in kWh. On average, the amount of lithium in a battery varies between 150 and 300 grams. If the battery is for 100 kWh, this amounts to between 15 and 300 kg of lithium for a car (Vitas, 2016). Lithium-ion batteries contain in addition to lithium, which is not a dominant element in batteries at all, the following metals, whose production is, as previously mentioned, more environmentally controversial and harmful (Žnidarič, Senegačnik, & Vuk, 2018).

In the initial phase of construction batteries for e-cars in the production of the necessary metals (15 metals) and technologies themselves compared to conventional diesel gasoline units more than two-thirds (74%) of CO_2 is released on 500 kg batteries which is more than would be generated by the production of more efficient classic cars, which using fossil fuels (Enavex, 2017; Battery University, 2018). The fact that this data shows is that the production of batteries for electric cars is not as green as that shown by supporters of current electric cars. Just to compare, the owner of an average classic car could travel 50,000 km before equaling the release of an electric Nissan Leaf with a 30 kWh battery. It should be noted that the Nissan battery is one of the smallest on the market, as the BMW i3 has a 42 kWh battery, the Mercedes EQC 80 kWh and the Audi e-tron 95 kWh (Rolander. N; Starn.J; Behrmann. E, 2018). The International Organization for Cleaner Transport (ICCT, 2018) states that between 56 and 494 kg of CO_2 are released for the production of batteries for each kilowatt hour or battery capacity (kg CO_2 / kWh). It accounts for an additional 1-2 g CO_2 per kilometer per kWh of battery (ICCT, 2018).

Table 1: Lists the metals and their values used in batteries.

Metals and batteries	Quantity in mg / kg
Aluminum	195,000
Cobalt	124,000
Baker	104,000
Lithium	18,000
Nickel	13,000
Iron	4,700
Manganese	1,700
Barium	1,200
Lead	300
Thallium	180
Zinc	160
Antimony	80
Chrome	30
Silver	30
Vanadium	20

2.3. Installation of additional energy networks for charging electric batteries and their impact in space

Existing electricity networks are already at the edge of capacity in some so-called developed countries. If we summarize only Slovenia, the strategy of the energy concept until 2055 envisages the achievement of 100% e mobility in the public and private transport sector. Bold plans that collide with the problems of dilapidated and overloaded transmission systems, and especially the lack of electricity (Agencija za energijo, 2017). For the needs of e mobility, it is necessary to build charging stations, which can be an additional problem in larger cities due to space constraints (Etrel; Polni si, 2018). The problem is also individual deficient parking / filling sites, which are not constructed for additional electric consumption (Schrak, 2018). All of these problems represent an additional logistical, charging problem if we want to successfully move to a fully electric automotive section (Elektro Ljubljana, 2019).

2.4. Generation of electricity from RER (Renewable Energy Resources) for mobility purposes

For the sake of e-mobility and more efficient use of energy or if we are to meet the country's 100% eligibility criteria for e-mobility and heating we would need to double our electricity production. From today 10 TWh (produced in Slovenia), we would need an additional 10 TWh. (Žnidarič; Valenčič, 2018). For green mobility, it should be produced from RER. Therefore, an appropriate energy strategy is needed at the level of countries and local communities that are moving towards the maximum use of RER (Žnidarič, Valenčič, 2018). At the moment almost all energy for charging batteries in electric cars come from fossil fuels. Because of this fact we cannot speak of green mobility.

2.5 Generation of electricity from RER for mobility purposes

For the sake of e-mobility and more efficient use of energy or if we are to meet the country's 100% eligibility criteria for e-mobility and heating we would need to double our electricity production. From today 10 TWh (produced in Slovenia), we would need an additional 10 TWh. (Žnidarič & Valenčič, 2018). For green mobility, it should be produced from RER. Therefore, an appropriate energy strategy is needed at the level of countries and local communities that are moving towards the maximum use of RER (Žnidarič & Valenčič, 2018). At the moment almost all energy for charging batteries in electric cars come from fossil fuels. Because of this fact we cannot speak of green mobility.

2.6. Electricity production from RES for e mobility needs

For the needs of e-mobility and more efficient use of energy, or if we want to meet the outlined criteria of the state of 100 percent in terms of electromobility and heating, we should double the production of electricity. From today's 10 TWh (produced in Slovenia), we should obtain an additional 10 TWh. (Žnidarič, 2018; Valenčič, 2018). For green mobility, it would need to be produced from RES. Therefore, an appropriate energy strategy is needed at the level of countries and local communities that go in the direction of maximizing the use of RES (Žnidarič & Valenčič, 2018).

2.7. Installation of additional energy networks for charging electric batteries and their impact in space

Existing electricity grids are already on the verge of capacity even in some so-called developed countries. The Energy Concept Strategy in Slovenia envisages achieving 100% e mobility in the public and private transport sectors by 2055. Bold plans that collide with the problems of worn out and congested transmission systems, and especially the lack of green electricity (Agency for energy, 2017). For the needs of mobility, the construction of charging stations is needed, which can be an additional problem in larger cities due to space constraints (Etrel & Polni si, 2018).

The problem is also individual deficient parking / filling sites, which are not constructed for additional electric consumption (Schrak, 2018). All of these problems represent an additional logistical, charging problem if we want to successfully move to a fully electric automotive section (Elektro Ljubljana, 2019).

2.8. The efficiency of e cars in terms of greenhouse gas production compared to conventional generators

Compared to the most efficient internal combustion engine vehicle, a typical electric car in Europe produces 29% less greenhouse gas emissions. If classic cars in Europe produce 260 (g / km) CO_2 and save 180 units, the average electric car in Europe is 130 g / km CO_2. Norwegians are among the most economical in Europe with 70 g / km of CO_2, followed by the French with 80 g / km of CO_2. While in Germany they produce about 180 g / km of CO_2 (ACEA, 2017).

2.9. Job transformation due to the transition to e-mobility (job loss)

The European car industry directly employs 2.6 million people and indirectly provides another 14 million jobs in other industries (Najdi si, 2019).

In Germany, which is the largest employer of workers in the automotive industry in the EU (840 thousand), according to a study by the Fraunhofer Institute of Engineering in 2018 (MMC RTV, 2018), due to the growing "need", the trend for electric cars endangered during 75 and 100 thousand jobs in the classic automotive industry.

Firstly the “classic” automotive industry takes 30% more time to produce conventional gasoline and diesel vehicles than for electric vehicles because the e cars have fewer mechanical parts and assemblies (only one-sixth of all compared to internal combustion engines). Therefore, the IG Metall union predicts that by 2030, e-mobility will directly or indirectly affect every second working job in the production of powertrains. Individual manufacturers in the automotive industry believe that the ratio of job losses to jobs created by e-mobility may be 1: 5 to the detriment of employees in the "classic" automotive industry.

Given that this is a low and medium skilled workforce (installers, mechanics, etc.) and if only one-fifth of the current workers are potentially made redundant the number of direct and indirect redundancies will be 2.8 million employe who must then find new jobs. Therefore it is also necessary to think about the retraining of redundant workers otherwise there will be additional social problems.

2.9. Exploitation of (human) resources in the production of base metals for batteries and the impact of multinationals on the exploitation of cheap labor

Almost 50 per cent of all cobalt which is important in the car batteries production is produced in the Democratic Republic of the Congo (DRC) where the minerals cobaltite (CoAsS), erythrite (Co_3 (AsO_4) 2 • 8 H_2O) and scooterudite ($CoAs_3$) are mined. Amnesty International has publicly exposed the exploitation of children who work in cobalt mines in the DRC where more than 40,000 children are expected to work for $ 2 a day without adequate protective equipment in inhumane conditions for more than 12 hours each day. The refined cobalt ore is shipped to China where it is processed into a suitable raw material for battery production. Many corporations exploit social and economical inequality of undeveloped countries for making profits.This exploitation leads to degraded or destroyed areas and even greater social inequality.

For example in Africa there are many resources owned by foreigners, most of all by Chinese companies, which in a very sophisticated way (Chinese companies provide loans that most of the impoverished countries are unable to repay. So in a different way than the USA (with wars-Irak) the Chinese are looking for an easy way to find the necessary resources) get the necessary resources for their own industry. China invested about 125 billions of US dollars in to the Africa in last years.

3. CONCLUSION

Generally electric vehicles tend to have much lower life cycle greenhouse gas emissions than cars with conventional diesel gasoline units (in Europe) even taking in to account the fact that CO_2 emissions in the production of batteries are higher than in conventional units (diesel, gasoline batteries). The average electric vehicle in Europe produces 50% less greenhouse gas over the life cycle of the first 150,000 kilometers although the relative benefit ranges from 28% to 72% depending on local electricity production. The fundamental problem, or criticism, applies to all other segments of the automotive industry that do not meet the green standards of sustainable and environmentally orientated activities.

In the production of electricity for recharging batteries in e-cars the main focus is still on fossil fuels or energy from nuclear power plants which have been proven to be harmful to the environment and society. The first is due to the increasing consequences of their use in the environment, dust and particles in soil, generally because of air pollution, the second is due to nuclear waste for which we have not yet found suitable solutions.

There is also the concern that some minerals are extracted by children and workers without adequate protective equipment. They are also not adequately compensated for their work. This is a problem not only in mining activities but also chemical processes at extraction of metals which can cause additional devastated and contaminated areas.

All these processes, mining, chemical and logistical, have a negative impact on the environment and humans. The attitude of corporations the largest consumers of metal for the production of batteries is also inappropriate since they exploit the social crises of the mining countries and thus deepen not only the environmental but also the social and economical crisis. Corporations neglect the environmental and social consequences of exploitation in order to maximize profits. Most of the time, they are left with even greater environmental and social problems as are most who operate on the NIMBY (Not In My Back Yard principle).

Solutions are possible only by reducing the use of resources, optimizing business, working and industrial processes and the reduction of personal consumption. Only with full consideration of all factors can we approach the fundamental purpose of green transformation, our survival on planet Earth. Modern technology together with IT technology, knowledge and human capabilities, today enables us to find the best-optimal solutions which without expressed political will cannot be implemented in life without change. The automotive industry is a segment where I wanted to show the positive and negative sides of "green technologies" that are often (un) intentionally overlooked.

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INNOVATIVENESS WITHOUT PROTECTION

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Abstract: *This paper analyses the most important findings of the analysis of innovation capacities of SMEs which were provided within consulting services by a team of associates of the Science and Technology Policy Research Center (STPRC) of the Mihajlo Pupin Institute (MPI), which is a member of the EEN Serbia consortium. These specific consulting services have been provided to SMEs since 2016 as a specific project within the EEN Serbia project, entitled "Extended EEN innovation support service for innovative SMEs in Serbia".*

Keywords*: SMEs, innovation capacity, EEN, Serbia*

1. INTRODUCTION

The European entrepreneurship network, named "ENTERPRISE EUROPE NETWORK" (EEN), is Europe's largest business support network, offering a variety of assistance to small and medium-sized enterprises (SMEs) in the European Union (EU) and beyond. Over 50 countries from Europe and other continents are part of this business network. In Serbia, this network was formed and started operating in 2009 thanks to the funds of the Competitiveness and Innovation Framework Program (CIP) and the European Commission. EEN in Serbia enables SMEs and scientific research organizations (SROs) access to the markets of the European Union and other member states. Specific support for SMEs and SROs, eager to operate in EU markets, is organized under the EEN Serbia project, which operates in Serbia since 2009 gathering several organizations within consortia named EEN Serbia. Main aim of this project is improving the competitiveness of small and medium enterprises through the implementation of integrated services focused on innovative capacities, productivity and internationalization of business operations of supported SMEs.

This paper summarizes the most important findings of the analysis of innovation capacities of SMEs which were provided within consulting services by a team of associates of the Science and Technology Policy Research Center (STPRC) of the Mihajlo Pupin Institute (MPI), which is a member of the EEN Serbia consortium. These specific consulting services have been provided to SMEs since 2016 as a specific project within the EEN Serbia project, entitled "Extended EEN innovation support service for innovative SMEs in Serbia".

2. INNOVATION CAPACITY OF FIRMS – THEORETICAL ASPECTS

Today, it is generally accepted that innovation plays an important role in enhancing a firm's competitive advantage (Hult et al., 2004). Innovation is mostly generated by the capacity of firms to find solutions to the existing problems and to respond to the challenges in the market (Zhi-Hong, 2015). There are several factors that affect the ability of firms to innovate and improve their innovation capabilities. Theoretical and empirical studies on innovation at the firm level have recognized several factors that have positive impact on innovation capabilities of firms. Organizational learning has been proved as an important driver in generating innovations (Hurley & Hult, 1998). Firms that are willing to learn have greater abilities to adapt to new market challenges. The findings additionally show that absorptive capacity has a positive impact on innovation (Spithoven et al., 2011; Fabrizio, 2009). Some empirical evidence also suggests that imitation serves as a source of innovation (Weterings & Boschma, 2009). Establishing an innovation network with other relevant organizations and inter-firm ties have also been recognised as an important factor of firm's competitive advantage (Freel & Harrison, 2006).

Based on previous research, it is clear that innovation is important for the firm and that there are certain factors that affect the ability of firms to innovate and create a competitive advantage in the market. Developing an adequate methodology for assessing the innovation capabilities of firms is important in order to take measures to improve internal capacities based on the assessment of the current situation. In this

regard, a significant number of techniques for measuring the innovation capacity of a company have been developed within various methodologies. Current methods and techniques for assessing the innovation capacity of a company include: innovation assessments, benchmarking, interviews, qualitative and quantitative types of questionnaires, etc. Innovation auditing is a methodological approach that comprehensively assesses the innovation capacity of a company which includes (Chiesa et al., 1996):

- assessment of existing innovation practices and performance;
- identification of discrepancies between existing and desired practices and the reasons for their occurrence;
- definition of action plan for overcoming the resulting deviations.

Determining the innovation capacities of a firm includes a large number of dimensions of the firm innovation process, namely, product innovation, process innovation, marketing innovation and organizational innovation. There are a number of different assessment tools developed in the past 20-30 years which main aim is to assess innovation and technological capabilities of firms. Tidd, Bessant and Pavitt in their work "Managing Innovation" have developed a framework for assessing the innovation capacity of the company which consists of short questions with the aim of helping the management of innovative companies to gain insight into their innovation capacities in order to get the most realistic answer to the question: "How well does the company manage innovations" (Tidd at al., 1997). There are also other assessment tools developed recently: Syntens Innovation Scan method, developed by the Dutch Syntens Institute, is an assessment tool that evaluates the innovation capacity of a company in a quick and illustrative way through schematic analysis. The IMP³rove Assessment, developed by European Innovation Management Academy (www.improve-innovation.eu), helps companies to understand the key success factors of innovation management in 5 innovation management dimensions: innovation strategy, innovation organisation and culture, innovation life-cycle management, innovation enabling factors and innovation results. This tool is based on benchmarking methodology. The INNOVATE assessment tool, that was used for the purpose of analyses presented in this paper, is a diagnostic tool that encourages domestic businesses to improve their innovation management in order to improve their competitiveness. It was created in the framework of ICIP and SECEP projects funded by the European Union. The presented assessment tools differ in complexity, approaches, innovative types that are evaluated and other dimensions. However, regardless of which assessment tool is used, they all the same aim, which is to assess the current state of the firm's innovation capacity and, based on the assessed state, to provide a basis for consultants to create an action plan for measures to improve the firm's innovation capabilities.

Recent studies conducted in Serbia have shown a very low level of innovation activities within SME sector and comparing them to the developed countries in the Europe, they are far behind (Prljić et al. 2016). As regards to the structure of innovation expenditure, Serbian companies are mainly focused on purchasing already developed machinery and they pay very little attention on technology transfer processes. The share of turnover from sales of unchanged or marginally modified products is dominant (Strbac & Kutlaca, 2018). However, some research papers indicate that new product development is a priority for a group of female Serbian SMEs, showing a high level of awareness of the importance of innovation for the company's development (Popovic-Pantic, 2014). The same research indicates that preferred forms of innovation commercialization in the companies are the sales of final products as opposed to selling concepts and patents which are almost never practiced.

General problem for the SME sector in Serbia is insufficient systemic and institutional support (Dukic et al., 2015). An innovation system is not sufficiently supported in the economy and society. Despite the progress in the development of certain parts of the innovation and scientific-technological infrastructure, the output indicators the National Innovation System (NIS) do not show significant improvements, with the exception of the increased number of papers in reference international journals (Kutlaca & Semencenko, 2015). The concept of NIS is in the initial phase of conceptualization and actually far from being functional. The management of innovation policy is not efficiently coordinated among responsible ministries and agencies which leads to the overlapping in innovation policy instruments (Semencenko & Kutlaca, 2018).

2.1. Innovation capacity: macro *vs*. micro level

Having in mind the very early stage of the development of the National Innovation System in Serbia, usual misunderstanding of the notion of innovation (mixing the concepts of invention and innovation), preferring scientific research activities which end with published articles instead of developing technologies and rather separated research sector and economy, SMEs in Serbia are faced with difficult mission to operate without adequate resources, knowledge and support. EEN is, therefore, engaged as "mission impossible" in order to provide SMEs with incentives and advice how to access international market with knowledge and competence, i.e. with innovation, rather than chip labour and low-cost raw material.

Nevertheless, particular task assigned to the teams of consultants within EEN-Serbia consortia since 2016 is to provide innovation support services to innovative SMEs in Serbia. This task includes the following steps: the identification of SMEs that have established their competitive position primarily through innovation of products, processes and services, and then, the analysis of innovation potential and capacity of these companies in order to identify shortcomings and provide advice on how to address these shortcomings and establish more efficient innovation activities in the company.

It is necessary to stress the fact that research on innovation capacity is, in literature, primarily addressed to the level of nation/country. Unlike the WEF (World Economic Forum) mostly qualitative based approach (experts opinions on number of different aspects of innovation process) (WEF, 2019), there are two distinguished, highly quantitative based methodologies (analysis relying on values of number of indicators) (Furman, Porter, & Stern, 2002; Radosevic, 2004).

One definition of *National Innovation Capacity* (NIC) is the ability of the state, as a political and economic entity, to produce and commercialize new technologies over a long period of time (Furman, Porter, Stern, 2002). According to this concept, NIC consists of a developed innovation infrastructure, a developed innovation environment in industrial clusters and connections between the innovation infrastructures and clusters. This concept integrates the functioning of research and innovation systems in the country, technological specialization, economic effects of knowledge use, human capital, institutions and state policy. The key indicator for this concept is number of patents registered in US PTO (Patent and Trademark Office) and because of small number of such patents from developing countries like Serbia the application of that concept is practically impossible here. According to the second concept, NIC research identifies four dimensions of innovation capacity: *absorptive, research, diffusion* and *demand* (Radosević, 2004). The initial assumption of this concept is that the growth and innovation capacity of the economy depends not only on the IR supply, but also on the ability to transfer and diffuse technologies and the demand for the creation and use of technologies. Majority of the indicators used for this concept are calculated within Innovation Scoreboard survey, organised and managed by the EUROSTAT (EC, 2019). Later concept is of particular importance for dynamic monitoring of NIC in transitional economics, providing wealth of information to decision makers (Kutlaca & Radosevic, 2011).

3. INNOVATION CAPACITY OF FIRMS – CASE STUDY

3.1. Innovation capacity on micro level: INNOVATE as tool for analysis

Analysis of innovation capacity on micro level, i.e. level of companies, is primarily based on expert opinion and assessment of different aspects that best describe the innovation capacity of on company. Previous, theoretical section of this article has provided several methods widely accepted for analysis of innovation capacity of SMEs within expert support for enhancement of the innovation performance of companies. The STPRC team of consultants has provided such sort of innovation support since 2016. Quality and reliability were criteria for selection of information collected during innovation scanning and innovation consultancy provided to 31 SMEs by STPRC team of consultants during the period 2016 - spring 2020, and arrangement for the purpose of this paper in order to emphasize major aspects that constitute innovation capacity of the firm. The INNOVATE is used as a diagnostic tool that encourages companies to improve innovation management, as well as to increase the level of their competitiveness. It is a self-assessment tool, and facilitated by the consultants can provide support with concrete action planning within SMEs.

An important feature of the INNOVATE tool is that it is applicable to all companies regardless of size and year of operation, including micro and start-up companies, and does not rely on quantitative financial data of companies, which is very often difficult to obtain from companies. INNOVATE provides feedback on the extent to which a company manages twenty one different aspects or “dimensions” of innovation management by comparing current company practices with one of four predefined statements. Answers are entered simply via a series of predefined drop-down menus, and the result is generated automatically through the tool's diagnostic element. The company's performance, compared to four possible levels, is then graphically displayed both in terms of dimensions and in terms of the company's overall performance (INNOVATE, 2012).

INNOVATE also includes a number of forms that help the company to develop and implement an action plan defined according to the priorities for improvement within the innovation management, with the application of (INNOVATE, 2012):

- SWOT analysis - management tool that highlights the strengths and weaknesses of the company, along with potential threats and opportunities;
- PESTEL analysis - technique used to analyse the external (macro) environment in which the company operates;

- Strategic Analysis and Roadmap tool - an analytical tool that highlights the company's long-term strategic goals and then demonstrates how they relate to key short-term goals, competition and obstacles, but also markets and partners;
- An action plan that transforms the roadmap into a concrete action plan and includes a clear specification of all project tasks and timetables within the project for each project task, while clearly defining related responsibilities and timelines;
- Locating resources that help the company identify available resources that may be helpful to them in implementing the action plan.

The company's performance in relation to each of the dimensions is automatically displayed graphically, and is divided into "resources" and "results". When the self-assessment is complete, the tool displays summarized results. The overall current performance of the company could be classified into one of the four predefined levels (INNOVATE, 2012):

- Level 0: Companies with a low level of innovation that apply the traditional approach in business;
- Level 1: Companies that accept external advice and the need for planning;
- Level 2: Companies that look at their business strategically;
- Level 3: Innovative companies with an international perspective.

3.2. Findings of the analysis

Descriptive statistics for selected 31 SMEs are provided in Table 1 with aggregated results of self-assessment phase of implementation of INNOVATE tool.

Table 1: Distribution of SMEs according to aggregate self-assessment level

Self-assessment level	Number of SMEs	Percent of SMEs
Level 0	0	0%
Level 1	20	64.5%
Level 2	8	25.8%
Level 3	3	9.7%
Total	*31*	*100.0%*

Although only three companies were assessed as "*companies with an international perspective*" (level 3), it is important to stress the fact that ALL companies are innovative, having innovation (process, product or service) as main driver of their competitiveness! This situation imminently leads to an obvious question - is the intellectual property (trademark, product, process, knowledge in any form) of the company protected? Data in Table 2 could provide answer to this question.

Table 2: Protection of the intellectual property of analysed SMEs

Intellectual property	Number of SMEs	Percent of SMEs
Patent	1	3.23%
Trade mark	2	6.45%
Patent + Trade mark	1	3.23%
Nothing protected	27	87.10%
Total	*31*	*100.0%*

Analysis of data in Table 2 should be combined with analysis of data in Table 3 which illustrates resident patent applications in Serbia in period 2014-2019. It is obvious that overall patenting intensity in Serbia is very low, only 23.2 patents per million population in 2018, which is 10 times less than same figure in Austria (Austria: 230.6 resident patent applications per million population in 2018, source: World Bank data)

Table 3: Resident patent application in Serbia, 2014-2019

Year	2014	2015	2016	2017	2018	2019
Individuals	145	123	144	124	112	120
R&D organisations	28	35	32	31	37	15
Companies	28	20	15	18	13	33
Total Resident patent applications	201	178	191	173	162	168

Source: Intellectual Property Office of the Republic of Serbia

The fact that only 4 companies have some sort of intellectual property protected, which is 12.9% of all observed SMEs, contributes to the previous finding that the lack of patenting culture is an important feature of Serbian national innovation system (Kutlaca and Semencenko, 2015). Most of the companies in the sample do not have a clear explanation for the low level of intellectual property protection, which implies that the awareness of the need for intellectual property protection is at a very low level.

Another surprising finding is illustrated in Table 4 – majority of observed SMEs were not aware of the existence of state funds and institutions established to support and finance innovation projects, such as Innovation Fund (IF), and/or programme for funding of innovation projects of the Ministry of Education, Science and Technological Development (MESTD)! Development agency of Serbia (DAS) is fairly known by observed SMEs, but EU funds remain mystery for majority of SMEs. Networking with RDO (Research and Development Organisation) in Serbia is not favourite option for cooperation in innovation projects as well as cooperation with other SMEs in country. EEN as possibility for networking and cooperation internationally is highly acceptable solution for most of the observed SMEs.

Table 4: Major advices to SMEs addressed to enhancement of the innovation capacity

Advice	Number of SMEs	Percent of SMEs
Application for funding by MESTD	27	87.10%
Application for funding by IF	22	70.97%
Application for funding by DAS	4	12.90%
Application for funding by EU	6	19.35%
Cooperation with domestic RDO	4	12.90%
Cooperation with domestic SMEs	3	9.68%
International cooperation using EEN	28	90.32%
Total	*31*	*100.0%*

Table 5 illustrates major threats identified by observed SMEs which could jeopardise their competitive position and realisation of already launched / intended innovation activities. Besides unfair competition, legal issues and lack of skilled human resources are the key obstacles for efficient performance of innovative SMEs in Serbia. Strong impact on their performance has economic and political situation in the country and in the Western Balkans, obvious market for majority of observed SMEs.

Table 5: Major threats for competitive position and realisation of innovation activities

Advice	Number of SMEs	Percent of SMEs
Legal framework for business in Serbia	10	32.26%
Lack of skilled human resources	10	32.26%
Unfair competition	12	38.71%
Insufficient use of IT	1	3.33%
Economic and political situation in the country and in the Western Balkans	8	25.81%
Total	*31*	*100.0%*

4. CONCLUDING REMARKS

Analysis of several aspects which constitutes innovation capacity of the SMEs, presented in this article, points to the following key conclusions:

- All SMEs selected for specific support addressed to innovativeness within EEN project activities are very innovative, ready to change / introduce new products, processes and services whenever innovations arise from market opportunities or there are results of curiosity driven activities of employed associates;
- Although owners and/or employees are aware of importance of intellectual property for competitiveness and market position of their company, often faced with overt attempts by competitors to take advantage of their intellectual property, just small number of SMEs are ready / knowledgeable to make step forward and apply for protection of inventions, trademarks etc. in Intellectual Property Office of the Republic of Serbia! This is not only “lack of patenting culture”, this represents ignorance of the main competitive tool in XXI century, which is knowledge!
- Another important finding is ignorance of the infrastructure built to support innovation activities in the country. SMEs are not aware of existence and variety of programmes and financing schemes addressed to innovative SMEs in Serbia; instead they apply for expensive bank loans! SMEs are not only to blame for such situation; there is a large space for disseminating information on the national innovation infrastructure, particularly funding institutions and schemes;
- Final finding could be call on the competent institutions to include companies in the process of harmonizing the legal framework with the needs, requirements and capabilities of domestic companies, without interfering with the freedoms and principles of the free market. SMEs are in “real economy”, confronted with unfair competition, ambiguities of the legal system and political instability of the region that threatens their business. They could be and should be partner to the creators of the political and economic milieu in creating the best possible conditions for business and support to innovation.

ACKNOWLEDGEMENT

Research presented in this paper was financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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ENVIRONMENTAL AWARENESS AS CORPORATE COMPETITIVENESS FACTOR: A RESEARCH FROM SERBIA

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Abstract: *Nowadays, environmental awareness appears as a universal European value, influencing and directing European business practices, strategies, and policies. The purpose of this empirical research paper is to provide insight into the value of corporate environmental awareness from the point of view of consumers living in the Republic of Serbia, directly estimating its potential as a corporate competitiveness factor. The value of corporate environmental awareness is analyzed both from general aspect for all investigated consumers, and from the aspect of the impact of the most important demographic features of respondents. Research results show that Serbian consumers highly value corporate environmental awareness, especially in case of older respondents, with lower economic standard and education, from rural areas, but there is room for improvement. Research implication is that corporate environmental awareness can be a significant competitiveness factor for companies operating in the Republic of Serbia, striving to achieve better business performance results.*

Keywords*: environmental awareness, corporate competitiveness, Serbian consumers*

1. INTRODUCTION

Environmental awareness has been rising since 1990s and the pressure of environmental stakeholders around the world is growing (Dixon, Mousa & Woodhead, 2005). Various environmental stakeholders require disclosure of environmental performance information, both from corporations (Cormier & Gordon, 2001) and from other institutions and organizations (Lynch, 2010; Frost & Seamer, 2002). Numerous professional associations insist on including elements of environmental impact in the financial statements themselves (APC, 1991; IAPC, 1995), leading to the birth of the environmental audit. Hence, environmental awareness is a very important area of research, which can be studied from different aspects, having in mind its increasingly complex effect on other areas of human existence and survival.

Even though environmental and quality of life issues in the Republic of Serbia are beginning to take the place they have long ago deserved (Jovanović & Aćimović, 2014), and even though environmental protection and improvement is one of the five priority areas defined by the National Strategy for Sustainable Development of the Republic of Serbia (Milanović & Kovačević, 2015), the elementary fact is that both from the theoretical and practical aspect, this area is not yet sufficiently explored and applied. The lag in practice follows poor historical base and incomplete research. In domestic academic circles, environmental awareness has not encountered particularly detailed elaborations. Literature in this domain is scarce, and it comes down to only a few articles that deal with this topic in non-comprehensive way. However, the topic of environmental awareness seems to be popular also in Serbia. Currently, a total of 128 electronically available scientific and professional papers containing the environmental awareness as a key word have been published in the Republic of Serbia, but only 11 of them deal with the environmental awareness as the main topic, and only 4 of them try to measure the level of environmental awareness among Serbian population. No article deals with corporate environmental awareness itself (SCIndeks Database).

The goal of this paper is to measure the significance of corporate environmental awareness for Serbian population as a whole, thus evaluating its potential as a corporate competitiveness factor. Environmental awareness is proven to be significant factor of competitiveness among consumers with high levels of environmental awareness (Chuang, Huang, 2018; Iraldo, Testa, Lanzini & Battaglia, 2017; Baptista, Madureira & Guevara, 2016; Stevens, 1998) The paper is organized as follows. After the introduction part, an overview of the scientific and professional literature is given, followed by a description of the research with an analysis of results. Concluding remarks are provided at the end of the paper.

2. LITERATURE REVIEW

As a country that has been exposed to numerous socio-political crises for decades, Serbia has paid very little attention to the protection of the natural environment and the development of environmental awareness among all citizens. After 2000, the state entered the processes of democratization, Europeanization, strengthening of civil society and acceleration of transition, but in the field of environmental protection there is an obvious imbalance between the normative framework and practice (Simeunović-Bajić, Majdarević & Manić, 2013), with elements that clearly indicate that there is a serious crisis of environmental rights and the environment in general (Arsić, Matijašević & Berber, 2011). Several studies indicated that many developing countries already equipped with environmental policies, legal frameworks and economic instruments, regarded as highly sophisticated by international standards (Huber et al, 1998; Fujisaki et al, 1997 in Iizuka, 2000) face the worsening of environmental conditions. Major difficulties these countries confront are not only the lack of legal and economic framework for environmental protection, but also lack of participation among general public in pro-environmental behaviours (Iizuka, 2000). In Serbia, a large number of laws have been harmonized with European legislation, which has made the greatest progress in this area. However, the effects of progress in the field of environmental protection are not sufficiently known to the public because environmental issues take up very little space in the media (Simeunović-Bajić, Majdarević & Manić, 2013), while the availability of scientific and technological environmental knowledge and adequate information is proven to be the essential prerequisite of environmental awareness building (Severo, Ferro de Guimarães, Dellarmelin & Ribeiro, 2019; Giudici, Guerini & Rossi-Lamastra, 2019). As a result, from the available research, in the Jablanica district, there is only the partially developed environmental awareness of this part of the population (Miltojević, Živković & Ilić-Krstić, 2011). The environmental awareness of "AXA Insurance" employees is also at a low level due to the poor preparedness of Serbian companies to meet environmental requirements and standards applicable in developed countries (Kitić, Kostić-Stanković, Cvijović & Lečić-Cvetković, 2015). The most attention in the future should be paid to the development and raising of environmental awareness of the inhabitants of Banat through permanent educational programs on environmental protection (Radanov, 2016). However, significant level of environmental awareness is found among students at the Faculty of Organizational Sciences, the University of Belgrade and the University of Maribor (Petrović, Išljamović, Jeremić, Vuk & Šenegačnik, 2011). In the local community of Zrenjanin, there is a certain degree of recognition of the solar potential in Serbia, so based on that, solar energy is widely used in public institutions and private facilities, demonstrating that with improving information and knowledge on important issues of environmental improvement the environmental awareness can be enhanced (Milanović & Kovačević, 2015). The result of Gallup *The Health of the Planet Survey* (1992) demonstrated only a slight environmental awareness difference between developed countries and developing countries, which is in contradiction with the conventional belief that the economic growth is a pre-requisite for higher environmental concerns (Iizuka, 2000). When the public gets better acquainted with environmental problems, they will be able to help solve them (Bulatović & Rajović, 2011). The usage of media is especially important to this goal - because their influence is the fastest and most penetrating (Jovanović & Aćimović, 2014). Special attention here is given to social networks, which proved to positively influence the formation of environmental awareness of users (Severo et. al., 2019). Formal education as an important determinant significantly influences attitudes about environmental protection, and the application of positive environmental practices (Šarković, Cvejić & Bogdanović, 2016). The quality of textbooks is a significant factor in raising the quality of education (Đurović, 2011). Ecological upbringing and education, as processes of permanent character, continuously deepen and innovate their contents, which are realized through compulsory and elective subjects, but also through free and optional activities organized already in primary school. Ecological contents provide students of younger school age in Serbia: introduction to the basic concepts related to ecology and the environment, acquiring knowledge about the positive and negative impacts on the natural environment, as well as measures to prevent and protect from everything that disturbs it. The topicality of this topic is reflected in the set tasks of environmental education, which relate to encouraging the personal responsibility of each individual to change the environment in the direction of a better quality of life, as well as to transfer acquired knowledge to young people to build environmental awareness (Minić & Jovanović, 2019). Science education has an important part in developing understanding of concepts that underpin environmental issues, leading potentially to pro-environmental behaviour. However, science is commonly perceived negatively, leading to inappropriate and negative models of science that do not connect to people's experiences. In that sense, the cognitive and affective domains need to be explicitly integrated in a science education that informs environmental education, as a sense of relationship essential for environmental care and responsibility leading to informed action (Littledyke, 2008). New and effective modes of professional environmental training have being developed, like the development of positive approaches to science and environmental issues through teacher modelling of biophilic behaviour, active learning through constructivist pedagogy, the politicisation of science education to address social and environmental issues, suitable experiences of natural environments and living organisms, and science curricula that emphasise conceptual integration to demonstrate complex environmental effects, including the environmental consequences of human behavior (Littledyke, 2008). Applying environmental

training modes and methods and gaining particular experience allowed effectively organizing the pedagogical process that would promote the development of environmental awareness and attitudes. Original techniques were used to stimulate intellectual activity of students in this specific field, facilitate the process of identifying personal potential and its activation in the field of nature and resource management, environmental protection, resulting in developing a holistic view of the issue (Nazarenko & Kolesnik, 2018). The results of the research study performed in two companies suggest that the training performed did not sufficiently increase employee environmental awareness of the company's environmental impacts despite a considerable time and financial investment in a one-time environmental awareness training program (Perron, Cote & Duffy, 2006), leading to the conclusion that participation in environmental awareness educational training efforts needs to be continuous activity, and not a one-time environmental awareness training program in order to produce enduring environmental knowledge and commitment. At the same time, the role of the family as the basic cell of society is expanding, and in terms of the development of environmental awareness, the family occupies a special place, especially in the formation of healthy and environmentally responsible individuals (Bjelajac, Počuča & Marković, 2012).

Knowledge of ecological laws, processes and phenomena in nature enriches man to perceive nature as a whole, but results come only if people behave in accordance with them (Skenderović, Kalač & Bećirović, 2014). Public participation has not received adequate attention in the field of environmental protection (Bulatović & Rajović, 2011). An unavoidable element of environmental awareness is, besides ecological knowledge, also environmental behaviour that should be developed and encouraged. So far, scientific research mostly demonstrates the existence of gap between environmental awareness and environmental behavior in favor of environmental awareness, due to the fact that barriers to pro-environmental behavior are stronger than motivators. Environmental concern, attitude, and knowledge indirectly affect pro-environmental behavior via behavioral intention. Moreover, a high level of perceived policy effectiveness facilitates the transformation of awareness into behavior, bridging the awareness–behavior gap (Fu, Sun, Zha, Liu, He, Sun & Jing, 2020; Gadenne, Kennedy & McKeiver, 2009). The formation of desirable ecological behavior is influenced by objective and subjective factors. Objective factors are the state of the environment - degree of degradation of the eco-system, socio-ecological infrastructure, level of technical-technological development. Subjective factors that are important for environmental behavior include attitudes, expectations, political affiliations, individual and social values. Individuals who have solidly developed ecological values, which are a prerequisite for pro-ecological behaviors and activities in environmental protection (Petrović & Škrbić, 2016), miss to behave in ecological manner. It is assumed that although there is an elementary socio-ecological awareness among citizens, its manifest dimension is not sufficiently developed due, above all, to the lack of tradition in political participation, inadequate cooperation with relevant institutions, and due to the rank of priority problems faced by citizens in everyday life, which, for the most part, do not leave enough room for engagements of this kind (Čikić, 2012). Individuals have solid environmental knowledge and a significant degree of environmental values, but much weaker potential for social mobilization in the field of environmental protection. The ecological awareness of the individuals is largely localized and reduced to the knowledge of ecological problems in the immediate environment (Pajvančić & Ristić, 2011). A significant disproportion between the importance of individual elements of sustainability for individuals, and the actual behavior of respondents in terms of sustainable consumption is found (Marić & Milovanov, 2015). In corporate world, as factors with the greatest influence on the evolution of such behavior from defensive to preventive environmental behaviour appear community support as the most important factor in this process, followed by managers' environmental awareness and companies' financial ability. However, financial ability is the most significant factor in the evolution from preventive to enthusiastic environmental behavior, followed by managers' environmental awareness and community support (Liu, Li & Su, 2019).

Recently, research demonstrates the rise of environmental awareness in Serbia. There is a growing concern among some consumers about the impact that their consumption may have on the environment and society as a whole. This is the new breed of consumers, the so called environmentally responsible consumers (Stanković, Đukić & Stanković, 2019). Veljković & Živković (2018) even observe environmental awareness as an important factor of subjective well-being and happiness among consumers, arguing that a person who possesses true environmental values, who has a developed environmental awareness can be a key success factor in the implementation of sustainable development models.

It is obvious that the level of environmental awareness among Serbian consumers changes in time, influenced and enhanced by media and educational ecological contents, but we can conclude that there is no research explaining the level of environmental awareness of Serbian population as a whole, at this point, which is an important missing link to the enhanced adoption, development, and implementation of successful environmentally based corporate and business strategies in companies operating in the Republic of Serbia.

3. RESEARCH DESIGN

In order to identify the significance of environmental awareness as a corporate competitiveness factor for consumers living in the Republic of Serbia, an empirical study was conducted. The research was based on the application of data collection methods from primary sources - surveys, interviews. The research was organized respecting the principles of the methodology of scientific research by Mihailović (2012).

3.1. Research Purpose and Research Questions

The purpose of the research is to examine perceptions and attitudes of public opinion in relation to the environmental awareness issue and to use surveyed perceptions and attitudes of public opinion to evaluate the degree of significance of the environmental awareness issue for corporate competitiveness. Considering that specific demographic characteristics, such as economic standard, gender, age, education, type of settlement, and number of household members, may appear as preconditions for the degree of influence of environmental awareness issue and the level of its importance for respondents, when choosing companies and their products i.e. services, in the following part, the purpose of public opinion research is aimed at examining the conditionality of the degree of influence and importance of environmental awareness issue with these factors. In this way, it is possible to find out for which customer profiles the environmental awareness issue is of the greatest importance, which can significantly help in creating successful business strategies.

In order to fulfill the purpose of the research, the following research subjects are defined: (1) measuring attitudes of the general public about environmental awareness issue in Serbia and the influence of the environmental awareness issue on decision making and opting for certain companies and their products i.e. services; (2) identifying and measuring the impact of respondents' demographic characteristics on their attitudes and perceptions in relation to the environmental awareness issue.

The research had the following defined goals: (1) determining the degree of significance of environmental awareness issue for members of the general public; (2) determining the existence of statistically significant differences between individual demographic characteristics of respondents and the degree of significance of environmental awareness issue for members of the general public.

The research answered the following research questions: (1) to what extent the environmental awareness issue has an impact on the choice of consumers and the public for certain organizations and their products i.e. services; (2) whether there is and what, if any, statistically significant difference, the connection, between the demographic characteristics of the respondents and their attitudes regarding the environmental awareness issue.

3.2. Research Participants

The research was conducted on a random, representative sample of 595 adult citizens of the Republic of Serbia. The survey of citizens was conducted using a combined application of quantitative research techniques via the Internet (Computer Assisted Web Interview - CAWI) for respondents who were able to complete the questionnaire via the Internet and quantitative research technique by telephone (Computer Assisted Telephone Interview - CATI), or the technique "face to face", i.e. "in person", in direct contact with the respondent for respondents who were not able to fill in the questionnaire via the Internet. In all three cases of data collection, the consent of each respondent to participate in the research was previously obtained. The 2011 census of the Republic Statistical Office was used as a sampling frame.

3.3. Research Instrument

As a research tool for implementation of the method of collecting data from the primary sources, the 7-point Likert scale questionnaire was used, established on the basis of review of the scientific and expert literature and as recommended by Mihailović (2012), and in compliance with the special needs of research. After demographic characteristics of respondents, the questionnaire contained question pertaining to the environmental awareness issue. Result of Cronbach's alpha test of questionnaire as a measure of its reliability indicates consistent reliability of results obtained ($\alpha>0.7$).

3.4. Research Model

The research model is based on examining perceptions and attitudes of public opinion in relation to the environmental awareness issue, as well as the importance of the environmental awareness issue for respondents from the general public and their impact on their choice for individual companies and purchase of their products i.e. services. In the second step, the research model refers to the examination of the

conditionality of the degree of influence and the importance of the environmental awareness issue with specific demographic characteristics.

3.5. Data Analysis

Items of the final questionnaire were analyzed using the statistical package SPSS (Statistical Package for Social Sciences - SPSS) v20. The data analysis in this study consisted of descriptive statistics. Univariate analysis was used through the analysis of frequency tables and individual ranking statistics. The nonparametric Mann Whitney U Test was used to examine the significance of the differences. In the study, results with $p<0.05$ were declared significant.

4. RESEARCH RESULTS

4.1. Evaluation of the importance of corporate environmental awareness for consumers in the Republic of Serbia

In order to evaluate the importance of corporate environmental awareness for consumers in the Republic of Serbia, univariate analysis containing descriptive and frequency statistics was used. Results show that the importance of environmental awareness in the business of Serbian companies, according to Serbian consumers, is at an enviably high level with an average value of 6.32 +/- 1.104 (Mean +/- Std. Dev.). A total of 92.9% of respondents attach the greatest importance to corporate environmental awareness when deciding to purchase products i.e. services, out of which 61.7% of respondents believe that companies should be fully guided by environmental awareness when developing and deploying their business strategies, 20.8% of respondents believe that companies should mostly be guided by corporate environmental awareness when developing and deploying their business strategies, and 10.4% of respondents believe that companies should be guided by corporate environmental awareness as a key value in developing and deploying their corporate and business strategies. 3.9% of respondents maintain a neutral attitude towards the importance of corporate environmental awareness for business operations of corporations. Only 3.2% of respondents do not pay attention at all, or pay very little attention to corporate environmental awareness as a factor of corporate competitiveness.

4.2. Evaluation of the impact of demographic characteristics on the importance of corporate environmental awareness for consumers in the Republic of Serbia

In order to profile societies in which the corporate environmental awareness is of special importance, the investigation of the influence of certain demographic characteristics of consumers, such as economic standard, gender, age, education, type of settlement, and number of household members on the perception of corporate environmental awareness is performed. The nonparametric Mann Whitney U Test was used to examine the significance of the differences. Results with $p<0.05$ were declared significant.

Economic Standard

In relation to the importance of corporate environmental awareness for consumers in the Republic of Serbia, it was examined whether there are statistically significant differences between respondents with lower and higher income, i.e., economic standard. Results reveal that respondents with a lower economic standard attach more importance to the corporate environmental awareness as a factor of enterprise competitiveness (296.17 vs. 239.79; $p<0.001$, Mann-Whitney U Test).

Gender

In relation to the importance of corporate environmental awareness for consumers in the Republic of Serbia, it was examined whether there are statistically significant differences between respondents of different gender. No statistically significant differences were found ($p> 0.05$).

Age

In relation to the importance of corporate environmental awareness for consumers in the Republic of Serbia, it was examined whether there are statistically significant differences between older and younger respondents. Results reveal that older respondents attach more importance to the corporate environmental awareness as a factor of enterprise competitiveness (323.21 vs. 268.47; $p<0.001$, Mann-Whitney U Test).

Education

In relation to the importance of corporate environmental awareness for consumers in the Republic of Serbia, it was examined whether there are statistically significant differences between respondents with lower and

higher education. Results reveal that respondents with lower education attach more importance to the corporate environmental awareness as a factor of enterprise competitiveness (310.68 vs. 278.43; $p<0.05$, Mann-Whitney U Test).

Type of Settlement

In relation to the importance of corporate environmental awareness for consumers in the Republic of Serbia, it was examined whether there are statistically significant differences between respondents from urban and rural areas. Results reveal that respondents from rural areas attach more importance to the corporate environmental awareness as a factor of enterprise competitiveness (288.43 vs. 319.22; $p<0.05$, Mann-Whitney U Test).

Number of Household Members

In relation to the importance of corporate environmental awareness for consumers in the Republic of Serbia, it was examined whether there are statistically significant differences between respondents from households with up to three members and over three members. No statistically significant differences were found ($p> 0.05$).

5. CONCLUSION

This empirical research paper gives an overview of environmental awareness as a factor of corporate competitiveness from the aspect of consumers living in the Republic of Serbia. The environmental awareness issue was considered, except from the general point of view of consumers, also from the point of view of the influence of individual demographic characteristics of consumers, such as economic standard, gender, age, education, type of settlement and number of household members. Obtained results show that environmental awareness appears as a highly valuable corporate competitiveness factor that is especially appreciated by older respondents with a lower economic standard, and with lower education, from rural areas.

The scientific contribution of the conducted empirical research is reflected in identifying the importance of environmental awareness as a factor of corporate competitiveness for consumers living in the Republic of Serbia, both in general, and by individual demographic features of respondents. The social contribution of the research refers to the possibilities of applying obtained results in practice. The analysis of research results should serve as a guideline and assistance to the management of companies operating in the Republic of Serbia in creating successful business strategies, which should result in better positions on the Serbian market.

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THE IMPORTANCE OF THE DIGITAL ECONOMY FOR THE TRANSITION TO A CIRCULAR ECONOMY

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Abstract: *The process of digitalization radically transforms the economy and the whole society. The digital economy has great potential, benefits and advantages for businesses and citizens. Digitization appears as an enabler of the circular economy. The transition from a linear economy to a circular economy can be successfully achieved using digital technology. This process imposes on companies finding new business models in order to successfully respond to the digital market and the principles of the circular economy. Institutional support and initiatives are essential in achieving the objectives of circular economy. The scientific literature shows a significant impact of digital technologies on the circular economy. However, most research is recent and lacks indicators of the direct synergy of the digital and circular economies. Examples of good business practice and new business models of companies will provide a better explanation of this synergy in the future.*

Keywords*: digital economy, linear economy, circular economy, sustainable development, business models*

1. INTRODUCTION

In the modern world circumstances the question of the sustainability of economic activities is becoming one of the most important issues of the future. Substantial changes need to be made in many areas. Within production, a distinction must be made between renewable and non-renewable resources. There must be a sustainable management of natural resources. Within consumption, a distinction should be made between needs and desires. Also, population policy, which includes education, social protection, health care, etc. becomes an indispensable element of sustainable development. Sustainable development opens up problems of climate change control and emissions of harmful gases into the atmosphere. In a sustainable society, there must be an acceptable combination of economic and environmental goals. That is why increased efficiency, control of climate change and pollution, and the transition to sustainable technologies are required.

The circular economy is one of the goals of sustainable development of the United Nations. There is a fundamental difference between linear and circular economy models. The circular economy strives to achieve a balance between the goals of the economy and the environment. It is not only important to achieve the main goals of economic activity, such as increasing production and consumption *per capita*, but also to achieve environmental sustainability. Hence, the circular economy is seen as a new business model that will provide further economic growth and living standards of the population, creating new jobs while reducing pollution and preserving the environment.

Pagoropoulos et al. (2017) performed a literature search which resulted in twelve articles are they deal with the synergy between the circular economy and digitalization. The mentioned group of authors identified seven different types of technologies. These technologies are grouped into three segments - data collection, data analysis and data integration. The results of the research indicate that there is a synergy between digitalization and the circular economy, but also that research on this topic is still in the initial phase. The reason for this is the acceptance of concepts from other areas and there is no specific case study. Reuter (2016) is convinced that in order to achieve the full potential of the circular economy, it is necessary to consider not only technological and environmental opportunities and limitations, but also social and economic ones. He divided the main challenges in the development of the circular economy into ten segments. Segments include the application of different technologies and platforms, recycling, innovation, energy efficiency and end-user involvement. Some authors emphasize the application of circular economy in the metallurgical industry through various digital platforms (Schalkwyk et al., 2018).

The synergy between the circular economy and the use of big data shows a significant gap in understanding, both in theory and in practice. A deeper understanding of this relationship will be crucial to achieving sustainable development. The success of the circular economy will depend on new ways of collecting and analyzing big data (Nobre and Tavares, 2017). The main digital technology that is transforming the industry is IoT. IoT represents the interconnection of devices that enable information sharing platforms through a single framework and innovative applications can present a common operating unit. IoT combined with cloud computing is one of the main drivers of the industry (Gubbi et al., 2013). On the other hand, the circular economy can be the driving force behind Industry 4.0 (Rajput and Singh, 2019).

There are many shortcomings in research in analyzing how industrial companies can take advantage of digitization to transform their business models to exploit the full potential of the circular economy. The question of the adequacy of the business model is also raised, as traditional business models cannot respond to new challenges (Maffei et al., 2019). The ReSOLVE based model emerges as a possible conceptual framework for the integration of the circular economy and digital technologies. The model can be modified depending on the company's activities and socio-economic environment (Jabbour et al, 2019).

The structure of the paper is as follows. The first part after the introduction shows the process of transition from a linear to a circular economy. The third part explains the impact of the digital economy on economic development. The fourth part gives examples of good practice in achieving synergy of digital and circular economy in companies. Finally, concluding remarks are given in the last part.

2. FROM LINEAR TO CIRCULAR ECONOMY

The subject of economics can be defined as any human activity that is aimed at the realization of goals that differ in importance and the degree of priority. To achieve these goals, certain resources are used, which are, on the one hand, limited, and on the other hand, can be used in different ways, ie. have more alternative uses. Due to scarce resources, business entities are forced to make rational decisions about how to optimally use the available resources to achieve its many objectives (Kragulj, 2018).

Efficient business (how to achieve a certain result with the least possible consumption of resources) is, therefore, crucial for economic science. It is especially important in the conditions of a growing world population and great climate changes. Also, modern economies insist on the concept of sustainable development, which implies an optimal balance between economic and social goals, as well as environmental factors. The circular economy plays an important role in the process of realizing the goals of sustainable development. However, world economic systems are still predominantly linear. Figure 1 describes the linear economy model.

Figure 1: Linear economy model

The linear economy is based on the use of resources in the production process and their further processing to final products or services, transport to consumers and finally waste disposal. The principle of linear economics is: take - make – use - dispose.The model is based on a one-time use product.Matter and energy move in one direction. The linear economy does not pay attention to the fact that natural resources are limited. The model does not care about renewable energy sources, product design and application of natural materials.The production process generates waste.The waste generated cannot be further recycled. The development of society increases the use of resources and energy, which becomes unsustainable in terms of economic viability and environmental protection. Access to resources must be sustainable. That is the reason why there is a tendency towards the transition of an economy based on recycling. Recycling means the process of using waste materials as inputs in the production process (Harris, 2009). Exactly circular economy model is trying to achieve in practice "zero percent waste". The aim is to put economic activity in the context of environmental protection. For the transition from a linear to a circular system, it is necessary to make a connection between the use of resources and the remnants of waste (Bilitewaski, 2012). The whole process of economic production needs to be understood as a circular flow in which waste can become a raw material for future production. However, problems related to waste and recycling are only part of the concept

of the circular economy. It is necessary to integrate waste management into the concept of circular economy and to be in the function of its improvement. The amount of waste worldwide is growing. This is a consequence of the increased population, accelerated process of urbanization, economic growth, but also unsustainable consumer behavior. Over 2.1 billion tons of municipal waste are generated worldwide. Of this, only 16percent is recycled each year while 46 percent is disposed of unsustainably. In the US, where 4% of the world's population lives, 12% of the total municipal waste is generated. Over 36 percent of the world's population lives together in China and India, and about 27 percent of total municipal waste is generated (Nichols, W., Smith, N., 2019). The total amount of waste generated in the EU-28 in 2016 was 2,538 million tons. Of that, 100,7 million tons, ie. 4% of the total amount is hazardous waste. Of the EU member states, only in Estonia and Bulgaria the share of hazardous waste in the total amount was higher than 10% (39.9% and 11.1% respectively). In 2016, every citizen of the European Union has created an average of five tonnes of waste. In some EU countries, a significantly higher amount of waste is recorded than the average of this integration. For example, in Finland there were 22.4 tons of waste created *per capita* (Eurostat). The European Union has promoted the goal of recycling 65 percent of household waste and 75 percent of packaging waste by 2030. In the Republic of Serbia, 49,2 million tons of waste were generated in 2018, of which 68,8 percent was non-hazardous and 31,2 percent hazardous waste. The mining sector has the largest share of the created hazardous waste, even 39.5% (Statistical office of the Republic of Serbia). Figure 2 describes the difference between a linear economy and a circular economy.

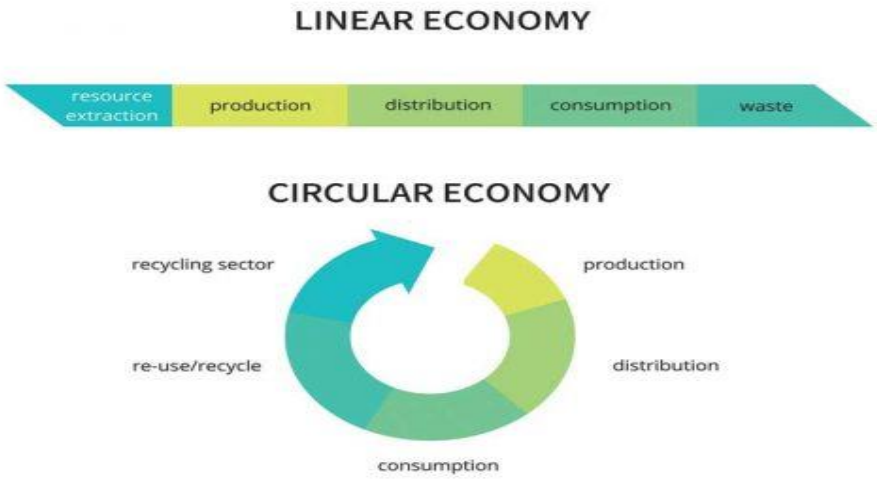

Figure 2: Linear economy vs circular economy (Barksanem, 2018)

The circular economy has a positive impact on the environment by keeping resources in a closed circle. Namely, the production process is viewed as a circular flow. In it, waste becomes a material for future production. The aim is to preserve the value created in the production process as long as possible. The concept of the "closed circle" requires the use of special technologies of the production process. It is necessary to avoid the creation of waste material that cannot enter into the recycling process. The recycling process enables resource savings, energy savings and environmental protection. However, it should be noted that the recycling process is always a compromise between maximum material recovery and minimum energy consumption. The concept of circular economy is closely related to the use of renewable energy sources.The emphasis is on the production of long-lasting products that are produced using renewable energy sources and natural materials.

The circular economy implies changes in consumer behaviour and habits. By making sustainable choices, consumers would show awareness of the need to preserve the environment.Products would be bought and owned less, and much more would be borrowed. In this way, products are becoming services. Also, companies are becoming interested in improving and extending the life of the products they own, as well as improving the recyclability of their products. Thus, companies are moving to new business models in which the sale of services is dominant, not the sale of products.Products are changing their performance in accordance with the fact that they are increasingly being rented and shared with other consumers wherever possible. It is insisted upon the eco-design of the product, which should extend its lifetime and be as recyclable as possible. Such a new product design would enable significant savings in materials and energy. It would also contribute to the preservation of ecosystems through the reduction of pollution and waste. The process of digitization will enable people to use sustainable solutions in everyday life.

3. DIGITAL ECONOMY

The digital economy is an economy based on digital technologies. This economy can be viewed in three ways: as an ICT sector that produces digital goods and services, as part of the economy where the output achieved by new technologies with a business model based on digital goods and services and finally, that the use of new technologies is present in all spheres of the economy (Jednak et al., 2019). According to Bukht and Heeks (2017), the digital economy is "economic output obtained primarily from digital technologies with a business model based on digital goods and services". The economy encompasses the core: Digital ICT sector (hardware manufacture, information services, telecommunications, and software & IT consulting), Narrow scope: Digital economy (digital services, platform economy, sharing economy, gig economy), and Broad scope: digitalised economy (e-business, e-commerce, industry 4.0, precision agriculture and algorithmic economy).

The characteristics of the digital economy are: digital platforms and multi-sided markets, network effect, big data, a dominance of market leaders, and not geographically located. Digital data and digital platform are the main drivers of the digital economy. Data is becoming a new economic resource for creating value. This economy uses and analysis digital data that are collected from personal, social, business, government, economic and other activities. Global Internet Protocol (IP), a proxy for data flows, has been grown over time. In 1992, traffic was 100 GB per day, in 2020, it was 100 GB per second, and in 2017, it was 45,000 GB per second. The projection of global IP traffic is 150,700 GB per second (Arai et al., 2019). Therefore, the digital economy is going to the smart, better-connected world and data-driven economy. Platforms use data-driven business models. They are intermediaries for transactions. Digital platforms are two-sided markets where two user groups interact through an intermediary or platform, and both user groups benefit from this. Platforms allow companies to attract new consumers/users, but also that there is a cooperation between companies from different industries. For example, Microsoft, Apple, Amazon, Google, Facebook, Alphabet, Alibaba and Tencent are digital platforms and generate large amounts of consumer data which gives them market power. These companies are among the first ten world`s companies due to market capitalisation.

The digital economy is growing due to economic and political interventions and technological innovations. Digital skills, industry 4.0, fintech, digital trade and data flows are applied in this economy. Industry 4.0 is trend refers to the change of manufacturing towards automatisation, data exchange and digitalisation using digital technologies like artificial intelligence, the internet of things (IoT), robotics, cloud computing and blockchain. These are all issues that bring new models of business and economy, make a shift in the labour markets (some jobs will disappear, new will be demanded), require new skills (digital), creation of new risk in the cyber area, obtain sustainable development goals, etc. (UNCTAD, 2019). USA and China are leaders in the digital economy. They account for 75 % of all blockchain technologies patents, 50 % of global spending on IoT, 75 % of the world market for public cloud computing (UNCTAD, 2019). According to Dehalman et al., (2016), developing countries could obtain economic growth, increase productivity, transaction cost decrease and enter into global markets by the digital economy. However, the level of ICT infrastructure determinate the development of the digital economy. Development of this economy is uneven across the world. Depend on the country, the size of the digital economy going from 4.5 to 15.5 % of world GDP. Around 3% of the global workforce is in the digital economy (Bukht and Heeks, 2017). In 2015, global employment in the ICT sector was 39 million. The ICT sector accounts for around 1% of the workforce in developing countries. Computer services are the largest component of the ICT sector. In 2018, the global export of ICT services was $2.9 trillion. ICT sector contributes 40% of total productivity growth in Europe (Vidas-Bubanja, 2016). Digital technologies influence labour productivity raise, market efficiency, reduction cost in search and decline of transportation costs (Chen, 2020). Due to all, digital technologies change the economy, society and business concepts and way how human and business entities behave, work and communicate.

The circular economy promotes economic transformation, while the digital economy supports digital transformation. Both economies are the issue in the world. Digitalisation is a part or tool for the digital economy. Digitalisation is the integration of digital technologies into everyday life, to shape a business model in order to provide revenue and to convert the information in digital content (Gartner, 2020; Ochs and Riemann, 2019). Sharing economy is an economic model based on acquiring, providing or sharing assets and services between entities. For example, Airbnb and Uber are platform and use the sharing model. Some studies explore how digitalisation, digital technologies may influence for realisation circular economy. Schwanholz and Leipold (2020) found that digitalisation and sharing economy could have the potential for realising circular economy. Bressanelli et al. (2018) show in which ways digital technologies (IoT, Big Data and Analytics) could be used for overcoming the circular economy challenges. According to Pouri and Hilty (2020), the digital sharing economy can significantly affect sustainable development and how sharing in this economy has a positive or negative influence on the circular economic goals. Digital economy and digitalisation enable continuous interaction and communication between different actors, automatisation of

production that reduces waste, apply digital innovations, use big data, apply online platform model. In this way, the digital economy and digitalisation contribute to the implementation of the circular economy.

4. CIRCULAR ECONOMY AND THE DIGITALIZATION PROCESS - EXAMPLES OF GOOD PRACTICE

At the global level, several initiatives have been launched to enable the transition from a linear to a circular economy with the help of digital technologies.One of the most influential is *The Circular Economy 100 (CE100) Network*, created by the Ellen MacArthur Foundation. The global partners of this initiative are: Black Rock, Danone, Google, Banca Intesa, Philips, Renault, Unilever, DS Smith, SC Johnson, Solvay and H&M Group. In addition to the listed companies, the *CE100 Network* has 130 companies and member organizations (Ellen MacArthur Foundation, 2020). It is of special importance for Serbia because a certain number of members of the initiative have production in our country. It is also important that Banca Intesa is one of the main financiers of the CE100 Network and that it has initiated certain projects in Serbia in the field of the circular economy. Only 9% of the global economy is the circular economy. The Factor10 project involves 26 global companies, which have teamed up to develop Circular Transition Indicators (CTI). CTI could help analyzing key indicators of a company in transition from linear to a circular economy (WBCSD, 2020).

For the members of the European Union, the most important initiative is the *European Circular Economy Stakeholder Platform*. The initiative includes a wide range of stakeholders from private businesses, national institutions to research centers and think tanks.On the internet presentation of the mentioned initiative it is possible to find a database of examples of good practice in the synergy of circular economy and digitalization. Of the countries in the region, most examples of good practice can be found in Romania (4 companies) and Slovenia (3 companies). Then follow Bulgaria and Hungary with 2 companies each and Croatia with one. All companies operate in the field of recycling or the use of renewable energy sources (European Union, 2020). The synergy of the digital and the circular economy leads to the achievement of the EU's sustainable development goals and the strengthening of competitive advantage (Figure 3). This synergy is projected to lead to a 7% increase in GDP and a net economic benefit of € 1.8 trillion by 2030. The application of the circular economy will reduce GHG emissions in the EU heavy industry by 50% by the end of 2050. EU citizens and institutions are also motivated to manage resources more rationally and create greater value for the existing value chain. The unity of the digital and circular economy in achieving the EU's sustainable goals will certainly determine the future development of the Union itself, both in economic and social contexts (Hedberg and Šipka, 2020).

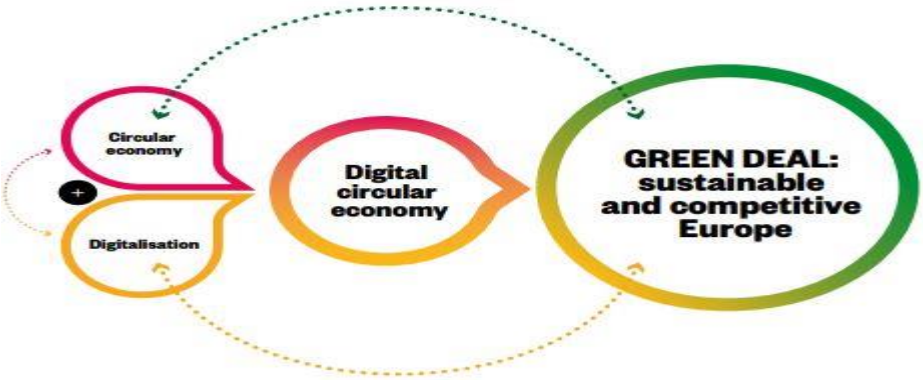

Figure 3: Interactions between a circular economy, digitalisation and the European Green Deal (Hedberg and Šipka, 2020, pp.12)

Companies use different business models depending on the technologies they use. BOMcheck is a shared database that founded by Siemens, Philips and GE Healthcare. BOMcheck currently has a network of 9,000 manufacturers and suppliers used to manage supply chains and compliance with regulatory regulations. Similarly, the UK web platform EC4P is helping companies operate in line with changes in waste electrical recycling legislation across the EU and the world, using secure cloud-based software for supervise. Even the big retail chains Walmart, Auchan and Carrefour are announced their own intention to use a blockchain to track their food products to ensure product safety. Auchan already uses RFID technology for tracking plastic crates and the improvement of reverse logistics. Similarly, the Danish company Pack and Sea uses RFID to provide better logistics between the ten Danish ports. In addition to these companies, it is necessary to mention Circularise, Provenance, Minespider, CircularTree and TrusTrace. These are platforms that enable a sustainable supply chain, based on blockchain technology (Hedberg and Šipka, 2020).

The circular economy is not reserved only for large global companies, on the contrary, it is a chance for numerous start-ups. The best examples are the winners of the Green Alley Award (award for the best European startups for circular economy): Aeropowder, Sulapac, Fjong, Grover, Biopack Packaging, Too Good To Go, Worn Again, Graapz, Refurbed, Re-circula Solutions.These companies are the best example of how to successfully use digital technologies in the circular economy and how to develop new business models.Also, they show the successful application of the principle of circular economy in different types of industries (Terrisse, 2019).

5. CONCLUSION

The process of transition of the traditional economy to the circular economy is full of challenges, primarily of economic, technological and legislative nature. A successful transition process requires the continued support of all stakeholders in the long run and at all levels. The governments of many countries have adopted their own strategies and initiated programs to stimulate the circular economy. The concept of the circular economy is of great importance for the future of sustainable development of the world economy. Also, digital economy, digital solutions and digital technology play a central role in the transformation of a linear economy into a circular economy. Innovation at digital speed is also very important.

The synergy of the digital economy and the circular economy is a new way of economic development for both developed and developing countries. The impact of digital technologies on the circular economy is present, but to what extent the impact is significant, scientific research does not yet have an unambiguous answer.Examples of good practice and the development of new business models will certainly complement this lack in scientific research.The implementation of different technologies in the business model depends on the industry and the available resources used in the production or providing of services.

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ENVIRONMENTAL FINANCIAL ACCOUNTING – INFORMATIONAL ABILITIES AND LIMITATIONS

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Abstract: *In response to stakeholder concerns about the increasingly serious risks associated with sustainable development, in recent years there is a worldwide trend of disclosing a larger volume of information on environmental and social influence of the companies' business activities. As a natural consequence of growing reporting requirements relating the effects of interaction between a company and the environment, environmental financial accounting has recently been imposed as a instrument for preparing financial and nonfinancial information of business sustainability and environmental protection that are intended for the public and key stakeholders. This article aims to point out the informational capabilities of environmental financial accounting in the provision of quality financial information on the company's activities in the field of prevention or mitigation of negative environmental effects.*

Keywords*: sustainable development, environmental protection, environmental financial reporting, IAS/IFRS.*

1. INTRODUCTION

Sustainable development can be understood as the ability of companies (and human society in the broad sense) to achieve their current goals without sacrificing and disrupting the ability of future generations to meet their own needs. The sustainable development goals of the company refer to the establishment of a system that will balance the necessary economic development with responsible consumption of resources, better environmental protection and improvement of conditions in the social community. In this sense, companies' today act in socially responsible manner by working on elimination of all activities that may have adverse effects on the environment. At the same time, companies are forced to inform the public and the most important stakeholders about the impact of their activities on the social and living environment, by publishing reports on the sustainability of their business. In parallel, numerous national governments are increasing the volume of legal requirements for sustainable development reporting, which consequently puts pressure on companies to increase the scope and quality of disclosure of sustainability information.

Financial accounting is recently perceived with need to change its traditional practices, which means finding ways to disclose financial and nonfinancial information about social and environmental influence of companies' business activities. As its entirely new branch, *environmental accounting* can be defined as a tool for monitoring various effects of company's activities with environmental impact and disclosing of these effects through financial and non-financial information. As such, "it implies all accounting areas affected by the companies' response to environmental demands" (Gray et al., 1993). It is necessary to emphasize that environmental accounting can be divided into *environmental financial* and the *environmental management accounting*, given its capability to serve informational needs of internal and external users.

However, despite the growing number of companies that disclosing environmental information, the quality and quantity of published information varies from 'pale green' to 'deep (ecologically) green', where 'deep green' corporate engagement in environmental protection is most often closely linked to radical changes in organizational culture and thinking (Gadenne et al., 2002). The aim of this paper is to analyze the abilities and limitations of environmental financial accounting in the field of providing quality financial information on the interaction between company and the environment through its official financial statements. In this regard, many authors believe that the basic assumptions underlying current financial reporting practices and the assumptions underlying sustainable development reporting are derived from radically conflicting world views. As a consequence, there is belief that current financial accounting practices should undergo major changes in the area of compliance with the sustainable development concept, in order to support new reporting requirements and challenges at all (Gray, 2006). On the other hand, there are justifiable opinions that financial accounting cannot be expected to serve all the information needs of sustainability reporting, nor to

radically change its established rules for the preparation of financial statements, since they are clearly limited by its primary purpose - informing users, such as current and potential investors, about the financial position and profitability of the company.

2. CORPORATE SUSTAINABILITY REPORTING

In an attempt to increase profits, companies have a negative impact on social and living environment, primarily through various forms of pollution and erosion of limited natural resources. Therefore, economic success, which leads to catastrophic consequences for the environment, in such circumstances cannot be sufficient objective by itself, as well as a focus on meeting the interests of stakeholders such as investors or creditors. Accordingly, the need to take care about the social and living environment recently has led to the development of the concept of sustainable development, which implies considerably wider corporate responsibility. This concept is based on the assumption that the minimization of negative environmental influences, preservation of natural resources and improving the quality of life must and can be achieved in parallel with the corporate financial success (Sekerez, 2016a). There is an widespread opinion, in this field, that companies, like individuals, represent members of society that acquire benefits from it, so at the same time they have an obligation to pay back the society in same way (ACCA, 2012). Therefore, companies should act as a “good citizens”, which means investing efforts in the field of environmental protection (through prevention, removal and minimizing the harmful effects on the environment) and helping the social community.

There is no doubt that such a responsible business strategy can provide companies with long-term sustainable development. It also motivates them to publish more intensively various sustainability and environmental reports. This innovative reporting approach is aimed at caring for the fulfillment of a wider range of social expectations, which implying that investments in environmental protection “cannot be considered a cost, but an investment in the future and a source of innovation” (Kamieniecka et al., 2013). Sustainability reporting is a concept of comprehensive performance measurement that should link and balance the economic perspective of a business with its social and environmental aspects. Such a broad focus on the three vital strategic variables should serve as a tool to improve communication with numerous non-financial stakeholders and integrate traditional financial performance measures with performance measures in the field of environmental protection and improvement of conditions in the social environment. Also, corporate sustainability reporting should serve as a communication tool to reassure shareholders that their investments "have a future" and, more importantly, to provide a clear picture of the extent of their risk exposure.

Regardless of variations in reporting methods (sustainability reports can be published as part of an annual report or as separate external reports) and variations in the terminology used for this type of reporting, many researches indicates an increasing number of companies regularly informing the public about the sustainability of their business, which is followed by the growing number of countries requiring such practices through their legislation. Considering the fact that, in the last decade, the number of companies regularly discloses information on the environmental impact of their business activities has increased rapidly, it can be concluded that corporate sustainability reporting tends to become standard business practice and one of the essential strategic management tools. Therefore, in order to increase the quality of existing sustainability reporting practices and identify major risks in an ever-changing environment, the most important question companies need to ask themselves is no longer *whether to report, but what and how to report* to generate maximum value for investors and other stakeholders (KPMG, 2015).

When it comes to the quality of reporting, it can vary widely in practice, where voluntary reports on sustainable development are particularly affected by criticism, as they often have very little to do with the true businesses engagement in socially responsible activities (Nickell et al., 2014). Similar to that, Gray (2006) states that, in most cases, with its extensive, trivial and selectively published content, such voluntary reports are nothing more than a means of promoting and building a positive corporate image. This does not mean that all voluntarily published sustainability reports are of poor quality, or that all binding reports offer relevant information on corporate sustainability performance, but the shortcomings of most voluntarily published reports are already sufficient reason to expand the scope of mandatory regulatory requirements, in order to increase comparability, transparency and quality of reporting.

Today, representatives of the academic and professional public share the almost universally accepted view that increasing the volume of mandatory requests for disclosure of business sustainability information and promoting new policies and guidelines for this type of reporting offers a significant opportunity to improve the quality of published reports. This way of thinking is supported by a wide range of arguments, such as: lack of comparability of voluntary sustainability reports, lack of “depth” and objectivity of voluntarily published information, discontinuity in publishing information (in most cases reports are not published on a regular

basis), selective highlighting of positive information on corporate responsibility and the lack of credibility of the reports due to the fact that they are most often not subject to external audit (Ribeiro et al., 2013). Parallel to the many mandatory rules recently issued by national governments, regional political bodies and regulators in the financial markets, development of increasingly high quality reporting guidelines, such as globally accepted GRI (*Global reporting initiative)* guidelines (the latest version known as the G5 was released in 2017), also contributes to this by facilitating the compilation of better-framed reports that are more focused on the quality and relevance of published information. As a consequence of increased reporting volume, large companies are becoming significantly more successful in identifying trends and risks related to the environment that have an impact on the business, thereby informing stakeholders more transparently about their intended risk mitigation activities. However, given the fact that quantitative increase in reporting does not necessarily lead to quality improvement, further development of mandatory regulatory mechanisms, which will focus on improving the quality, comparability and relevance of sustainable development reports, is expected.

3. INFORMATIONAL SCOPES OF THE ENVIRONMENTAL FINANCIAL ACCOUNTING

Sustainability reporting is a new reporting model aimed at informing a wider range of users than traditional financial reporting, which is primarily oriented towards meeting information needs of investors. Therefore, the relevance of the disclosed information on sustainable development must be viewed through the prism of their ability to meet the demands of a wider group of stakeholders than participants in the financial markets. Providing stakeholders with full insight into the risks of doing business requires additional engagement in the reporting process. It requires the inclusion of non-financial, as well as necessary financial information on the effects of the company's interaction with the environment, which traditionally falls within the scope of financial accounting tasks.

The fact that companies are increasingly disclosing financial and non-financial environmental information within official financial reports (and less and less in separate reports) increases the responsibility of financial accounting, as the main generator of information for the purpose of publishing the annual reports. As one of the emerging branches of accounting, *environmental financial accounting* accounting is aimed at providing information to external stakeholders. This is achieved by publishing environmental information and reports within official financial statements (or their notes) or by publishing separate sustainability and environmental reports.

However, notwithstanding the aforementioned findings, it would be unrealistic to expect financial accounting to assume full responsibility for the volume and quality of environmental information produced, in which it can only partially participate, since it is not initially created to measure the financial impact of an enterprise's activities to the living and social environment (Bracci et al., 2013). Because of its core mission of presenting information on the effects of previous business transactions on the entity's financial performance, which are primarily intended for users such as current and potential investors, traditional financial accounting is forced to strictly adhere to defined reporting rules, which by their very nature cannot cover all environmental and social aspects of interaction between business and environment. Although the trend of integrating financial and non-financial business information is expected in the future, along with some changes in financial reporting rules, financial accounting cannot be declared the sole "culprit" for the insufficient quality and scope of disclosed environmental information, although there are sharply contradicted views in the literature that we will deal with in more detail in the remainder of this paper.

In this regard, globally accepted IAS / IFRS undoubtedly have the potential to help achieve the global comparability of sustainable development reports, although the analysis of the solutions contained therein indicates limited opportunities for full reporting on all environmental issues, as this is not the primary purpose of financial accounting, as we stated above. Although no IAS / IFRS are exclusively dedicated to the environmental impact of an entity's activities, many of them treat different aspects of this issue indirectly or directly, creating a solid reporting base. After all, this has resulted in the development of a separate segment of accounting, often called environmental financial accounting. It is sufficient to state here that environmental accounting issues are addressed by IAS 8, IAS 10, IAS 16, IAS 20, IAS 36, IAS 37, IAS 38, IAS 41, IFRS 3, IFRS 6 and IFRS 8, as well as interpretations IFRIC 1, 3, 5 and 6 (Negash, 2013; Goyal, 2013). Also, IAS 1 - Presentation of Financial Statements emphasizes that all financial risks, including risks associated with negative environmental impacts, should be disclosed, which should encourage entities to publish additional financial and non-financial information about assets, liabilities, costs and risks related to business sustainability through notes or separate reports (Goyal, 2013). This is the reason why many authorities in this field consider that IAS / IFRS provide a significant starting point for creating quality information on business sustainability, whose further formulation and publication depends on the level of corporate awareness and the specific regulatory requirements of individual countries.

On the other hand, critics of existing solutions in the accounting regulatory framework refer to the limitations of IAS / IFRS to offer broader opportunities for recognizing and evaluating environmental costs, obligations and risks. As a result, in their view, numerous valuable information remains hidden, disclosed at best in the notes to the financial statements, as a type of qualitative information. Measuring a wide range of complex business sustainability aspects and narrowing them into tight and accurate financial information frameworks requires a broader stakeholder perspective. Therefore, when considering the relationship and the feasibility of reconciling sustainability (environmental) and financial reporting, it is impossible not to look back at the fact that they are based on antagonistic views of the world and the environment (Gray et al., 2002). Namely, mainstream financial reporting practices, as one of the main pillars of the functioning of financial markets, are mainly aimed at monitoring the process of generating profit for owners, which, unfortunately, is often taking place selfish, short-sighted and without looking at unsustainable consumption of resources, devastating environmental impacts, and various forms of social inequality.

Keeping to its basic goals, financial accounting makes one closed and exclusive information system determined to ignore all other external factors and ideas that are not closely associated with generating value for stakeholders. Sustainable development reporting, on the other hand, offers a broader alternative approach within which these external factors (related to environmental and social impacts) are the focus of reporting and where the costs of economic success of a rich minority are expressed by the losses suffered by the majority, that is, society and the natural environment (Sekerez, 2016b). This discrepancy between the predominant purpose of traditional financial reporting to serve the most powerful stakeholders and the need to better serve the wider community in the face of increasing pollution and climate change motivates individual authors to recognize financial accounting and its profit measurement mechanisms as one of the responsibility bearers for the contemporary environmental crisis (Patten, 2012).

Referring to the divergence between financial and sustainability reporting, Gray et al. (2002) concludes that, in the face of dramatic climate change, never-ending pollution and threatening shortages of elementary (non-renewable) natural resources, the issue of increasing the accuracy of financial accounting information becomes at least irrelevant, if only its elemental unconformity to the requirements of sustainable development reporting is taken into account. Such a radical attitude is accompanied by a call for revision of certain essential aspects of its practice for the purpose of adaptation to new reporting requirements. In order to be effective, these adjustments must cover all fundamentally important areas, and not just be "cosmetic" changes within existing parameters and rules. Otherwise, there is a risk that only superficial and incomplete information on sustainable development is accepted in the financial statements, while many of the essential issues of measuring the performance of businesses in the field of environmental protection (as before) are left out.

It should be noted that the initiators of changes in traditional financial reporting practices are often investors, who are increasingly recognizing the fact that business sustainability factors have a significant impact on a company's market value. The current and potential investors need to understand the financial implications of emerging environmental and social risks, along with the company's intended strategic initiatives to mitigate them. In other words, they are interested in quality information on the effects of the enterprise's activities on preventing, mitigating or eliminating negative environmental impacts, so that they can protect their investments from future losses that may result from current sustainability risks (Thistlethwaite, 2011).

Limitations in accounting for the external environmental factors are explained by arguments supported by accounting conventions and principles (materiality, causation, prudence, fair insight, etc.) that create a closed system unable to flexibly respond to the increasing environmental challenges. The paradox that arises on this occasion is related precisely to the inability of the external reporting system, such as financial accounting, to cover a wider range of increasingly significant external factors of business, primarily because of existing rules and principles. These rules, by their very nature, are narrowly technical, neglecting the fact that the long-term problems of preserving the environment and improving the quality of life in the community go beyond the scope of a single reporting period. Among the factors that most affect the limited ability of financial accounting to disclose a larger volume of financial information on sustainable development is the lack of materiality of most of the effects that result from an entity's interaction with the environment, which prevents them from disclosing under IAS / IFRS solutions. As a result, a significant portion of environmental costs, liabilities and assets are not included in financial statements statement, despite the significant likelihood that they will be incurred in the future. The limited potential of financial accounting to make those items more visible results in omitting them beyond the reach of the financial statements, which results in information asymmetry related to business sustainability performance and motivates investors “to allocate their funds in a more sustainable and greener way” (Thislethwaite, 2011).

At this place we will look at some of the characteristic restrictive solutions of IAS / IFRS in the field of treatment of the environmental issues. For example, IAS / IFRS pay close attention to environmental

obligations arising from previous polluting activities of enterprises, which incur costs of wastewater treatment, remediation and restoration of land, disposal of electrical and electronic waste, closure production facilities or violations of existing rules. IAS 37 - Provisions, Contingent Liabilities and Contingent Assets obliges entities to make provisions for such costs if there is a legal obligation or long-term engagement of the company in the prevention, minimization or elimination of adverse effects on the environment, as is the case with the long-term dismantling of a nuclear power plant (IAS 37, 1998). However, the recognition and measurement of costs arising from environmental commitments is associated with many difficulties, as they are often categorized as potential due to variations in pricing inputs and uncertainty about the occurrence of future events that will confirm the company's losses. This practice has been sharply criticized recently by various groups of stakeholders, as it leads to "underestimation and failure to disclose real obligations and environmental costs" (Thistlethwaite, 2011).

Unlike environmental obligations, which are a consequence of previous events, environmental risks are the effects of an entity's ongoing activities on future financial performance. It is very difficult to measure the exact amounts of these risks and to determine whether they are materially significant, because they represent the potentiality of future losses. In addition, the aforementioned risks relate to long periods of time (potential damage from climate change) and do not form current liabilities (companies can avoid materializing these risks), so accounting rules for identifying and measuring them are very restrictive, leaving room for their presentation only in the notes to the financial statements. However, recently there has been very strong pressure from organized groups of financial market investors to make these risks more widely disclosed in financial statements, which has motivated the International Accounting Standards Board (IASB) to take some action to mitigate this problem. In this regard, during a series of meetings and analyzes conducted in 2007, the IASB expressed its readiness to, due to investor pressure, once again consider and further clarify the criteria for (non) recognition of business risks and differentiate them from regular liabilities and provisions. However, at the end of that project the provisions already set out in IAS 37 were confirmed, so nothing has changed (IASB Staff, 2007).

Some authors argue that the solution to the problem of non-compliance of accounting regulations with the requirements of sustainability reporting consists in considering the option of the "introducing a completely new report on assets and liabilities related to environmental protection, as part of a mandated set of financial statements that would affect companies in industries with significant impact to the environment should be published periodically" (Negash, 2013). The same study suggested that IAS / IFRS could serve as a global tool for measuring companies' environmental performance, but it should be accompanied by certain changes to the Conceptual Framework for Financial Reporting and by reviewing existing definitions of assets, liabilities, costs and risks. Otherwise, the practice of inadequately recognizing provisions for environmental costs or, more often, not disclosing their amounts and adequacy in the notes, leads to a direct threat to the interests of investors, who, through the financial statements, receive a distorted picture of the realized profit and liabilities of the company.

Perhaps the first step in the field of anticipated changes in the area of environmental financial accounting has been made by revisions of Conceptual Framework for Financial Reporting performed in 2010 and 2018. In the 2010 Conceptual Framework, changes were made regarding the qualitative characteristics of information, so reliability was replaced with faithful representation (EFRAG, 2010). This change, compared to the 1989 version, has opened up the space for a potential revision of the criteria for recognition of individual elements of financial statements, because the focus is directed on the importance of disclosing information about their valuation. This is an important change from the point of view of recognizing environmental risks and obligations in financial statements, since most of them do not meet the criterion of reliable valuation (primarily because valuation is mainly based on judgment that can be subjective). The 2010 Conceptual Framework emphasizes that if the valuation process, amount received and any process constraints are clearly described, such presentation is considered credible and in that case the valuation may provide the best available information on the value of the property. The continuation of the revision process and a new version of the Conceptual Framework from 2018 brought about a change in the definition of an asset, which also opened the door for potentially wider inclusion of some environmental assets, obligations and costs in official financial statements (IASB, 2018).

Despite the seriousness of the aforementioned criticisms and the evident need for changes, it is important to emphasize that financial accounting cannot be imposed with full responsibility for insufficient disclosure of environmental information, since it, as an information service, cannot affect the increase of corporate social responsibility. Undoubtedly, the primary responsibility for this lies with the owners, management and national regulatory bodies. In addition, broader disclosure of sustainable development information requires the support and involvement of other information sources, such as management accounting, while full reporting of the effects of the environmental impact should be done outside the set of traditional financial statements, which would only provide some of the necessary (financial) information for this purpose. This is why many

authors question whether financial accounting should serve as the sole generator of sustainable development information at all, and whether the problem of insufficient disclosure of this information is properly addressed by "easily" changing its established definitions, rules and principles. After all, the problem of non-disclosure of environmental information in financial statements or their notes should not only be related to the financial reporting regulatory framework, but also to the firm's compliance with those rules. In our view, the primary responsibility in this regard lies with the national regulatory bodies, which should (through their mandatory rules) encourage companies to improve the quality, transparency and comparability of information on the effects of negative environmental impacts and efforts to mitigate and eliminate them.

4. CONCLUSION

Investors and a growing number of non-financial stakeholder groups today perceive information on corporate sustainable development as increasingly important for evaluating current business performance and understanding future risks. Therefore, further approximation of the concepts of traditional financial reporting and reporting on sustainable development is expected in the future, the symbiosis of which should improve the quality of external reporting and offer ways to integrate financial and non-financial information within the annual reports. This tendency is aided by the growing volume of mandated reporting requirements worldwide, which should stimulate companies to improve communication with key stakeholders and improve the sustainability of their businesses. In this regard, the question arises as to whether a greater amount of published information a priori implies an improvement in the quality of reporting. A clear answer to this question has not yet been offered in academic and professional circles.

However, in practice a close link between financial reporting and environmental issues has not yet been developed, despite the aforementioned trends. Conventional financial accounting is often emphasized as one of the “culprits” for insufficient quality of reporting on performance in the field of environmental protection and, consequently, a lack of integration between social and financial reporting. The reason for such a harsh opinion is probably lies in the current financial reporting rules, which are technically narrow by their nature and blind for wider long-term environmental problems that exceed the framework of the reporting period. The lack of recognition of numerous environmental ultimately results in insufficient and inadequate disclosure of information about environmental costs, assets and liabilities. Moreover, even if information about environmental costs or liabilities meets the criterion of tangibility and measurability, it is still prepared selectively and has reduced visibility since it is only a part of the broader positions in financial reports. Therefore, despite the fact that IAS / IFRS offer the possibility of development of adequate accounting treatment of a number of specific environmental issues, numerous changes are needed in this regard. Many authorities believe that one of the solutions in this area would be to prescribe a minimum amount of environmental information within the existing financial reports or by introducing an entirely new mandatory record.

Further improvement of environmental reporting practices is almost impossible to achieve without the support of mandatory legislation (as its main driving force) and certain changes in current financial reporting regulations and practices. However, it is difficult to avoid the skepticism of the realism of the latter assumption, since financial accounting has its strictly defined tasks and the tools to accomplish them, so it can only partially serve as a generator of environmental and business sustainability information. Because of this, it is not realistic to expect radical changes within the existing set of IAS / IFRS, which strictly define the criteria for recognizing, evaluating and disclosing information about costs, liabilities, assets and risks related to the impact of an entity's activities on the living and social environment. Financial accounting is primarily concerned with the consequences of previous transactions, rather than anticipating future uncertain events, such as environmental risks. As a result, it is often overly harshly apostrophized as the main "brake" of the broader disclosure of information on business sustainability and the integration of financial and non-financial external reporting.

We expect to see how the new concepts and initiatives in the field of external corporate reporting, such as integrated reporting, will affect the relevance and quality of disclosed information on sustainable development, but it is undoubted that a greater share of environmental financial information would improve the overall quality of reporting. Some academics are increasingly advocating the view that broader recognition of risks, costs and obligations related to business sustainability would entail the introduction of a completely new mandatory report within the annual accounts or at least prescribing a minimum set of necessary environmental information within the existing financial reporting framework. We believe that the second option would be a more rational solution for now, with the hope that the urgency of environmental problems will outweigh certain technical aspects of accounting, so a broader range of interested users will receive the relevant and useful information on corporate environmental performance and the resulting risks. In parallel with the development of environmental accounting, radical changes in the organizational culture of the company and management are necessary, which should encourage environmental behavior of the

accountants and other employees. We expect that, along with certain changes in accounting rules, wider use of audit in the field of sustainable reporting and further development of mandatory regulation, it is possible to improve the quality of reporting on environmental issues.

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INFORMATION SYSTEMS AND TECHNOLOGIES IN THE ERA OF DIGITAL TRANSFORMATION

CONTENT

IOT LABORATORY FOR SUPPORTING DIFFERENT TYPES OF SECURE COMMUNICATIONS WITH SENSORS, WITH THE SPECIAL EMPHASIS ON SATELLITE LINK

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Abstract: *Nowadays, sensors in organized IoT networks are gaining momentum in sensitive surveillance scenarios such as border control.The real challenge for many countries is the capability to control inaccessible border areas which often have poor communication infrastructure. The most feasible solution for such cases is the utilization of the satellite link for communication between sensors and command and controls centers. Considering the very expensive cost of satellite link renting it would be extremely desirable to be able to simulate the particular satellite link in laboratory environment prior sensor network deployment. In this paper an improvement of one such laboratory environment has been proposed in order to introduce additional protection of communication between sensors and command and control center. Additionally, support for other types of communication between sensors and command centers is added. At the end, a new purpose of the proposed laboratory environment has been defined in the form of educational laboratory for students of technical faculties.*

Keywords*: IoT laboratory, satellite link, sensor network, Intrusion Detection System, education*

1. INTRODUCTION

For security critical applications, such as border security, every type of unauthorized and illegal crossing must be detected and tracked. Sensors can be used as efficient and economic solutions for this kind of problem, especially when there is a need to be implemented in inaccessible wide border areas. Accordingly, in addition of sensor density along border areas, communication network coverage is very important as well as the possibility of uninterrupted communication of the mentioned sensors with command and control center (Routray, 2019).

Internet of Things (IoT) can be described as world-wide network that connects all smart objects or sensors in order to enable them to communicate to each other (Elsaadany, 2019). IoT communication is the core of connectivity layer (the second layer of IoT reference model), and can be realized through different network technologies include NFC, RFID, Bluetooth, WLAN, WPAN, Ethernet, Power Line Communication, GSM, 3G, LTE, 5G or satellite link communication. The communication aspect is particularly important due to the growing number of sensors which services should be delivered safely and on time (Tahei, 2020). In the case where the communication infrastructure is poor or where the communication environment is harsh, the IoT communication infrastructure needs to be carefully planned and implemented in order to IoT successfully performs its role. This is especially important in the case of critical IoT applications such as border control and surveillance. For example, in lot of cases the existing communication infrastructure is poor or even non-existing and in such cases satellite communications can provide necessary IoT communication backbone (Petrovic, 2020b).

Different types of network traffic generated from different services such as VoIP, video streaming or detection files sent from surveillance radars are subject to various performance analyses in order to determine the best network traffic classification and optimization of communication infrastructure resources (Tahei, 2020). This is particularly important for satellite link communication regarding its limited performances and high cost renting. Consequently, it is absurd to use the satellite link in the development and testing

phases of sensors and their applications. Moreover, the most of today`s applications implemented on different sensor that can be reached only through a satellite link, are developed and tested exclusively in the Local Area Network (LAN) environment. This leads to significantly lower performances in production then in test conditions. User satisfaction with the application depends on parameters such as reliability, speed, real time responses, latency, navigation, personalized interaction, access convenience, simplicity and functionality. The exchange of various data with some sensor through satellite link can be significantly worse in term of user satisfaction given the larger packet delay and greater packet losses that are not existing in the test environment where data is instantly being exchanged without any delay or loss. The most satellite links, that are for example used to cover border areas without DSL and cable access to the Internet, are characterized with large propagation delays, significant variations in delay, packet loss, unpredictable interruptions, and limited bandwidth shared with other users (Routray, 2019; Ilcev, 2017; Santics, 2016).

The satellite link is also the subject to various cybersecurity threats and attacks why it is important to use and develop systems such as Intrusion Detection Systems (IDS) in order to provide the normal and secure operation of satellite network. In the case of using an IDS that additionally ensures the security of satellite communications by detecting the illegal intrusion, system complexity is significant increasing. The reason for that is the fact that IDS must be trained over and over again as new types of attacks and threats appear constantly. This refers particularly to the IDS that uses machine learning and deep learning methods such as auto-encoder (AE), deep belief network (DBN), recurrent neural network (RNN), convolutional neural network (CNN), generative adversarial network (GAN), to process large training set and to classify the normal traffic from the anomalous traffic (Aldweesh, 2020). Processing of large training data set can lead to congestion of satellite link that is unacceptable for the system in production. Therefore it can be concluded that the ability to simulate the characteristics of secure satellite link, same like it has in real conditions environment, is considered very important for predicting performance and behavior of different network systems, network applications and sensors before the network is physically implemented and application or some new sensor is developed (Zhu, 2019; Hudaib, 2016).

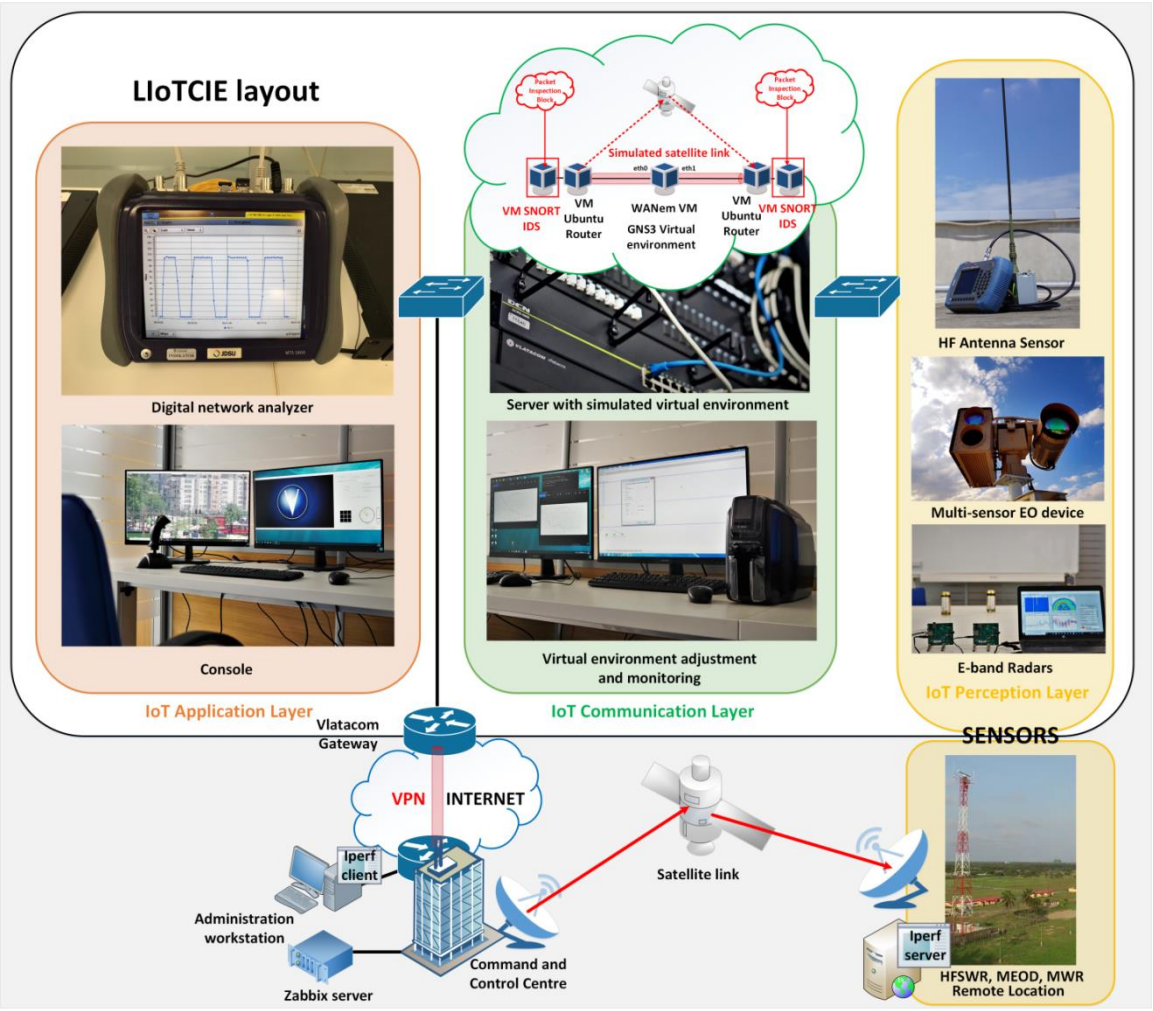

Figure 1: Layout of the implemented LIoTCIE in the Vlatacom Institute

As mentioned previously, there are very important IoT use cases that include covering large inaccessible areas with poor communications infrastructure. Thus, it is important to have IoT laboratory that will focus on IoT communications infrastructure along with the IoT sensors and applications. Such IoT laboratory would enable the efficient development of new IoT applications that can be tested and analyzed in different communication conditions. Petrovic et al. (2020b) have presented one such laboratory for Internet of Things (IoT) communication infrastructure environment (LIoTCIE) in order to facilitate maritime sensor network design process in areas where communication network is dependent on data transfer over satellite links. Layout of the implemented LIoTCIE in the Vlatacom Insitute is shown in Figure 1. In this paper, the improvement of the LIoTCIE laboratory in the form of additional intrusion detection blocks is proposed. Moreover, besides sensors for maritime surveillance such as High Frequency Surface Wave Radars (HFSWR), multi-sensor electro-optical devices (MEOD) and conventional microwave radars (MWR), the others, more typical IoT sensors such as CCTV cameras, temperature and humidity sensors etc. are added to the laboratory environment. In addition to its practical application in maritime surveillance, recently, LIoTCIE has been actively used for educational purposes for students of technical sciences.

The paper is organized as follows: Section 2 provides an overview of existing IoT laboratories with a special emphasis on IoT communication layer. Section 3 describes the communication challenges that IoT sensors are facing, especially regarding wide geographical areas with unfavorable communication conditions. LIoTCIE architecture with new additional blocks for intrusion detection is presented in Section 4. The practical usage of LIoTCIE with a special attention on its educational purposes has been described in Section 5. Section 6 gives conclusion and directions of future work.

2. EXISTING IOT LABORATORIES

Since IoT has become one of the most important parts of our everyday life, IoT is still attracting a lot of attention and as result various IoT laboratory environments have already been proposed in the literature (Poongothai, 2018; Karvinen, 2018; Guan, 2017; Kumar 2017; Dobrilovic, 2016; Kirichek, 2015). However, the main focus of the most of these laboratories is only on development and testing different IoT sensors for educational purposes to generally introduce the students into IoT field. The subjects of laboratory analysis are mainly sensors that contribute to a better quality of life in smart homes and smart cities such as temperature sensors, humidity sensors, CCTV, smoke sensors, motion detection sensors, etc. (Poongothai, 2018; Guan, 2017; Kumar 2017). Besides standard IoT sensors, the proposed laboratories are equipped with different IoT platforms and development boards for IoT prototyping such as Arduino, Raspberry Pi, Intel Edison etc. For example, Karvinen and Karvinen (2018) have proposed setup with Arduino Uno and Python program for rapid IoT prototyping to help students to turn their ideas into new IoT devices. Kirichek and Koucheryavy (2015) have proposed the laboratory equipped with long list of sensors, actuators, and devices based on open hardware platforms, then with hardware and software that allows monitoring network performance at all layers of OSI model, as well as carrying out simulation of wireless network sensors based on ZigBee technology. Some of the laboratory environment (Sperling, 2018) are designed in order to test security vulnerabilities of IoT devices and to track intruders in IoT networks by analyzing DNS traffic. Dobrilovic and Stojanov (2016) have described platform that defines all aspects of IoT environments and enables students to learn about this whole IoT concept and its functionalities. In this platform the network layer relies on LAN and Internet using HTTP protocol. Besides IoT model (Guillen, 2017) for evaluating impact of parameters such as latency, jitter and control protocols on IoT applications, to the best of our knowledge, the previously presented laboratories do not deal with the IoT communications problems in general, especially for wide geographical area. The communication part of these laboratories mainly implements and uses short and medium range communication technologies and protocols such as Bluetooth, ZigBee, RFID, WiFi, MQTT, etc. This is exactly what makes the proposed LIoTCIE different from the other IoT lab environments because it focuses mainly on the IoT communication infrastructure and its impact on wide geographical area IoT networks. Moreover, it should be noted that IoT laboratory that supports complex IoT devices and sensors installed in wide geographical area other than LIoTCIE to the best of our knowledge does not exist.

3. IOT CONNECTIVITY LAYER CHALLENGES

Data collected from a sensor located on a remote location should be forwarded to a central site where data are processed. A numerous wired and wireless access technologies are available for connecting different types of sensors. In the domain of IoT, the wireless technologies are dominant type of communication. One of the reasons for this is the possibility for sensors to be mobile, without losing the connectivity (Hanes, 2017; Shahid, 2016).

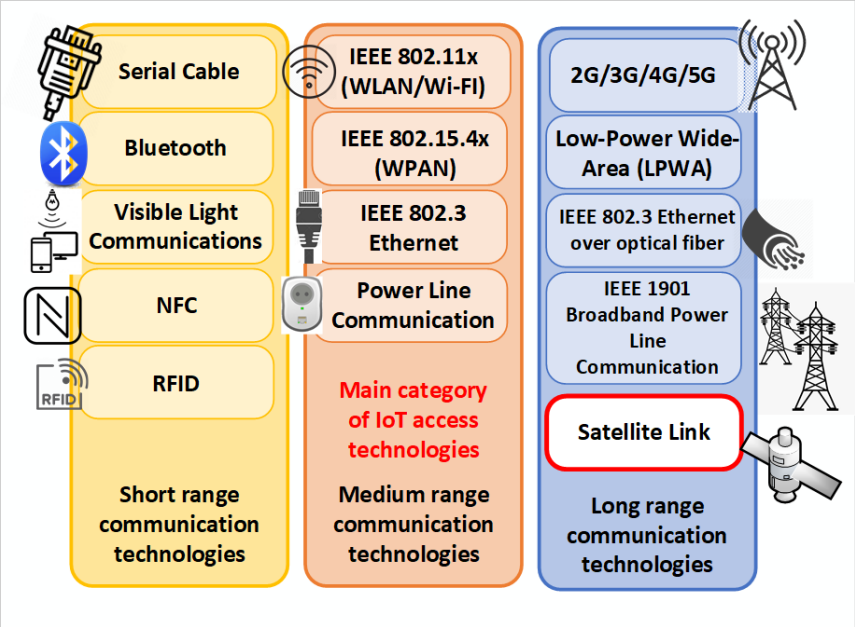

Figure 2: IoT communication technologies

It is possible to categorize all IoT wireless and wired communication technologies based on their coverage area into three main groups: short-range communication technologies, medium-range technologies and long-range technologies, as it shown in Figure 2 (Hanes, 2017).

Concerning long-range communication technologies satellite links and 4G cellular are the most commonly used options. For example, in urban zones, 4G LTE cellular service is available and can provide good performance, from 1 to 30 Mbps, with round-trip time of 20 to 80 ms. Geostationary (GEO) satellite link is very expensive and with limited performances in the form of large round-trip delays of 600 ms and more. But, as it mentioned before, in some inaccessible areas where, for example, it is necessary to perform border control and surveillance using various sensors, the utilization of satellite link is the most feasible solution. For implemented LIoTCIE, long-range communication technologies are in focus, especially GEO satellite link. In the future, simulation of low earth orbit (LEO) satellite link and 5G network is planned within LIoTCIE.

3.1. IoT over satellite link

In some cases, when standard IoT wireless technologies cannot achieve the range required, data services exchange with remote sites depend on satellite link communications. There are many examples of IoT applications where the use of satellite link is necessity such as, previously mentioned border control, smart grid, environmental monitoring, smart agriculture, ship and vehicle tracking, and emergency management as it shown in Figure 3. It can be concluded that these are critical applications from the communication point of view, because sensors are deployed at locations where human presence is not possible and where increased reliability and coverage have very high priorities (Routray, 2019).

Regarding smart grids, satellite link may be used to provide monitoring of offshore wind-farms or solar energy systems in desert areas. Also, it can be used as back up link in order to provide high availability of some important systems such as border surveillance, oil tankers tracking, nuclear power plant surveillance etc. Satellite links can also be used for outdoor environmental monitoring in order to detect natural disasters such as forest fires, volcano eruptions, floods, earthquakes. For most of these application requirements on communication delay are quite relaxed since these applications do not require real time operation (Sohraby, 2018; Sanctis, 2016).

As shown in Figure 3, the satellite collects data measurements from a huge number of sensors and sends it to a central site for data processing. Also control data is sent from central site to actuators through same satellite link.

However, although the satellite link has a significant utilization in IoT communication, to the best of our knowledge, there is no research specifically focused on the simulation of satellite link for IoT communication in laboratory environment.

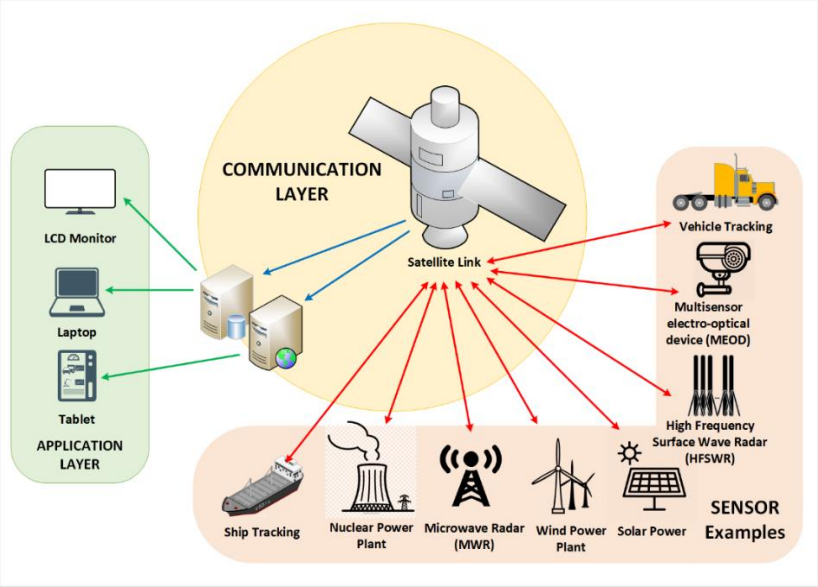

Figure 3: Satellite communications supporting Internet of Things

3.2. Satellite link parameters

In area where WAN connectivity is difficult to acquire, satellite link comes into play with all its deficiencies in form of relatively low bandwidth, high latency and high packet loss. Regarding that the number of implemented IoT sensors is constantly growing, these deficiencies of the satellite link become even more important. The current condition and quality of real satellite link can be presented through network parameters such as bandwidth, throughput, latency, jitter, packet loss, packet corruption, random outage (Kurose, 2013). Open source software tools for network analysis are used to collect necessary information about characteristics of particular real satellite link that is used for communication between command and control center and sensor network for maritime surveillance as it shown in Figure 1. Data such as throughput, jitter, packet loss, as well as the average transmission time of the detection files have been measured and collected for one year (Petrovic, 2020b). Also, during the same year, data on the weather forecast for each day have been collected, so, it was possible to perform an analysis of the impact of weather conditions on transmission via satellite link. The information obtained on that way is used to create a template that is inserted LIoTCIE in order to simulate a real satellite link.

4. IMPROVED LIOTCIE ARCHITECTURE

The outline of the modified laboratory that is explained in (Petrovic, 2020b) is shown in Figure 4 and its focus is on connectivity layer of IoT reference model. The main purpose of this layer is transferring data between IoT application layer and IoT perception layer across different types of network. Also, network security in the form of encrypted traffic, is implemented in this layer. In the proposed laboratory, IP, TCP and UDP are considered as network and transport protocols that bring connectivity to IoT sensors.

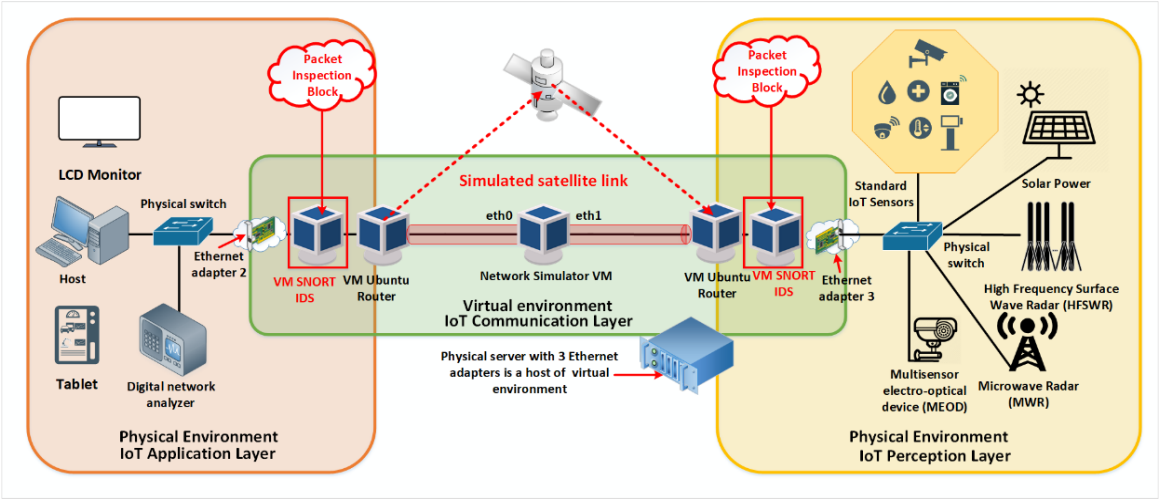

Figure 4: LIoTCIE architecture

The LIoTCIE consisting exclusively of easily accessible open source solutions is a combination of virtual and physical networks. In addition to template for simulating satellite link, based on detailed analysis, some new templates for simulation other types of network traffic are created such as (Petrovic, 2020a):

- Mobile network X24 LTE modem (125.08Mbps/54.6Mbps; 17ms latency; 25ms jitter) (Qualcomm, 2018b)
- Mobile network X16 LTE modem (128.35Mbps/24.9Mbps; 22ms latency; 13ms jitter) (Qualcomm, 2018a)
- Home broadband internet (300Mbps/75Mbps; 14ms latency; 6ms jitter)

The need for security increases also in satellite communication because the users of this type of communication also have demands regarding confidentiality and data integrity, especially in the case of military and security applications. Complete IP traffic between IoT application layer and IoT perception layer in proposed LIoTCIE is encrypted by configuring Site-to-Site IPsec VPN. The encryption algorithm used to achieve secured communication over the simulated satellite link is the Advanced Encryption Standard (AES) 256. In order to raise security to higher level, new additional blocks for intrusion detection are proposed in this paper and explained in the section 4.1.

4.1. IDS implementation in simulated satellite link based on open source solution SNORT

In this paper improvement of the LIoTCIE architecture in the form of additional intrusion detection blocks is proposed. The main purpose of using the IDS in satellite communication is to improve the security level by detecting the illegal intrusion as well as inappropriate, incorrect and anomalous activities in satellite network (Varma, 2017). Satellite networks with its wireless characteristics are subject to different security threats such as spoofing, eavesdropping, traffic hijacking etc. The potential threats in satellite communication can be classified into two categories, passive and active attacks (Varma 2017; Borkar, 2017). In the passive attacks, traffic between sender and receiver is sniffed without affecting the resources of the system. In satellite networks the example of passive attack is presented through the ability to tune to different frequencies in order to receive traffic destined to other terminals by using only the basic knowledge of the communications protocols without leaving any trace. In active attacks, intruder attempts to access the system by exploiting or modifying its data, resources or devices. In such compromised network, intruder is able to transmit, modify or delete data. The most famous active attacks are Denial of Service (DoS) (Gavric, 2018), distributed DoS (DDoS), session replay attack, traffic hijacking, spoofing. In DoS attack that includes flooding the target with the traffic, system becomes unavailable for a certain period of time. The example of DoS attack is ICMP flood attack which uses the ping to cause the remote system to crash. Using spoofing attack, the intruder is able to capture, alter and retransmit a communication stream to recipient. The example of this type attack is Domain Name Server (DNS) spoofing that alters DNS records in order to redirect online traffic to fake website (Aldweesh, 2020; Zhu, 2019; Hudaib, 2016; Borkar, 2017; Haripriya 2018).

In order to detect and identify intrusion in the LIoTCIE simulated network two IDS blocks collect important information from the network, processes it, and if the problem is detected, then the security administrator is alerted for the possible attack (Kumar, 2012). Depending on the type of analysis that is applied, intrusion detection systems can be classified into two groups, misuse-based or signature-based, and anomaly-based. Misuse-based IDS compares analyzed data with predefined well-known patterns or signatures from the database using a specific set of rules (static approach). Anomaly-based IDS assumes that every deviation from predefined normal system activity is considered as aberration (dynamic approach). Misuse-based IDS achieves very good results in detecting well-known attacks with small false positive rate. On the other hand, anomaly-based IDS achieves better results in detecting new, unseen attacks if their signature is different compared with normal traffic. The main problem with anomaly-based IDS is the fact that not all abnormal traffic is malicious. Combination of these two approaches represents hybrid IDS (Varma, 2017; Kumari, 2017; Samrin, 2017).

SNORT (CISCO Systems, 2020) is open source software that is mostly used as signature-based IDS. IDS compares packet content with well-known threats signatures from the database that can be updated from time to time. Therefore, SNORT uses predetermined attack patterns in the form of signatures in order to inspect the network traffic in real time, to predict the behavior of network attacks, and to notify the server whether to accept or discard inspected packet. SNORT overcomes the situation in which the signature of intrusion is not in the database, by analyzing every packet in real time and estimating whether network performance degradation has occurred. If that is the case, SNORT stores the details of that threat as a new signature in the database (Goel, 2017; Singh, 2013; Kumar, 2012).

IDS blocks within LIoTCIE, shown in Figure 4, beside port scanning and ping detection, use specially written templates to prevent leakage of sensitive information such as for example ID data. The rules for detecting and recognizing the characteristic payload of IP packets are written using Perl compatible regular expressions.

5. THE USE OF LIOTCIE

The LIoTCIE was mainly designed and developed during deployment of maritime surveillance network in the Gulf of Guinea in order to facilitate maritime sensor network design process in areas where communication network is dependent on data transfer over satellite link (Petrovic, 2020b). Using LIoTCIE with the gained experience it is possible to design and build some future similar sensor networks in other locations of interest as well. The proposed laboratory was used in iterative process to tune multi-sensor data integration algorithms to the real working conditions, but in the laboratory environment, and later integrated into real maritime surveillance sensor network.

5.1. LIoTCIE in educational purposes

Besides its practical utilization in development of maritime sensor network, LIoTCIEis being actively used for the education of students of technical sciences as part of student's mandatory internship within the Vlatacom Institute. Following the instructions and tasks from the laboratory manuals (Petrovic, 2020a; Petrovic, 2019), students are getting the opportunity to get familiar with various network technologies in a practical way. During the one month of internship, students learn to configure routing, switching and security technologies such as static and dynamic routing using EIGRP and OSPF routing protocols, VLAN and routing on stick concept, site to site IPSec VPN etc. Students also get experience in measuring network parameters of traffic generated by packet generator using digital network analyzer as well as open source tools such as Wireshark and Iperf. Measured parameters such as bandwidth, propagation delay, jitter, packet loss and bit error rate, are used than in order to set link emulator within the LIoTCIE. Students also test the impact of different network parameters on services provided by different IoT and other network sensors and analyze traffic and user experience. In the end of the internship, students learn how to write technical report on completed assignments. Some of the advanced students managed to set up a VoIP server in order to try to legally eavesdrop it (Nerandzic, 2018). The main goal of the internship is the final employment of the best candidates, who thus get the opportunity to work on very attractive projects in very dynamic environment.

6. CONCLUSION

Design of IoT solution highly depends on available connectivity, and for every type of IoT sensor, suitable access technology should be selected. In some wide geographical areas that must be under control surveillance, communication infrastructure is very often poorly developed, leaving only satellite links as somewhat reliable means of communication. Proposed LIoTCIE gives the possibility to network designers to plan and implement IoT networks that includes satellite communication as an essential part of the communication infrastructure. In this paper, improvement of LIoTCIE is proposed in form of additional blocks for Intrusion Detection in order to achieve stronger protection of simulated satellite link. Using Pearl compatible regular expressions the rules for detecting and recognizing the characteristic payload of IP packets are written in order to prevent leakage of sensitive information. Also, the completely new utilization of laboratory environment for education of students of technical science is proposed. Specifically, during the one month of internship, students learn different network technologies and their impact on various IoT applications by actively using the LIoTCIE platform. Finally, three completely new templates for simulating different types of network traffic are designed and added to LIoTCIE platform. Two templates are designed to simulate LTE mobile network with different network parameters based on modem in use. The third one is designed in order to simulate home broadband Internet. Future work will focus on further expansions of the LIoTCIE environment in order to support implementation of different cyber security technologies.

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TRENDS IN MILITARY APPLICATIONS OF ARTIFICIAL INTELLIGENCE

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Abstract: *This paper presents comparative analysis of perceptions and treatment of artificial intelligence in the field of national defence for a number of selected countries and international organizations. The idea and research motivation came from perception of growing importance of artificial intelligence in military applications and some novel technologies and tactics applied in some ongoing military conflicts. The first finding is nearly almost simultaneously issuing of national strategies related to artificial intelligence and national security for several countries and organizations of interest. The second finding is the recognition of similarities in perceptions of possible uses of artificial intelligence in the military domain among different countries and organizations. Finally, declared trends of military application of artificial intelligence will make significant impact on defence affairs, international conflicts physiognomy and military organizations.*

Keywords*: military, strategy, artificial intelligence, warfare, drone*

1. INTRODUCTION

Several strategic documents related to applications of artificial intelligence (AI) in the military domain appeared in a relatively short time in recent years. In November 2019 German Army Concepts and Capabilities Development Centre published a positional paper on AI under the title: "Artificial Intelligence in Land Forces" (German ACCDC, 2019). In October 2019, NATO Parliamentary Assembly issued a report: "Artificial Intelligence: Implications for NATO's Armed Forces" (Tonin, 2019). In September 2019 French Ministry of Defence issued an official strategic document on the topic: "Artificial Intelligence in Support of Defence" (MoD France, 2019). This may indicate that the main European powers are starting to work more systematically on the issue of implementing cutting-edge technologies such as AI and to try to keep the pace with its global competitors like USA, China and Russia. Relevant European Union (EU) administrative bodies are aware of this EU weakness (Franke, 2019, p.2) and some advancement should be expected in a near future.

But, why are issues about artificial intelligence in military applications important at such (strategic) degree? Isn't that one of the evolutionary changes? The shortest answer is that AI, along with a few other emergent technologies, has potential to be a "game changer" in conflicts and wars. Sechser, Narang and Talmadge (2019) explained how emerging technologies influence strategic stability at the highest level of political and international relations. Layton (2018) discussed the concept of algorithmic warfare which is defined as "combined employment of autonomous weapons, uninhabited systems, AI, smart algorithms and big data analysis". Algorithmic warfare is novel term introduced in 2017 when Department of Defence of the USA established a multidisciplinary working team dedicated to the study of algorithmic warfare (DoD, 2017). Immediate consequences of possible implications of AI and other cutting-edge technologies for tactical and operational level of military missions, concepts and organizations were discussed by Allen and Husain (2017). Quality and relevance of their discussions came from their professional background (Allen is retired Marine Corps general with reach field deployments and commanding experience, while Husain is top technology entrepreneur and inventor). Allen and Husain (2017) refreshed perception and perspectives of hyperwar offering renewed definition as follows: "hyperwar may be redefined as a type of conflict where human decision making is almost entirely absent from the observe-orient-decide-act (OODA) loop; as a consequence, the time associated with an OODA cycle will be reduced to near-instantaneous responses; the implications of these developments are many and game changing". Up to now human factor was present in all phases of military decision making cycle (Nikolic, 2017, p.677) and it has been spending significant time in several consecutive steps (tandem queueing) of OODA cycle. Algorithmic warfare and hyper warfare could be seen as two sides of the same coin: new emerging technologies in military applications are means (algorithmic warfare) which have a goal to produce changes in conducting warfare (hyperwar).

This paper presents a comparative analysis of perceptions and treatment of artificial intelligence (AI), its importance, influence and possible applications in the field of national defence for a number of selected countries and few international organizations. While AI issues seem very technical and narrow by its character and content, it has huge potential for different applications and substantial improvement of existing technical and socio-technical systems and processes. Consequently, military applications of AI have good potential to be considered at a higher level of conflict research and security analyses. Johnson (2019) discussed general impact of AI on future warfare and implications for international security and found that AI could arise as a major potential source of competition for great powers and a source of international instability (p.147), due to three main aspects: as follows (p.159): amplification (based on AI implementation) of existing security threats and uncertainties; transformation (based on AI implementation) of nature and character of existing threats and involvement of new threats to security and balance of power.

As main information sources, we used strategic documents related to artificial intelligence and other classes of relevant documents issued on topics of artificial intelligence and national defence or military organization. Idea and research motivation came from perception of growing importance of artificial intelligence in military applications and some novel technologies and tactics applied in a number of ongoing military conflicts. Hybrid warfare is the most dominant conflict concept at the moment and it has many forms in different aspects: military, political, economic, civil, informational, etc. AI applications are present in an indirect way in many aspects of hybrid warfare, as it is mentioned by Yan (2020), from swarming of military drones (p.8), up to production of fake video news (p.11) in order to create panic among population or denunciation of state leaders. Thiele (2020), in a research paper from referential European Centre of Excellence for Hybrid Warfare, even marked AI as a key enabling factor for hybrid warfare.

2. ARTIFICIAL INTELLIGENCE IN MILITARY DOMAIN

One of the best indicators of systematic introduction of emergent technologies in the military domain is an order issued from the top management of defence ministry (Deputy Secretary of Defense, 2017) for setting up one multifunctional working team for algorithmic warfare with the main task to field technology for improving and automating processing and delivering information for unmanned aerial vehicles (UAV) including processing video materials (initial motivation was better countering ISIS at the Middle East). This DoD's undertake, known also as project Maven, assumed engagement of some non-military companies which have appropriate expertise and capacity to respond to DoD's requirements. One of them was Google until large number of its employees signed a petition against engagement in project which is connected with drone strikes in armed conflict. In its essence project Maven is an attempt to build a mobile aerial observation platform for reliable search and identification of targets (small targets and individuals) and their tracking and engagements by other combat (armed) drones. This futuristic concept of targeting enemies at the battlefield should be enabled by use of AI and other disruptive technologies such as: advanced sensors, miniaturized computing capacities, high-speed networks, offensive and defensive cyber capabilities, improved decision making capabilities, autonomous platforms, big data analysis, machine learning, etc.

While there is no widely accepted definition of AI, there are more definitions of AI in the national defence specific context such as:

- Definition of the USA Department of Defense (DoD, 2018): "AI refers to the ability of machines to perform tasks that normally require human intelligence – for example, recognition patterns, learning from experience, drawing conclusions, making predictions, or taking actions – whether digitally or as the smart software behind autonomous physical systems." (p.5).
- "AI is based on algorithms that are purpose-build to solve specific problems. Such AI algorithms are being leveraged to collect, compile, structure, process, analyze, transmit, and act upon increasingly large data sets," (Tonin, 2019, p.2).
- "Any artificial system that performs tasks under varying and unpredictable circumstances, without significant human oversight, or that can learn from their experience and improve their performance. They (AI systems) may solve tasks requiring human-like perception, cognition, planning, learning, communication, or physical action," (Hoadley & Lucas, 2018, p.1).
- "Artificial Intelligence is an interdisciplinary field of theoretical and practical study which seeks to understand the mechanics of cognition thought and use a combination of hardware and software to imitate them in order to assist or replace human activities," (MoD France, 2019).

French MoD definition of AI seems the most appropriate and general. Also, there are similarities between the French definition and the ones from US DoD, particularly if we assume that "mechanics of cognition and thought" (elegant phrase from French definition) practically means: "recognition patterns, learning from experience, drawing conclusions, making predictions" (USA DoD definition).

A comparative view of motivating factors and priorities for application of AI in the military is presented in Table 1. Until recently, it was considered that there are three main global players in the field of AI: USA, China and to some extent Russia. Like in other fields, they see each other as competitors in the field of AI as well. So, they started to explore and develop AI not only in military applications relatively early and are leading the global race in AI inventions and implementations. Wider dedication to AI including military applications in European countries, have started latter then in USA and China but almost simultaneously in main EU countries. So, it could be said that the second main motive for military application of AI was fear from competitors, while the first one is perception of possible huge gains of AI applications and inventive developments of platforms with implemented AI capabilities.

Table 1: Motivation factors for AI and AI-enabled technologies development for military applications

NATO (Gilli, 2019)	USA (DoD, 2018)	France (MoD France, 2019)	EU (Franke, 2019)	UK (DCDC, 2018)	Germany (German Army ACCDC, 2019)
Proactivity for technological novelties, instead of passivity	Delivering AI-enabled capabilities that address key missions	AI as a flourishing field	Strengthen European defence	Effective integration of humans and machines into war fighting systems	AI capabilities of potential adversaries
Preserving and enhancing military superiority	Scaling AI's impact across DoD,	Dual and defence-specific uses	Develop European technological sovereignty	Coherent future force development	Increasing dynamics of combat operations
Improving and refining existing technological and industrial capabilities	Enabling decentralized development and experimentation	Abundant potential to support operational superiority	Keeping the pace with global players (USA, China, Russia)	Framing Defence strategy and policy on automation and autonomy	Fewer qualified personnel available
Sustaining global security dominance	Cultivating a leading AI workforce	Revolutionary change with threats and risks	Coordinate efforts among members		Declining relative purchasing power and shortage of resources
Following and coordinating modernization trends in member states	Engaging with commercial, academic, and international allies and partners	Keeping the edge with international competition			Increasing quantity and density of information
	Leading the military ethics and AI safety	Ethical concerns			Increasing dynamics in the development of IT and AI

Allen and Chan (2017), offered a possible explanation for growing interest for AI application not only in the issues of national security, but in general. In their view, (p.7), there are several key factors for expanding presence of AI, such as: long standing exponential growth in computing performances of IT hardware; growing availability of large datasets (appropriate for machine learning systems), which is a consequence of overall IT development including advances sensor technologies; development and implementation of machine learning methods and models; and, acceptance and wide usage of AI by commercial market and consequently further development.

Interesting approach for demonstration of a possible scenario of future combat situation is offered in German strategic document on AI (German Army Concepts and Capabilities Development Centre, 2019). At the very beginning of the document they describe an example of protection of critical infrastructure (an energy facility). Their future (hypothetical) military unit possesses a respective number of small drones which they engage in a swarm around protected object and area and wait for the enemy. Starting with such example German document gradually explores possible development of AI in the military domain but staying in the framework of Land forces (excluding Navy and Air Force). Unlike the German case where one service (Land forces) declared its AI strategy, French approach is more comprehensive and they issued AI strategy for whole ministry of defence.

3. COMPARISON OF MILITARY APPLICATION OF AI IN SELECTED COUNTRIES

Representative discussion through hypothetical but logical examples of possible military applications of AI and corresponding consequences are presented by Allen and Husain (2017). They discussed different aspects and consequences of military application of AI and engagement of AI enabled combat platforms. One of the most important findings is that the decision making time in a military command and control (C2)

process will be drastically reduced. That means that response time to the threat is much shorter and consequently there are better prospects for mission success. Some of other interesting findings are (Allen & Husain, 2017): AI systems has much better endurance than human operators and decision makers so that possibilities of errors and lack of care are minimal; logistics for AI enabled platforms (drones, robots, sensor networks and systems) is less demanded; exchange of experience, implementation of lessons learned and training is much more relaxed with AI enabled platforms.

One of the strongest impressions in our research is nearly simultaneously issuing of national strategies related to artificial intelligence and national security for a number of countries and organizations of interest. The second finding is recognition of similarities in perceptions of importance and possible applications of artificial intelligence in the military domain among different countries and organizations. Final finding is that trends of military application of artificial intelligence will make significant impact on defence affairs, international conflicts, warfare physiognomy and military organization. Table 2 presents a comparative view of main sorts of applications of AI in the military domain. Since information in Table 2 comes from novel strategic documents of mentioned countries, it is reasonable to perceive them as relevant trends in military applications of AI. Countries and organizations displayed in Tables 1 and 2, should be perceived just as a representative sample based on data availability, while a deeper research should certainly include more countries.

Table 2: Military application domains of AI according to strategic documents and relevant studies

NATO (Tonin, 2019)	USA (Hoadley & Lucas, 2018)	France (MoD, 2019)	EU (Franke, 2019)	UK (DCDC, 2018)	Germany (German Army ACCDC, 2019)
Information and decision support. C4ISR (Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance)	Command and Control/ Intelligence, Surveillance and Reconnaissance (ISR)	Decision and planning support	Command and control (centralized planning that combine various flows of information, from different sensors, into a single source of intelligence). Intelligence, Surveillance and Reconnaissance (ISR)	Evolution in Headquarters and decision-making. Evolution of OODA-loop (observe-orient-decide-act)	Analysis Methods. Next Generation Battle Management Systems
Cyber security and defence Electronic warfare. Intelligence. Social media	Cyberspace	Cyber security and digital influence. Intelligence	Cyber operations (both defensive and offensive)	Evolution in cyber and information operations	Image Analysis
Logistics	Logistics	Logistics and operational readiness	Logistics (predictive maintenance, efficient shipping, and autonomous transport systems)		Material and Infrastructure
Robotic autonomous vehicles	Autonomous vehicles. Lethal autonomous weapon systems (LAWS))	Robotics and autonomy	Semi-autonomous and autonomous vehicles and weapons (including LAWS). Swarming	Evolution in remote and automated platforms (RAS); and countering RAS	Tactical Unmanned Aerial Systems
Human resource management. Training. Combat casualty care	AI Acquisitions Challenges	AI in support services (administration and health)	Training (using methods such as war games and simulations)		
Peacekeeping operations		Collaborative combat	Forecasting		

Looking at the AI application domains in the military and defence branch (Table 2), it is clear that they relate to concrete and specific issues. Ayoub & Payne (2016) made a distinction between modular AI and general AI (p.795): modular or narrow AI applications relate to the concrete technical or organizational system or process which have clear structure, elements and regulated mutual relations; while general AI is broader, more flexible, more adaptable and more capable to solve ill-structured, ambiguous and abstract problems which require higher level of understanding and even dealing with human values and way of thinking. Authors (Ayoub & Payne, 2016) advocated that general AI, due to its' complexity, is still far from wider

application (p.816), while narrow or modular AI already has many applications with strong tendency of further development and implementation into concrete applications.

Summarized, dominant trends in military applications of AI are:

- Embedding AI in weapons platforms in order to improve their performance and enable collaborative aspects among platforms
- Situational awareness, reconnaissance and threat monitoring through engagement of autonomous unmanned platforms able to discover, identify and track potential targets, and deliver information to response teams
- Data gathering from various sources and sensors, processing large volumes of data, recognizing patterns and correlations, information extraction and delivery to decision making unit
- Advanced target recognition, probabilistic forecast of enemy behavior, assessment of mission approaches and selection of courses of action
- Application of AI in cyber security domain: protection of networks, computers, programs and data; and recognizing patterns of cyber attacks and creating appropriate counter-attack capabilities; development and use of autonomous transport system (particularly for “last mile delivery” of critical needs like ammunition and fuel in forward combat zone)
- Optimize logistics: monitor supply chain dynamics; track supply demands; support maintenance activities; identify bottlenecks; predict consumption of ammunition, fuel and spare parts
- Improving battlefield healthcare
- Advancing training and combat simulation

4. DRONES – THE BEST-KNOWN MILITARY APPLICATION OF AI

Some of the most obvious examples of AI applications in the military domain are robotic autonomous vehicles, usually named as unmanned vehicles, or better known as drones. There are many kinds of drones. MacDonald & Howel (2020) suggests aerial drone (UAV – Unmanned Aerial Vehicle) classification (p.104) as: Unmanned Aerial Combat Vehicle; High Altitude Long Endurance UAV; Medium Altitude Long Endurance UAV; Tactical Unmanned Systems; Small Tactical Unmanned Aerial Systems; Loitering Munition; Small Rotor-based UAV; Cargo & Transport UAV. Besides Unmanned Aerial Vehicles, there are other types of unmanned vehicles for other physical environments: sea-based unmanned vehicles (underwater and surface); and ground-based unmanned vehicles.

In early decades of development and operational use UAVs were mainly used for reconnaissance missions and were produced by a limited number of companies mainly from great western powers. However, promising potential of UAV was recognized by many other countries, organizations and researchers. For example, Pokorni (2002) offered an exhaustive review of UAV which were actual at that time. Extensive review of current affairs in UAVs development, production, trade and operational use deserve much more space and one separate research effort. During the last two decades many countries, including small ones like Serbia, started to develop its own UAV and have even reached a high level of expertise in UAV technology and operational use like Israel. Some countries, like Turkey, used its own UAVs in ongoing conflicts in Syria and even in Libya by Turkey-backed forces. At the beginning of this year, media at a global level was full of reports on combat use of US UAV in eliminating an Iranian general on visit in Iraq. Many times there were reports about use of UAVs against singular targets during long anti-terror war in Afghanistan. However, some of that UAV attacks were on the wrong targets for different reasons. Failures of UAV mission opens many questions related to ethical, legal, moral and political issues. It is expected that novel UAV with advanced AI based capabilities will have better capacity for target identification and recognition.

Unmanned aerial vehicles are even seen as future substitute for manned combat aircrafts. In a novel paper Zegart (2020) cited an earlier opinion of one of the top defence officials where he said that the new F-35 Joint Strike Fighter will probably be the last manned combat aircraft (p.6). Pashakhanlou (2019) found a similar conclusion about evolving role of pilots in the armed forces (p.337) and associated a new term for such type of UAV as: pilotless aerial vehicle (PAV). Main reasons for such perspective for drones against manned fighters Zegart (2020) saw in several aspects like: small cost of drones vs. manned fighters; high precision and reliability of armed drones; and appropriate capability of drones for long duration of conflicts. The main factor for such capabilities of drones lies in the advanced application of the AI. Various kinds of UAV have already reached operational deployment in many armed forces and operational use in several conflicts during last decade (from NATO bombing of Yugoslavia in 1999, across conflicts in Asia and North Africa, up to ongoing conflicts in the Middle East).

Main use of UAV in the beginning, was observation and reconnaissance missions, while actual trends assumes expand towards combat engagement missions. UAV capable for conducting combat engagement are sometimes referred as lethal autonomous weapon systems, or LAWS (Wayatt, 2020, p.1), and their development is seen as possibly a major military innovation in ongoing new wave of Revolution in Military Affairs, RMA, (Wayatt, 2020, p.4). The most important technology for successful development of LAWS is AI and its use for control over critical battlefield functions (Wayatt, 2020, p.6), like: capability to conduct sensing of environment, identify threats, locate targets, decide and finally act; as well as capability to sustain self-mobility and autonomy.

When talking about LAWS, one specific concept of combat engagement of LAWS known as swarming is unavoidable. Key point of swarming is presented in the following idea: attack the high-value enemy target with engagement of cheaper LAWS in a synchronized way which enables the achievement of a situation where the enemy defence capacity is saturated or overloaded. While being known for decades (Arquilla & Ronfeldt, 1999), concept of swarming acquired new fuels with involving AI (Ilachinksi, 2017). Alongside complex defence systems of great powers, concept of swarming seems to be useful particularly for small countries due to their limited defence resources (Jankovic & Milinovic, 2019).

While defence applications of AI may have a wide scope and variety of areas, DoD AI strategy (DoD, 2018) points out some specific focus areas with higher priorities, such as (p.11): Improving situational awareness and decision making; Increasing safety of operating equipment; Implementing predictive maintenance and supply; and Streamlining business processes. In order to make progress in efficient and effective manner, DoD strategy (DoD, 2018) recognizes importance of fruitful cooperation with adequate partners and stimulate following actions: forming open missions initiatives on global challenges; strengthening academic partnership; enlarging partnership with industry; developing cooperation with international partners and allies; engaging with open source community in order to engage talents and new ideas (p.12).

5. CONCLUSION

Artificial intelligence and AI enabled technologies have entered in military applications in many ways and become critically important and influential in many domains. AI in military applications is perceived as a phenomenon that causes some kind of revolution in military affairs. Besides the changes in technologies, AI will produce changes on all levels: tactical, operational and strategical. AI will change structure of military units and ways how they operate in combat. Growing importance and influence of AI and AI enabled technologies is recognized and many countries have started to produce initial-strategical documents dedicated to military applications of AI. Some of them did it recently and that was presented in this paper.

Putting an issue, like AI implementation in the context of national defence, on the pedestal of strategic documents, is a clear sign of importance of that issue, and intensive development in the near future could be expected. In summary, military applications of AI could be grouped as: AI applications in weapon systems; AI in cybersecurity; AI application in logistics, transportation and battlefield healthcare; AI applications in systems for situational awareness, threat monitoring and target recognition and identification; AI applications in data and information processing and intelligence, military training and combat simulation.

Acknowledgement: This work was partially supported by the Ministry of Education and Science of the Republic of Serbia under Interdisciplinary Project No.III-47029 (title: “Cost Effective Selection of New Technologies and Concepts of Defence Through Social Reforms and Strategic Orientations of Serbia in 21st Century).

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REVIEW AND COMPARISON OF BIOMETRIC DATABASES FOR TECHNOLOGY EVALUATION

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Abstract: *This paper provides an overview of frequently used biometric databases, as well as more recently published databases in this area. A comparative review of databases can help researchers select the appropriate data set for system evaluation. Reviewed databases contain physiological biometric modalities, like face, voice, fingerprint, iris, as well as multimodal biometric data. Thirteen different data sets were compared, where in addition to a brief description for each, an approximation of the number of persons and the number of instances in them was given, as well as the popularity in the academic community measured through the number of citations of the associated database scientific research paper.*

Keywords*: biometrics, evaluation, datasets*

1. INTRODUCTION

Biometrics today is gaining an increased popularity as an alternative form of authentication, complementing or even replacing traditional authentication methods such as passwords and access tokens. Banks are using biometrics for authenticating users, big smartphone manufacturers integrate biometrics into their devices. Many countries use some form of biometric recognition for border control (Daugman, 2004). Social networks implement facial detection and recognition as their standard features (Facebook). These are just some examples, as the list of potential applications can be easily extended.

The choice of an adequate biometric system for a certain use case can be a challenging task. Several factors must be taken into account. Algorithm precision, matching speed, usability and system costs are usually the most important factors that need to be considered. In order to estimate how a certain biometric system will perform in required circumstances, a system evaluation should be conducted.

According to the widely accepted definition given by (Phillips, Martin, Wilson, & Przybocki, 2000), there are three different types of biometric system evaluation. First type is the technological evaluation. In this type of evaluation, the precision of a biometric system algorithm is tested. This type of evaluation is fully replicable, but may fail to include some important characteristics of a specific scenario into account. To remedy this potential ailment, a scenario evaluation should be conducted. In a scenario evaluation, a biometric system is evaluated for use in a specific scenario. Application of facial recognition for access control at an airport could be an example of a scenario evaluation. Further extension of a scenario evaluation brings us to an operational evaluation. Application of facial recognition for access control at Heathrow airport would be an example of operational evaluation. Operational evaluation is defined by a concrete location, specific group of system users and a defined timeframe. While the scenario evaluation can be performed by applying a system prototype or executed in a simulated environment, operational evalution is more specific and based on authentic rather than simulated environment. Results of an operational evaluation are unique, and can not be exactly replicated.

In this paper we have conducted an analysis of biometric databases commonly used for technological evaluation. For each database, a short description is given, and important parameters are outlined. In section 1, an introduction to biometric evaluation is given. Section 2 of our paper contains the problem statement. In the following section, biometric databases for facial recognition are described. In section 4, some commonly used voice databases are presented. Section 5 contains information about available fingerprint databases. In section 6, iris databases are presented. Section 7 presents some of the multimodal databases used for system evaluation. Section 8 provides an overview of available datasets. Finally, Section 9 contains paper conclusions.

2. PROBLEM DESCRIPTION

Biometric algorithm designers, both from academia and industry need to evaluate the precision on some biometric data. If each algorithm test is done on different datasets, it is impossible to compare the evaluation results. Even differently applied testing protocols on the same data can lead to misinterpretation of the results.

Therefore, it is necessary to use commonly used databases for system evaluation, in order to be able to compare work with the previously published results. Sometimes, it is not clear which datasets are considered standard for certain biometric modality, and it takes some research to find the proper dataset. In this paper, a review of most commonly used databases for technological evaluation is given for several biometric modalities. The database comparison should help researchers when they need to decide which database is best suited for evaluation in a certain case.

3. FACE DATABASES

Extended Yale Face Database B represents a popular data set for working with faces. This database contains 16128 images collected from 28 different people. Each person was photographed in 9 different poses and from 64 different lighting conditions.

Next frequently used database is LFW - Labeled Faces in the Wild (Huang & Learned-Miller, 2014). The LWF collection was released in order to encourage research in this area. It was created as an image set extension collected at Berkeley named “Faces in the Wild” (Berg, Berg, Edwards, & Forsyth, 2005). This set contained photographs from newspaper articles, which had faces in different poses, with various face expressions and lighting conditions. Although popular for experiments, “Faces in the Wild” database was not suitable for face recognition because 10% of images within the database were not correctly labeled, and there was also a certain number of image duplicates. Due to demands of the academic community, this set was manually refined and evaluation protocols were formulated for working with newly formed data collection.

In the basic version, LFW database contains two evaluation protocols, protocol with predefined images and protocol for free evaluation. Protocol for free evaluation allows making new image pairs from the database for creating score comparison. As many researchers have begun to add data outside the basic LWF set when training algorithms, there has been an expansion of the evaluation scenario, and new protocols were added to the LFW database technical solution (Huang & Learned-Miller, 2014).

This database contains images whose poses and conditions in which they were taken vary significantly. Since its publication, a large number of different papers have cited this database as a benchmark for testing. The set contains more than 13000 face images collected on the internet. Every face is marked with the name of the person it belongs to. The only restriction for these images is that they are detected using the Viola-Jones algorithm.

Another important database is CASIA WebFace (Yi, Lei, Liao, & Li, 2014). Although the LFW database has long been the standard benchmark dataset on which researchers have successfully evaluated the accuracy of their face recognition algorithms, certain problems have arisen. By applying more perfect algorithms, their accuracy has increased significantly and reached a level of accuracy between ninety-five and ninety-nine percent. Two dominant approaches used by the researchers were primarily in-depth modeling and wide modeling. Some of the variations of the LBP algorithm would be a good example of a wide one, while deep neural networks, for example CNN (convolutional neural networks) belong to the approaches of in-depth modeling. With the growth of computer power, the training of convolutional neural networks is no longer a difficulty, so this approach has given the best results in solving the problem of face recognition. Because in-depth algorithms benefit when there is more data available for training, the most accurate approaches were those that used additional data in addition to those available for training within the LFW database.

In order to compensate for the described problem, authors (Yi, Lei, Liao, & Li, 2014) decided to form a new, larger database that would allow a more precise and deeper evaluation of recognition algorithms, using an even larger data set. The database is formed semi-automatically, and contains images available on the Internet. The main difficulty in collecting images from the Internet is the fact that it is not always easy to determine the identity of the person to whom the image belongs to. Authors bridged this problem with a special approach of data clustering. In fact, beside forming the database, as additional results of the experiment, an algorithm for collecting and identifying publicly available face images on the Internet was created, as well as a neural network used for face recognition, since the size of the data set made it necessary to automate recognition. The IMDB site, which contains a large number of photos of celebrities

with accompanying metadata, was used as a data source. The database contains pictures of 10575 people with a total of 494,414 pictures.

Microsoft's MS-Celeb-1M database contains biometric data of 100,000 celebrities. There are a total of 10 million images. This is currently the largest publicly available data set. However, it is not filtered, so it also contains the wrong labels, which can be a problem when training an algorithm on this database (Guo, Zhang, Hu, He, & Gao, 2016).

Authors state three main contributions to their work. The first is to associate images with an entity in the knowledge base, rather than an isolated string of characters containing only the first and last name. In this way, possible misunderstandings during recognition are avoided. Because each entity in the database is associated with a rich set of different information, this approach to recognition is closer to that used by humans, and also easier to use in different types of real-world applications.

The second contribution is the creation of a large-scale evaluation scenario, as well as the construction of a set of parameters used for evaluation. Unlike most other evaluation scenarios for testing face recognition accuracy, images of individuals used to assess the accuracy of the algorithm are not made public. This means that there can be any of the 1 million individuals included in the experiment, resulting in less variation between classes. There are people who look very similar, or are identical twins. On the other hand, the same people may look different in different photos, which increases the variation within the class as the sample grows.

The third contribution is a large set of data for training algorithms. This data set consists of images of the first 100,000 public figures from the database, based on the frequency of their occurrence. Although there are a certain number of incorrectly marked photos in this set, the size of the set itself makes it significantly more difficult to remove them manually.

4. VOICE DATABASES

When it comes to voice, a certain number of data sets are available for public evaluation. In particular, the problem of recognizing speakers in real conditions, without limiting the spoken content, with the noise present as well as with the different quality of the recording itself, is a challenge that is current in the research community.

MIT has published a database used to recognize speakers in real conditions with noise present, collected from mobile devices (Woo, Park, & Hazen, 2006). This database is primarily focused on text-dependent speaker recognition. Within each session, data were collected for each user at three different locations. Each location had a different background noise level. The advantage of this approach is in the adaptation of the speaker to the conditions of the environment, where if there is a background noise, the speaker adapts the articulation of the speech to the new situation. Previously published data sets mostly solved the problem of background noise by simulation, which resulted in overlooking this causal relationship.

One of the publicly available databases for evaluation is the SITW (Speakers in the Wild) data set (McLaren, Ferrer, Castan, & Lawson, The Speakers in the Wild (SITW) speaker recognition database., 2016). This is one of the first open databases designed to recognize speakers in real-world conditions. The database contains recordings collected from 299 different people, with an average of about 8 different sessions per person. Some of the recordings contain only the speech of one person, while some have more than one person. The lengths of the recordings also differ, as well as the type of the voice recording that was recorded (interview, multi-person conversation, monologue). Certain sessions were recorded with equipment specialized for this task, while in the case of others lower quality devices were used, such as microphones on mobile phones. Authors state that, in addition to the large number of databases that have been listed so far in the framework of scientific papers, this is the first data set that contains data of a real character with appropriately marked recordings.

Probably the largest public speaker database at the moment is VoxCeleb (Nagrani, Chung, Xie, & Zisserman, 2020), an open database of speakers, collected from public recordings available on YouTube. The database contains data collected from over 6,000 different people, with more than a million voice samples in total. In paper (Nagrani, Chung, Xie, & Zisserman, 2020), beside the database, describes different approaches where this database was used for training and evaluation of different algorithms, and shows that the use of such a constructed data set, in addition to evaluation capabilities, further contributes to the accuracy of speaker recognition algorithms.

5. FINGERPRINT DATABASES

NIST (National Institute for Standardization and Technology) has several available fingerprint databases. One of them is NIST Special Database 302, created as a result of the Nail to Nail fingerprint Capture Challenge evaluation (National Institute for Standardisation and Technology, 2019). The unique characteristic of this approach is reflected in the fact that fingerprints include data collected from one side of the nail to the other, and that in this way significantly more data is collected for further processing than by simply pressing the frontal part of the fingertip. The database contains biometric data of 331 people. In addition to these specially collected fingerprints, the database also contains fingerprints collected using classic sensors, as well as a special subset of latent fingerprints.

Another publicly available fingerprint database is the Sokoto Coventry Fingerprint Dataset (Shehu, Ruiz-Garcia, Palade, & James, 2018). This database contains about 6000 fingerprints collected by over 600 different people. The primary purpose of this database was the detection of altered fingerprints, where the authors used a combination of original and software altered fingerprints. A convolutional neural network was used to identify changes in the prints. The success rate of the model published in (Shehu, Ruiz-Garcia, Palade, & James, 2018) was 99.8% on this database and the data generated based on it.

6. IRIS DATABASES

The CASIA database is one of the available databases for evaluating iris recognition algorithms. There are several versions of this biometric database, Casia-IrisV4 is the last published version (Institute of Automation Chinese Academy of Sciences, 2012). In total, this database contains 54,607 iris images collected by 1,800 real and 1,000 virtual individuals. This database is an extension of the data collected in previous versions, and contains six different subsets of data. The first subset was collected by a specially developed sensor for imaging the iris up close, and this data is suitable for studying the details of the texture of the iris itself. The second subset refers to data collected using a manual sensor, where data were collected in two modes, with and without artificial lighting from the sensor. The third subset has iris data collected from the twins. The fourth contains 20,000 iris images collected from 1,000 people using an acquisition sensor with visual feedback and it was the first set of this size to be publicly available. The last set of data contains generated iris images which make up the data from the so-called "virtual" persons that we mentioned earlier in the description of the database.

Another popular iris data set is UBIRIS. It contains images that are not of ideal quality and contain a certain amount of noise (Proença & Alexandre, UBIRIS: A noisy iris image database, 2005). The data set formed in this way is used to evaluate those scenarios where the user does not put his head in a specific place and looks at the sensor, and the acquisition of data is done during the user's movement. The advantages of this approach are lower invasiveness as well as avoiding longer user retention for biometric authentication. The quality of iris images especially affects the segmentation performance of this biometric modality. The database contains 1877 iris images collected from 241 people, within two different acquisition sessions.

7. MULTIMODAL DATABASES

Multimodal biometric databases contain data of multiple biometric modalities collected from a single person. One such database was collected at the Faculty of Organizational Sciences (Starčević, et al., 2011). Biometric data was collected from 39 individuals. The database contains the following biometric modalities: face, fingerprint, ear, fist and voice. Data was acquired in two rounds of acquisition.

The face of each person in the database was photographed from 9 different positions, from the frontal shot to the profile. The photos were taken with a ten-megapixel camera, while the face videos were memorized at a resolution of 320X240 pixels at 30 frames per second. The fingerprint was collected using two sensors, optical and capacitive. Index and middle fingerprints were taken, on both hands, four instances for each finger.

During the voice acquisition, users had three different sessions. In the first session, they read a series of numbers. In the second session, they read three randomly selected 4-digit PIN codes. In the third, last session, the acquisition was done by reading a shorter, predefined text. The frequency of voice sampling was 44kHz and was performed in stereo mode. For the acquisition of the palmprint, an ordinary document scanner was used, as well as a piece of black cloth to cover the hand and the scanner during scanning.

Based on the analysis of the available literature, it can be concluded that there are relatively few publicly opened multimodal biometric databases, as well as they contain a limited amount of data. Researchers dealing with the problems of multimodal biometrics therefore often resort to the formation of so-called chimeric biometric databases. These databases are formed from several different unimodal biometric

modalities collected from various persons, when there is a presumption of mutual independence of data related to individual modalities.

NIST published a multimodal database collected from a sample of fifty-one people (National Institute of Standards and Technology, 2018). During the acquisition process, the biometric authentication process for accessing the international airport was simulated. Modalities that were used are fingerprint, face and iris. For fingerprint acquisition 14 different scanners were used - optical, capacitive and contactless. Standard optical as well as thermal cameras were used for face acquisition. For fingerprints, within the accompanying instructions corresponding to this database, assessments of the quality of fingerprints are given.

8. REVIEW OF AVAILABLE DATABASES

In our review we have included thirteen different datasets. Modalities included are face, voice, fingerprint, iris, and in one multimodal dataset ear and palmprint. For each database, the number of persons in the database is given, and where applicable, the approximate number of biometric instances. Final two columns are related to citation count, and the notable references for certain datasets.

Table 1 Databases review

Database Name	Modality	Number of Persons	Number of Instances	Number of Citations	Notable References
Extended Yale Dace Database B	Face	28	16K	2303	(Lee, Ho, & Kriegman, 2005), (Wright, Yang, Ganesh, Sastry, & Ma, 2008), (Tan & Triggs, 2010)
Labeled Faces in the Wild	Face	6K	13K	202	(Hassner, Harel, Paz, & Enbar, 2015), (Liu, et al., 2017), (Wen, Zhang, Li, & Qiao, 2016)
CASIA WebFace	Face	11K	500K	998	(Amos, Ludwiczuk, Satyanarayanan, & others, 2016)
Microsoft's MS-Celeb-1M	Face	100K	10M	623	(Wu, He, Sun, & Tan, 2018), (Deng, Guo, Xue, & Zafeiriou, 2019), (Cao, Shen, Xie, Parkhi, & Zisserman, 2018)
MIT data collection	Voice	88	8	91	(Ming, Hazen, Glass, & Reynolds, 2007)
Speakers in the Wild	Voice	299	2K	121	(McLaren, Ferrer, Castan, & Lawson, The 2016 Speakers in the Wild Speaker Recognition Evaluation., 2016)
VoxCeleb	Voice	7K	1M	18	/
NIST Special Database 302	Fingerprint	331	/	/	/
Sokoto Coventry Fingerprint Dataset	Fingerprint	600	6K	2	/
CASIA Iris database	Iris	2800	55K	3	/
UBIRIS	Iris	241	2K	592	(Proença & Alexandre, Iris segmentation methodology for non-cooperative recognition, 2006), (Vatsa, Singh, & Noore, 2008), (He, Tan, Sun, & Qiu, 2008)
FON - Multimodal database	Face, fingerprint, ear, palmprint	39	2K	6	(Milenković, Pantović, Starčević, & Minović, 2011), (Jovanović, Milenković, Bogićević-Sretenović, & Simić, 2016)
NIST Special database 301	Fingerprint, face and iris	51	/	/	/

Citations were primarily taken from Google Scholar, so they are just an approximation of database usage. Some of the databases are more recently published, such as NIST Special Database 301, and as such they are still not widely cited. Other datasets, while still important, are more popular with industry than academics. Also, if the database was not followed by an accompanying scientific paper, it is harder to find references to papers that have used the dataset for evaluation. The CASIA iris dataset is an example of such a database. For certain databases, some of the more notable papers that have used the related dataset are listed in the notable references column.

9. CONCLUSION

The importance of biometric databases, primarily those that are publicly available for technical evaluation, is growing precisely because of the growing popularity of biometrics itself, which today replaces various forms of authentication.

As for the face as a physical modality, the following four databases are considered to be the most commonly used in both academia and industry. In addition to the very popular Extended Yale Face and the standardly used Labeled Faces in the Wild database, CASIA WebFace and Microsoft's MS-Celeb-1M also come to the fore, with a much larger number of instances. Publicly open real-time speaker recognition databases such as MIT, Speakers in the Wild and VoxCeleb contribute greatly to the evaluation and improvement of algorithms over biometric data.

What is important to note is that it is more difficult to find references to papers that use a particular biometric database when evaluating, if a given set of data is not accompanied by scientific research paper, as is the case with the Casia Iris database. It is also more difficult to assess the popularity of relatively new databases such as the multimodal NIST Special Database 301 concerning iris, fingerprint and face, as well as the fingerprint database, NIST Special Database 302 from 2017.

As for researchers, it is very important to choose proper set of data when testing the accuracy of algorithms, and therefore they must conduct detailed research on previously defined biometric databases, depending on the modalities they deal with, which can help them decide which is the most suitable for their purposes

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BUSINESS PROCESS CONFORMANCE ANALYSIS WITH PROCESS MINING

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Abstract: *Process mining, as an interdisciplinary field that uses data science to extract insights from business process event logs, provides a valuable set of tools for learning about and improving upon processes that permeate organizations. This paper approaches process mining by delving into the analysis of a real-world process log using one of the core techniques of process mining – Conformance analysis. Through this, the paper will outline deviations and inconsistencies between the desired state, or rather a model of the system, and the system's observed real-world behavior. The interpretation of results can provide a plethora of ways for improving the process, thus showcasing the potential of process mining and its place in the modern world.*

Keywords*: process mining, event log, business process, conformance analysis*

1. INTRODUCTION

Process mining is an emerging discipline that bridges the gap between data mining, computational intelligence and process science (Aalst, 2012). Data science approaches tend to be process agnostic whereas process science approaches tend to be model-driven without considering the "evidence" hidden in the data (Aalst, 2016). Much of the progress in process mining has occurred in the past 15 years, with professor Aalst from the Eindhoven University of Technology being one of the prominent experts in the field.

There are several prerequisites needed to conduct a successful process analysis. The first is a suitable dataset. It should contain ample data describing the observed process, along with all of the events grouped into cases. A single case is a process instance (i.e., when observing the process of customer purchase in a supermarket, a single case is the journey an individual customer takes from the moment they enter the system to the moment they depart), while an event is a single atomic unit, or building block, of a case (i.e., in the supermarket example, one event would be one customer approaching the cash register. Paying for groceries would be another event, etc.). The next prerequisite is adequate process mining software. In order to properly handle the data, software usually used for machine learning is insufficient, so a number of tools, open-source as well as commercial, have emerged over the years. The third big prerequisite is knowledge of both process science and data science. Adjusting and properly choosing business process models can help create a more suitable representation of the data, while general and process-specific data science techniques can help process the data in a more meaningful way.

The aim of process mining is to analyze a certain process, usually a business process, and provide crucial insights showing its components and attributes. There are three core process mining techniques – process discovery, conformance checking and performance checking.

- Process discovery is used for generating a business process model based on event data. There are different process discovery algorithms, sensitivity levels and other parameters that can be tuned to increase the quality of the resulting process model.
- Conformance checking is the focus of this paper and is used to assess how well the designed or generated model fits the real-world observations. This measure is called fitness and will be further elaborated in the latter parts of the paper. A low score in fitness can not only mean inefficiencies, or instances of employees failing to follow protocol, but also undiscovered processes or "desire paths" (The term "desire path" is derived from a real-life phenomenon where people or animals produce paths on grassy surfaces by frequently walking along the same routes. Here the term is used in the context of people performing work the way they find better or easier than the one envisioned) of a system (Aalst, n.d.).
- Performance checking is a tool used for discovering inefficient process threads with the goal of eliminating them or improving upon them.

In order to put process mining to use for this paper, a real-world dataset that represents the process of taking out loans was used. The dataset was provided by the Dutch Financial Institute for the Business Process

Intelligence Challenge 2012 (BPIC, 2012). The process mining software used was ProM – an open-source software with a range of tools developed primarily by the Eindhoven University of Technology (ProM, n.d.).

The paper consists of the following sections. Section 2 is dedicated to exploring the technical terms needed for understanding the subject matter. Section 3 explores the data, analysis methods and key insights. Section 4 presents the conclusion and forecasts.

2. TECHNICAL TERMS AND CONCEPTS

This section will provide an explanation and a deeper delve into the terms relevant for this paper. The terms discussed are Petri nets, the four process mining quality criteria and the XES standard.

2.1. Petri nets

Petri nets are, in a mathematical sense, directed bipartite graphs with two types of nodes: transitions and places, which are linked by directed arcs. When using them to model systems, places are regarded as conditions, while transitions are regarded as actions which change states, or more accurately, move a system from one condition to another. Tokens are utilized to keep track of which place, or condition, the system is in, and which transitions/actions can occur or "fire" at any given moment (Nešković, 2019).

In Figure 1 places are represented as circles, transitions as rectangles, and tokens as dots. A transition is only eligible to fire when all of its preceding places have at least one token each. In Figure 1 only T1 is eligible to fire. When a transition fires it "takes" one token from each of its preceding places and "gives" one token to each of its succeeding places.

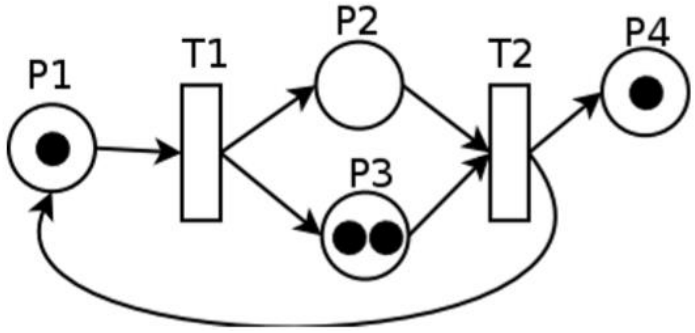

Figure 1: An example of a Petri net.

Petri nets are favored in some process mining tools due to the relatively small set of concepts needed to model a process. Special types of Petri nets are usually used in modeling processes in process mining – Workflow nets. A workflow net is a Petri net with a clear starting point (source place), a clear ending point (sink place), and a path between them (Aalst, 1998).

2.2. The four quality criteria of process mining

In order to gauge how good a process mining algorithm is at creating process models from event logs, a researcher has to measure their algorithm across a multitude of dimensions. Aalst (2016) describes four distinct dimensions, or criteria, for measuring the quality of a certain algorithm. There is generally a tradeoff, so modifying the algorithm for a better result against one criterion tends to reduce the result against another criterion. These four criteria are precision, generalization, simplicity and fitness.

- Precision: The discovered model should not allow behavior completely unrelated to what was observed in the event log. A low score in precision means the model is too general, which is known as "underfitting".
- Generalization: The discovered model should generalize what was seen in the event log. A low score in generalization means that the model is too specific, which is known as "overfitting".
- Simplicity: The discovered model should be as simple as possible.
- Fitness: The discovered model should allow behavior observed in the event log. Conformance analysis focuses on meeting this particular criterion.

2.3. The XES standard

XES (eXtensible Event Stream) is an XML-based standard for event logs. Its purpose is to provide a generally-acknowledged format for the interchange of event log data between tools and application domains. Its primary purpose is for process mining, i.e. the analysis of operational processes based on their event logs (Günther, & Verbeek, 2014).

A single XES file contains all of the data about a certain process, including the complete set of use cases, otherwise known as traces, and every single event that constitutes each trace. Each trace can be made up of a different number of events, ranging from one to hundreds or more. Long cases are commonly nicknamed “Spaghetti cases”, while short cases are nicknamed “Lasagna cases”.

The following example shows how a single trace is stored inside an XES document. The first part of every trace is reserved for information about the trace itself, like the date of occurrence, required amount of resources etc. The second part are the events, along with their timestamps, names and other attributes:

```
<trace>
    <date key="REG_DATE" value="2011-12-05T23:32:21.698+01:00"/>
    <string key="concept:name" value="191575"/>
    <string key="AMOUNT_REQ" value="7500"/>
    <event>
        <string key="org:resource" value="112"/>
        <string key="lifecycle:transition" value="COMPLETE"/>
        <string key="concept:name" value="A_SUBMITTED"/>
        <date key="time:timestamp" value="2011-12-05T23:32:21.698+01:00"/>
    </event>
    <event>
        <!--Event data-->
    </event>
    <!--Other events-->
</trace>
```

If data is provided in CSV or other formats, it should be converted to XES before the analysis starts.

3. DATA ANALYSIS AND RESULTS

The data used was provided by the Dutch Financial Institute. The data describes the process of applying for a loan. The record is made up of 262.000 events grouped into 13.087 cases. Each case represents a client’s journey from starting the application process to having the request granted or denied. The analysis was done in ProM. The goal was to demonstrate how much insight about the way a business is run can be drawn from a process log.

3.1. Due diligence

The first step is to acquire surface-level data about the record. Each event belongs to one of the following three categories: state of the application, state of the offer belonging to the application, and state of the work item belonging to the application.

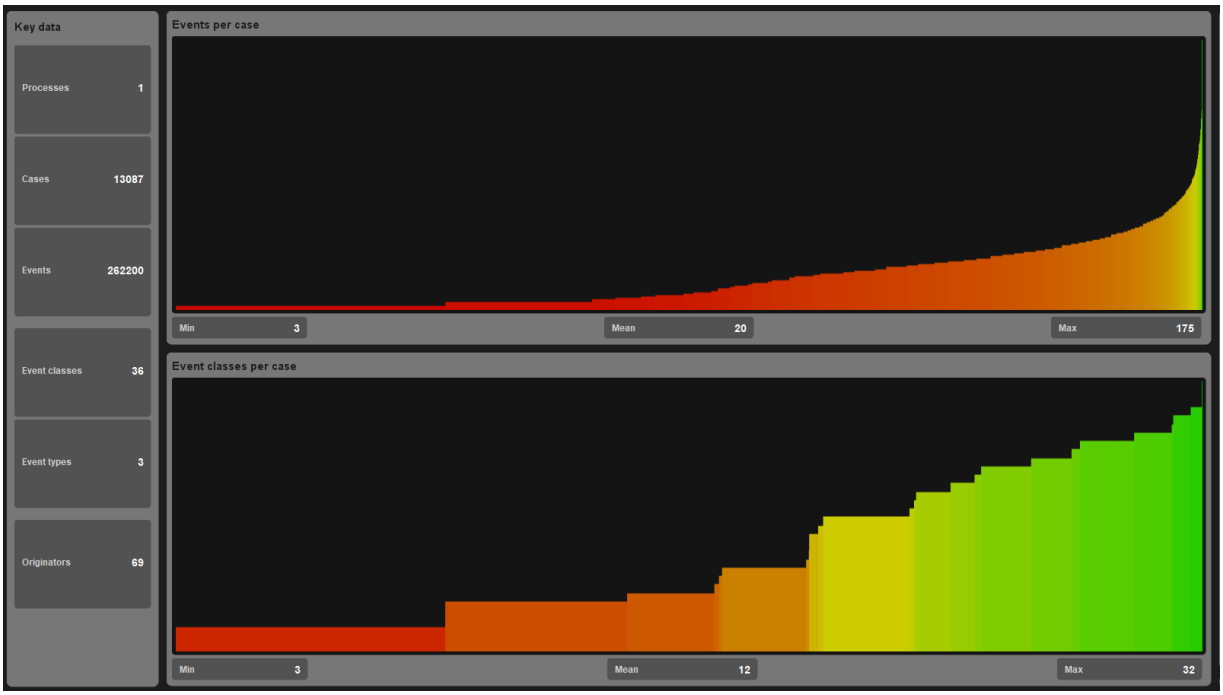

Figure 2: Dataset statistics

Figure 2: Dataset statistics shows general statistics about the dataset. The data is represented graphically. The x-axis shows the number of events/event classes per case sorted from lowest to highest, while the y-axis shows a cumulative number of corresponding cases.

The shortest case is comprised of 3 events – the client submitted an incomplete application, the application was then reviewed, and finally rejected. The largest case is comprised of 175 events. There are only 36 event classes (unique events) in the set, so this case reached its large number of events by moving back and forth between 2 or more events several times i.e. reviewing the application, categorizing it as incomplete, submitting additional documents, reviewing the application again and so on. The figure also shows that the highest number of event classes appearing in a single case is 32, while the lowest is 3.

Similar statistics can be extracted on an event basis. They can show which event classes are the most common, and which are the rarest. This can be an indicator of outlier events and cases.

3.2. Mining the model

There are several algorithms that output a model from an event log. For this study, the tool *Inductive Miner – Infrequent* (*IMi*) was used. There are less sophisticated algorithms, but they are more susceptible to noise and missing information.

Typically, 80% of the observed behavior can be explained by a model that is only 20% of the model required to describe all behavior. The 80% model shows the “highways” in the process. Hence, it is more intuitive, but can also be used as a starting point for outlier detection (Leemans, Fahland & Aalst, 2014). Leemans, Fahland & Aalst (2014) state that *IMi* aims to find a sound 80% model fast, so the algorithm filters infrequent behavior.

The algorithm allows for tuning the noise threshold from 0.00 to 100. At 0.00, the model will fit the log perfectly, at the expense of the other three quality criteria. It will not account for missing values or noise. At 100, the log will be completely simplified at the expense of fine detail. For this study, a threshold of 20 was chosen.

Figure 3: The original and the simplified Petri net shows two representations of the dataset through Petri nets. The first one takes into account all of the events in the dataset. The second one is only built upon events from the “state of the application” category, disregarding the other two. This makes the second Petri net simpler, with fewer events and branches, making the processing less demanding later on.

Transitions colored black are “silent transitions”, which simply move a token from one place to another, without any specified meaning. There may be events that cause a change in the state of the system but that are not observable by an outside observer (Giua, Seatzu, & Corona, 2007). These events are represented by silent transitions. They are displayed so that the model can catch up to the event log.

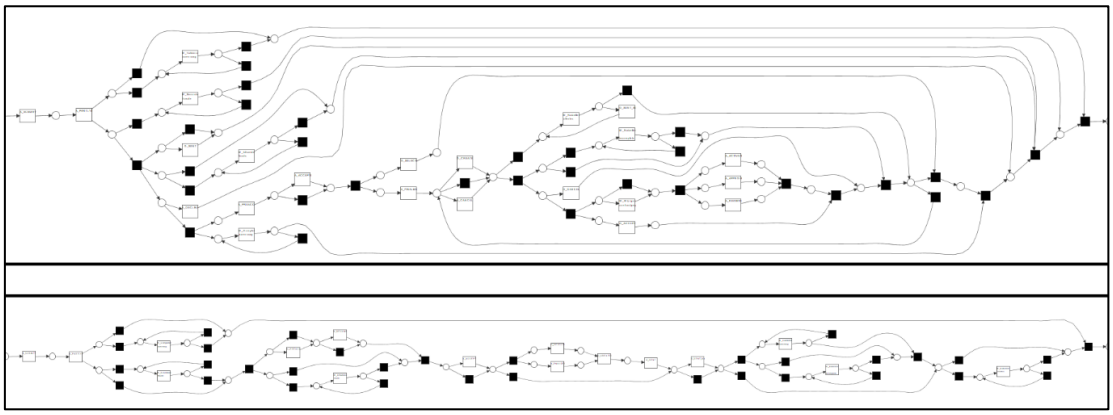

Figure 3: The original and the simplified Petri net

3.3. Conformance checking

Two ways were used to conduct conformance checking: replaying the log and running the Inductive visual miner.

Replay a log for Conformance analysis is a tool that enriches the Petri net with color scales and numbers which signal an event’s level of conformance.

Figure 4: Enriched Petri net (Only the first half due to its length) shows the first half of the second Petri net from Figure 3: The original and the simplified Petri net, complemented with conformance data displayed through colors and numbers on events and transitions.

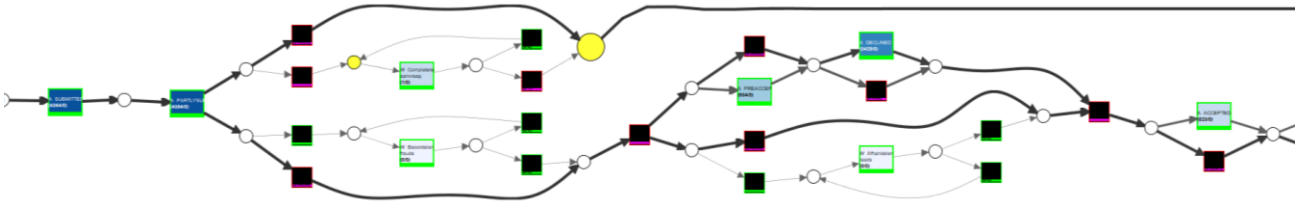

Figure 4: Enriched Petri net (Only the first half due to its length)

The more synchronous moves (moves both in the event log and predicted on the model) occur, the greener a transition is labeled. The more a transition fires only on the model to compensate for misalignment, the more purple it is labeled. The model also marks states which have been unexpectedly altered by misalignment as yellow circles. When the "yellow" state is selected, it and all states affected by the same anomaly, change to red. Oftentimes the misalignment occurs because two states switch roles between the model and the log.

The first part of Figure 5 displays transitions, their colors, and the number of times they fired correctly compared to the number of times they fired on the model, but not in the dataset. The "Preaccepted" and "Declined" transitions fired correctly every time they should have. However, the silent transitions indicate that there is unaccounted behavior that the model had to compensate for. The second part shows states, their frequencies, and the number of times they were "sink states" – states that were final for a given case. Sink place 25 (the upper of the two red circles) had 62 occurrences of not passing along the token when the "Created" transition should have fired.

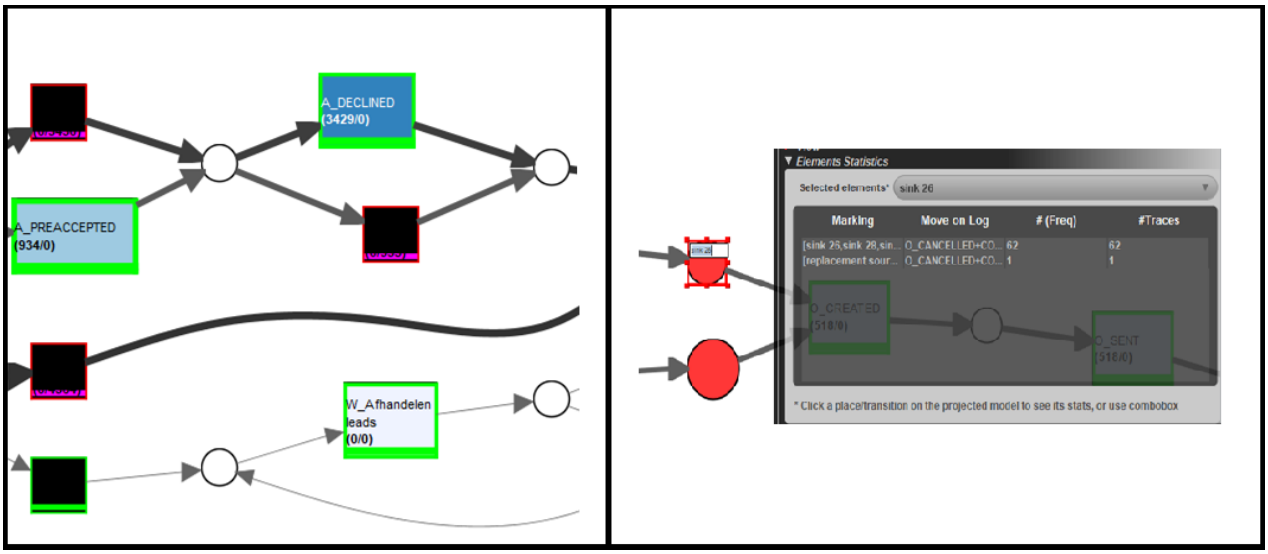

Figure 5: A closer view of the data provided for each place and transition

Mine with Inductive Visual Miner is a tool that shows an animation of cases moving through the system and plots all of the "jumps" or deviations not predicted by the model. Deviations are a crucial part of the evaluation: they show precisely what parts of the model deviate with respect to the log. Deviations are visualized to show which parts of the model fit well and which parts do not (Leemans, Fahland, & Aalst, 2014). It allows for dynamically changing the number of activities and paths appearing on the model, making it more or less detailed in the process (Leemans & Ramezani, 2016). The activities slider controls the fraction of activities that are included in the event log on which a discovery algorithm is applied (Leemans, 2017). The paths slider controls the amount of noise filtering applied: if set to 1, then no noise filtering is applied, while set at 0, maximum noise filtering is applied (Leemans, 2017). Deviations are shown as red lines, alongside the number of occurrences, while the movement of each case can be tracked by following the yellow dots (Buijs, n.d.).

The red line in the first part of Figure 6 signifies that one case failed to follow the model by skipping the cancellation event and going straight to the approval event, deviating from other 934 events, whose paths the model accurately predicted. The second part is a frame of the animation showing how the cases move through different events based on the timestamps from the log. This particular frame shows that there was initially a

batch of declined clients, followed by a batch of approved ones. In general, the animation is useful for discovering bottlenecks in the system.

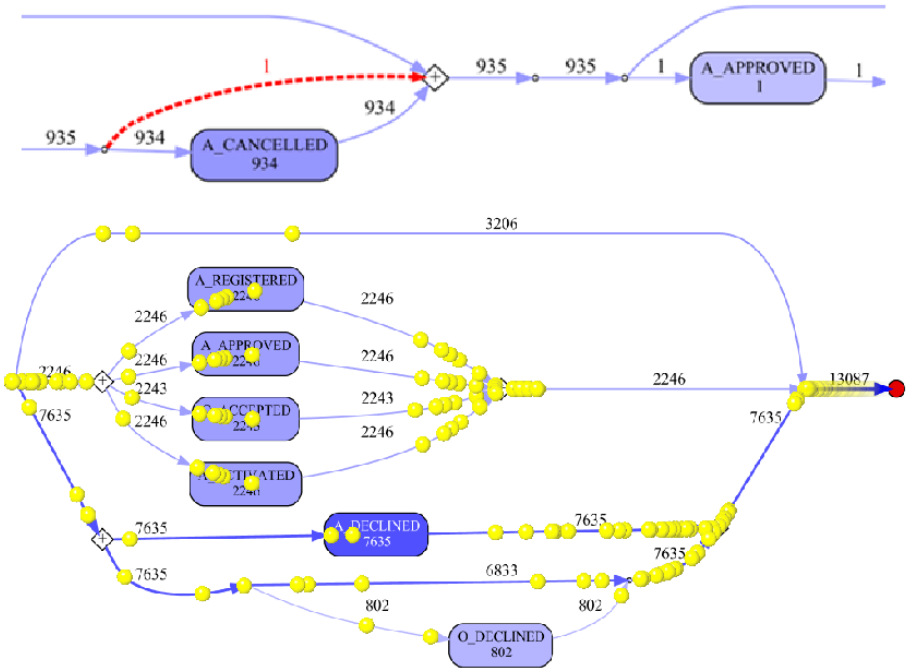

Figure 6: Deviations (red line) and movement (yellow dots)

Conformance is calculated by analyzing the number of tokens that disappear (missing) or stay (remaining) on the model due to mismatch. The following formula is used for the calculation:

$$f = \frac{1}{2}\left(1 - \frac{\sum_{i=1}^{k} n_i m_i}{\sum_{i=1}^{k} n_i c_i}\right) + \frac{1}{2}\left(1 - \frac{\sum_{i=1}^{k} n_i r_i}{\sum_{i=1}^{k} n_i p_i}\right) \quad (1)$$

In the formula k is the number of different traces, n_i is the number of occurrences of the current trace, m_i, r_i, c_i and p_i the counters for missing, remaining, consumed and produced tokens (Rozinat, & Aalst, 2008).

The model's trace fitness is at 88%, which means it has high fidelity. The different analyses opened the possibility of looking into different anomalies which might turn out to be breaking the protocol in real-life, the most notable of which is a single case that follows along a path of cases that would wind up rejected (the model discovered that rejected and approved cases usually take separate paths), but ends up approved. Part of this is seen in Figure 6 where a single case "jumps" to avoid being canceled and heads on straight to the "approved" event. The animation clearly shows the anomalous movement.

Such discoveries can point decision-makers towards underperforming segments of a system for more effective error management and improvement operations.

4. CONCLUSION

This paper introduced the potential of process mining by analyzing a real-world dataset describing the loan taking process in the Netherlands. It showed some irregularities which could lead to a possible improvement of the real-world system – the "Cancelled" sink places from Figure 5, and the "jumping" case and batches of approved/canceled cases from Figure 6. They point to parts of the system of credit approval and rejection that should be examined more closely to discover the causes and the fixes of anomalies.

The data comes from the Netherlands because the Technical University of Eindhoven is one of the hotspots for this research area which is still young and relatively unknown. There are plentiful ways of understanding and improving processes even with free-to-use open-source tools, provided the data can be extracted from the system. Pajić & Bečejski-Vujaklija (2015) pointed out that ERP systems have rudimental, if any, capabilities of extracting process logs in the format required for process mining. If systems as robust as ERP are struggling to meet the requirements, then that means there is a lot more progress to be made before process mining proliferates like other data science disciplines have done in the past several years.

The simple example in this paper demonstrates that process mining can help present business processes through Petri nets (Figure 3, Figure 4, Figure 5, Figure 6), check for anomalies and potentially improve performance beyond what was possible before. Lee, Verbeek, Munoz-Gama, Aalst, & Sepulveda (2018) give an example of using conformance checking for audits and compliance testing of business processes. Wide-scale adoption could immensely improve existing supply chains, production lines and business operations across many industries, so the sooner data scientists, software providers and regular companies join forces, the more beneficial it will be for all parties' bottom lines.

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DESIGN AND IMPLEMENTATION OF .NET CORE WEB APP BASED ON LAYERED ARCHITECTURE

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Abstract: *The sharp jump in the number of Internet users and the growing popularity of Internet services has contributed to the intensive development of web applications. In order to meet spikes in demand, applications should meet all customer needs. Layered software architecture represents a type of software architecture that uses a number of layers for allocating the different responsibilities of a software product. Therefore, this paper explains the challenges of the design and implementation of .NET Core web application based on a layered architecture. Multi-layered applications consist of multiple layers and each layer has a different specific responsibility. This paper will outline the separation of the layers in a way that demonstrates that it is very easy to create and maintain the Web applications, advantages of using layered architecture, issues and possible solutions for these issues.*

Keywords*: layered architecture, dependency injection, design patterns, .NET Core, clean architecture*

1. INTRODUCTION

Web applications are predominantly based on the client - server model architecture and it could be said that the nature of the Web is layered. Over the years, many approaches have been developed for creating applications based on a layered architecture. The simplest deployment model that is accepted as a good solution for much smaller traditional .NET applications is deploying applications as single units inside a single application domain (Smith, 2020, p. 24). Through the use of layers, the application is logically separated into smaller parts according to specific responsibilities and parts called concerns. The term *Separation of concerns* points to the *design principle* that explains the advantages of separating a software system into different segments, in a way that each segment marks a separate concern, where each concern affects the code of a system (Smith, 2020, p. 19). The concept of layered architecture led to the division of program code into segments that implement precisely defined system functions enabling independent development of layers and their simple replacement. For an application based on a layered architecture which uses the SQL Server database for persistence, there may be a need for changing this persistence layer in the future. With layered architecture, only the SQL Server specific layer could be replaced by a new one. Some benefits of using layered architecture are given below:

- Code organization and its reuse following the DRY - Don't Repeat Yourself principle, replacing repetitions in the application code by abstractions (Cneude, 2019),
- Ability to enforce restrictions (which layer can communicate with which layer),
- Increases flexibility, maintainability, scalability, and enables easy testing.

2. TECHNICAL TERMS AND CONCEPTS

This section will provide an explanation and a deeper delve into the using layered architecture for the design and implementation of .NET Core Web application. The terms discussed are monolithic application, layered architecture, dependency injection, Repository Unit of Work design patterns.

2.1 Monolithic application

Concept "monolithic application" stands for an application in which all functionalities are integrated into one single unit (Smith, 2020, p. 13). The design of monolithic applications is characterized by connections between system modules that are tightly coupled. Tightly coupled relationships actually prevent the independent existence of each module, because the modules are interconnected and very dependent. When changing system components, the whole application must be rewritten, even when changes are made to only one component (Smith, 2020, p. 19). Modularity represents the ability to reuse parts of the code, repair

or modify existing parts of the code, without affecting the rest of the application. Monolithic applications become larger and more complex over time, reducing speed installation, testing, and commissioning. As the application becomes more complex, the process of changing the application code is more complex too. The application should be divided into a smaller number of projects, where each project corresponds to one layer of the application - logical separation within the application (Smith, 2020, p. 26).

2.2 Layered architecture

Applications based on a three-layered architecture can easily control communication between layers. Each layer can communicate with other layers and those layers will be affected by the changes that occur when one layer is replaced by another. It is important that the effect of the changes is mitigated as much as possible so that one change does not affect the entire application. Dependency between layers means the layer that depends on another layer, needs instances of the dependency objects to perform certain operations (De Oliveira & Bruchet, 2017). Typical ASP.NET MVC web app has a three-layered architecture with isolated components depending on each other:

- UI, Presentation layer - responsible for managing the data record so that it is understandable to both parties in communication and also enable more efficient communication between those parties,
- BLL, Business layer – responsible for managing the business logic of the application, which consists of business processes and business components. Business rules obtained in the process of analysis are also most often implemented in this layer,
- DAL, Data layer - responsible for providing access to data stored in the persistence storage. Interfaces that the business layer can easily consume should be provided here.

Requests are passed through the UI layer and this layer only communicates with the BLL. The BLL needs the data in order to perform its operations and this layer communicates with the DAL. Based on the architecture principles, the UI layer doesn't communicate with the DAL directly. Similarly, the BLL should only interact with persistence by going through the DAL. If an application is intended to grow, there is a possibility that a more complex deployment solution is needed. Changes in the infrastructure, such as database replacement, can affect the BLL, creating unnecessary coupling. Coupling is what affects maintainability and preventing parts of a system from being upgraded. The solution to this problem could be found in the principles of Clean Architecture.

2.3 Clean architecture

Clean architecture puts the business logic and the application model in the center of an application. Business logic does not depend on the Infrastructure, while the Infrastructure depends on the center named Application Core. Interfaces are defined in the core of the application and implemented in the infrastructure part. This how the dependencies are organized in the clean architecture and this mechanism is called the Dependency Inversion principle (Smith, 2020, p. 31). This architecture has an onion-like structure, where each onion is a layer represented by a circle. Information about testing, frameworks, and similar are in the outer layers, while business logic and domain model are placed in the inner circles (Martin, 2017). Each circle represents one piece of software. Circles of smaller diameter are policies while larger are mechanisms. The larger diameter represents the higher level of the software complexity. **Figure 1** shows a diagram of clean architecture.

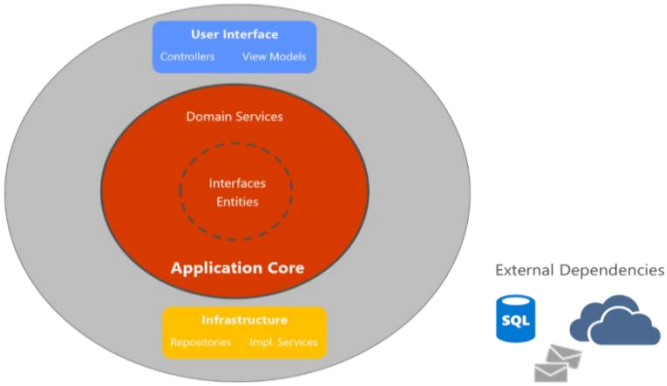

Figure 1: (2019, April 12). *Clean Architecture; onion view* [digital image]. Retrieved from https://docs.microsoft.com/en-us/dotnet/architecture/modern-web-apps-azure/media/image5-7.png

The above diagram depicts the architecture where dependencies are organized in a way that all code can depend on layers more central, but at the same time, code cannot depend on layers further out from the core. All coupling is toward the center which means that the application code doesn’t depend on the layers

that are further out from the Application Core (Martin, 2017). UI and Infrastructure layers are outside the Application Core and as mentioned, this layer depends on the Application Core, but at the same time, UI and Infrastructure don't have dependencies that directly connect them. This leads to a structure that facilitates testing or changing application requirements. Martin (2017), has pointed out that keeping the Application Core isolated from Infrastructure, automated unit tests for this layer are simple to write. **Figure 2** represents a diagram of an ASP.NET Core application's architecture based on a clean architecture principle.

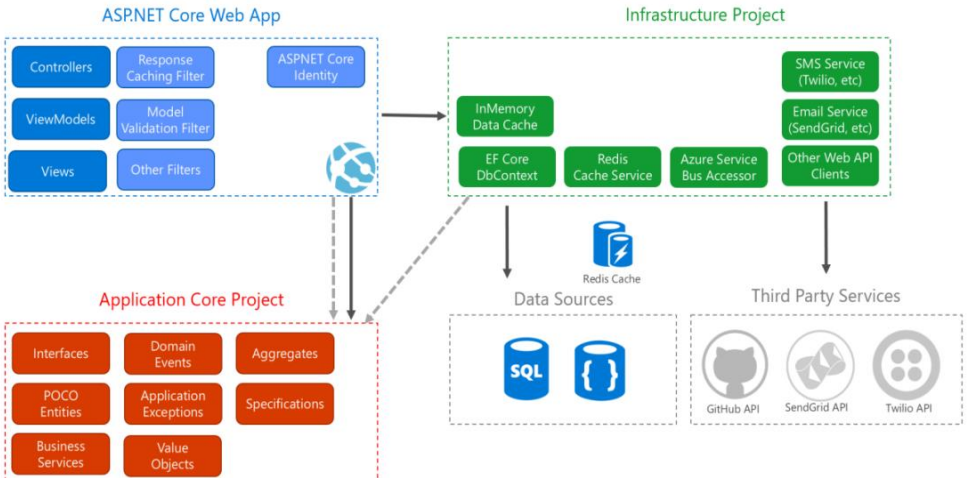

Figure 2: (2019, April 12). *Representation of the ASP .NET Core onion architecture through the Application Core part of the project and Infrastructure part of the project* [digital image]. Retrieved from https://docs.microsoft.com/en-us/dotnet/architecture/modern-web-apps-azure/media/image5-9.png

Following Clean Architecture approach, code is organized in a way that each part has clear responsibilities:

- Application Core part - holds the business model that consists of entities that are persisted, services and interfaces (Smith, 2020, p. 35),
- The Infrastructure part – this part is responsible for managing communication between the application and external dependencies, in this case, through the ORM Entity Framework. Creating an abstraction layer between the domain entities and the business logic is a way to abstract data access implementation code and it is achieved by using the Repository design pattern. Communication between this abstraction layer and the UI part is achieved through the Service layer. Having a reference to the Application Core part of the project, the Infrastructure part contains implementations of services that implement interfaces defined in the Application Core (Smith, 2020, p. 36),
- User interface part – this part of the project is responsible for managing the entry point of the application through the Startup.cs class which is mandatory in ASP .NET Core web applications. UI part reference the Application Core part and interacts with Infrastructure part of the project through the interfaces defined in the center of the application (Smith, 2020, p. 36).

Decoupling the application from the database and file system leads to lowers the cost of maintenance for the life of the application.

2.3 Dependency Injection

As the application becomes more complex, the need for additional features also increases. These features can be included in the project through various libraries and components. In order to use third-party components in the ASP.NET Core applications, Microsoft has developed an open-source package management system named *NuGet*. Using the features of the *NuGet* manager, applications only depend on functionalities they really require. Dependency Injection is a technique that passes objects to another object that needs them, instead of being created by that specific object itself. Forwarding objects to a class is called injecting, and the objects are called dependencies. Through the usage of the Inversion of control technique, each class gets all the objects it needs during application execution. An *IoC* container is an object that takes care of the relationships and connections between objects. ASP .NET Core supports the Dependency Injection technique by injecting objects of dependency classes through constructor or method by using built-in *IoC* (Le, 2020). The classes managed by a built-in *IoC* container are called services and there are three types of lifetimes (De Oliveira & Bruchet, 2017):

- **Singleton:** a single instance of a service is created and shared throughout the application's lifetime,
- **Transient:** a new instance is created every time when the service is created
- **Scoped:** an instance is generated once per request (scope) and it is reused within that scope

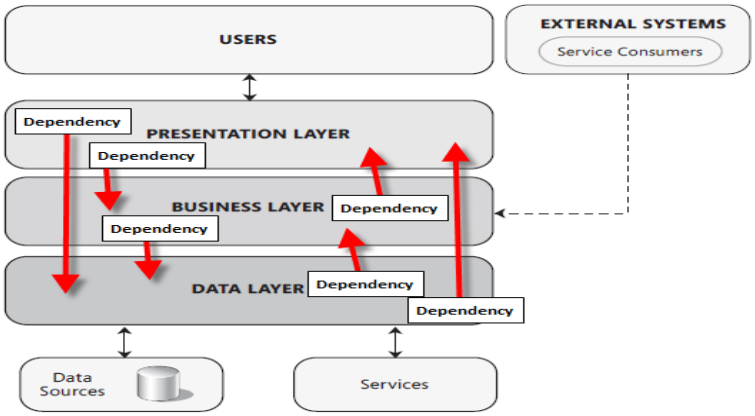

Figure 3: (2010, November 9). *An example of using dependency injection in the layered architecture* [digital image] Retrieved from https://ov5be7llex1q6xb110esf3bt4-wpengine.netdna-ssl.com/wp-content/uploads/2010/11/image4.png

3. DEPENDENCY INJECTION IN UNIT OF WORK PATTERN USING REPOSITORIES

When implementing .NET Core Web application through the layers, each layer can be easily injected as a dependency injection when the need arises.

3.1 Design patterns

Developing a web application's architecture involves creating a variety of objects. As complexity grows, so does the number of objects as well as the number of their interrelationships. If the connections between objects are tightly coupled, it will be much more difficult to change or upgrade the application. That is why it is important that these relationships be as loosely coupled as possible. One way to achieve this is by using software techniques named as design patterns. A common way of implementing communication between the data access layer and the business logic is by using the combination of the Repository and Unit of Work pattern. When mentioned design patterns are applied, the application becomes insulated from changes in the data store and it is easier to test the business logic of the application (Dykstra, 2013).

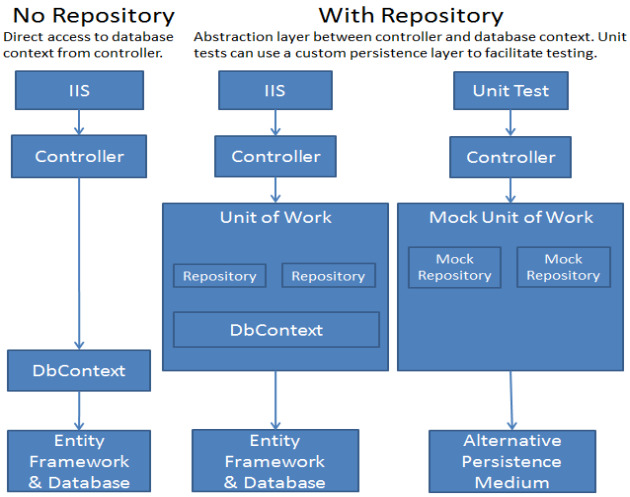

Figure 4: (2019). *Rought structure of the architecture* [digital image] Retrieved from https://www.asp.net/media/2578149/Windows-Live-Writer_8c4963ba1fa3_CE3B_Repository_pattern_diagram_1df790d3-bdf2-4c11-9098-946ddd9cd884.png

3.2 The Repository Pattern

As shown in the diagram above, when the repository pattern is not used, the application communicates directly with the data store. The slightest change in business logic will have an impact on other parts of the application and vice versa, changing the persistence layer strategy could break the business logic. A common way to prevent this scenario is by creating an abstraction layer between the business logic and the

data access layer with the Repository pattern. Generally accepted definition of the repository is that the repository mediates between the domain and data mapping layers, acting like an in-memory domain object collection (Fowler, 2002, p. 322). There are two ways to implement this pattern (Ciliberti, 2017):

- One repository for each domain class (entity): This is a non-generic repository. One repository class is created for each entity in the data store. As an example, entities like *Instructor, Task*, and *TaskEngagement* will have a repository class with operations related to this entity
- Base repository: This is a generic repository. This class can be either used for *Instructor* or *TaskEngagement* or any other entity. The generic repository contains basic *CRUD* operations or any other operations which are performed over all entities.

The recommendation is to use a repository pattern by defining an interface. The interfaces are like defining structure so that others can implement in their own way. Interfaces allow the implementation to be changed in a simple way, and their usage makes testing simplified. Dependency injection is most often implemented using an interface. The high-level module will inject the interface or abstraction of the low-level object. This injection can be done by using a constructor, method, or property. If the whole application is dependent on the interface, then it's possible to change the definition of interfaces as per our different versions of classes based on a similar interface (Ciliberti, 2017). The following example shows a simple interface *IRepository* consisting of the most basic database operations. Its definition and implementation describe a sufficient way to implement the repository pattern. *IRepository* creates an abstraction layer over different ORMs, while the class *BaseRepository* defined in the example represents an abstract class for *EF Core* which implements the described interface.

```
  public interface IRepository<T> where T : class
        {
            IEnumerable<T> SelectAll();
            T GetEntityById(object id);
            void InsertEntity(T object);
            void UpdateEntity(T object);
            void DeleteEntity(int id);
            void SaveChanges();
        }
```

```
  public class BaseRepository<T> : IRepository<T> where T :
class
      {
        private readonly ApplicationDbContext contextObject;

        public BaseRepository(ApplicationDbContext
contextObject)
        {
            this.contextObject = contextObject;
        }
        public virtual IEnumerable<T> SelectAll()
        {
            return contextObject.Set<T>();
        }
                . . .
       }
```

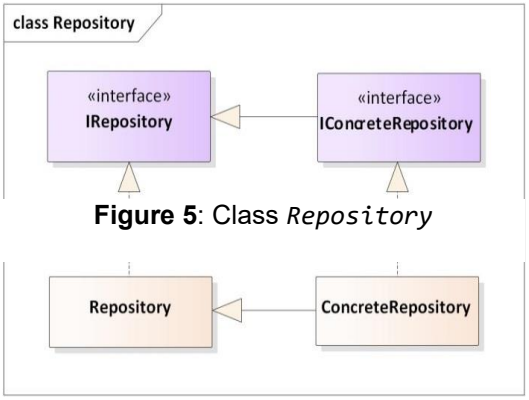

Figure 5: Class *Repository*

In this example, the main purpose of the *IRepository* interface is to define common database operations that could be performed over each entity. The main task of the *BaseRepository* class is to implement *IRepository* interface methods. We call this class generic because this class uses the generic type T. Generic type refers to the relevant *DbSet* based on the type of T. In this case, generic type T represents the domain class. From the perspective of the database, *DbSet* usually represents the table created for each entity class. As shown in Figure 5, a concrete repository class is created for each domain class that implements a concrete interface. For example, for an entity *Instructor*, concrete interface *IInstructor (IConcreteRepository)* will implement the *IRepository* interface and the class *InstructorRepository (ConcreteRepository)* will implement the *IInstructorRepository* and *BaseRepository*, where T will refer to the type of *Instructor*. The problem occurs when this pattern is applied for all other domain classes, and each one of them creates an instance of the *ApplicationDbContext* class, which represents the one session with the database. If the *SaveChanges()* method of one of the repository class completes successfully and the other one doesn't, it will lead to the database inconsistency (Ciliberti, 2017). To prevent this scenario, it is useful to implement the Unit of Work design pattern, which will be explained below.

3.3 The Unit of Work Pattern

All activities performed during a business transaction can affect the database. These activities include multiple insert/update/delete operations. Instead of performing multiple database transactions, by using a Unit of Work design pattern, the user performs all the desired operations, and when he completes, the Unit of Work puts all the operations into a single transaction, ensuring the database consistency (Fowler, 2002, p. 184). *UnitOfWork* class comprises the property for each of the repositories and an instance of the *ApplicationDbContext* class. This instance of the data context object is created once and shared within all repositories (Ciliberti, 2017). This class also implements interface *IDisposable* that provides an ability to release memory as soon as the execution is over.

```
public interface IUnitOfWork : IDisposable
    {
        IInstructorRepository InstructorRepository { get; set; }
                              . . .
        ITaskEngagementRepository TaskEngagementRepository  { get; set; }

        void Save();
    }
```

```
public class UnitOfWork : IUnitOfWork
    {
        private readonly ApplicationDbContext contextObject;

        public UnitOfWork(ApplicationDbContext contextObject)
        {
            this.contextObject = contextObject;
            InstructorRepository = new InstructorRepository(contextObject);
                                 . . .
            TaskEngagementRepository = new
TaskEngagementRepository(contextObject);
        }

        public IInstructorRepository InstructorRepository { get; set; }
                                                          . . .
        public ITaskEngagementRepository TaskEngagementRepository { get; set; }

        public void Save()
        {
            context.SaveChanges();
        }

        public void Dispose()
        {
            contextObject.Dispose();
        }
    }
```

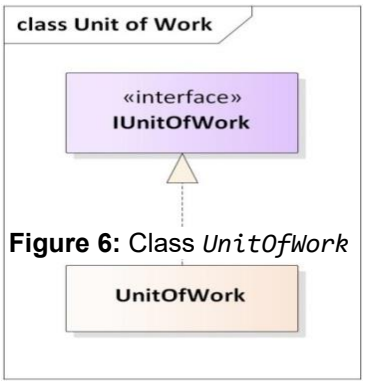

Figure 6: Class *UnitOfWork*

Benefits of using this design patterns are (Ciliberti, 2017):

- Creates a level of abstraction between the data access and business logic layer,
- Managing multiple database operations in the one single transaction,
- Making layers loosely-coupled relationships between layers using dependency injection,
- Testing the application is easier when using combination of these design patterns

Now, it is possible to inject the *UnitOfWork* class and Repository class in the *Controller* or *Service* class, in order to handle business logic and use CRUD operations. Between the repository layer and controller, the service layer is placed. The service layer consists of the service classes for example *InstructorService*, containing business and validation logic for the database operations performed over the *Instructor* entity. By defining interfaces for each service class, the service layer is isolated from the controller layer which handles requests. Since the goal is targeting basic database operations performed over all entities, the implementation of these methods should be simple. Figure 7 shows the scenario described. The service layers use the repository layer that is at the lower level, and the controller layers use the service layer.

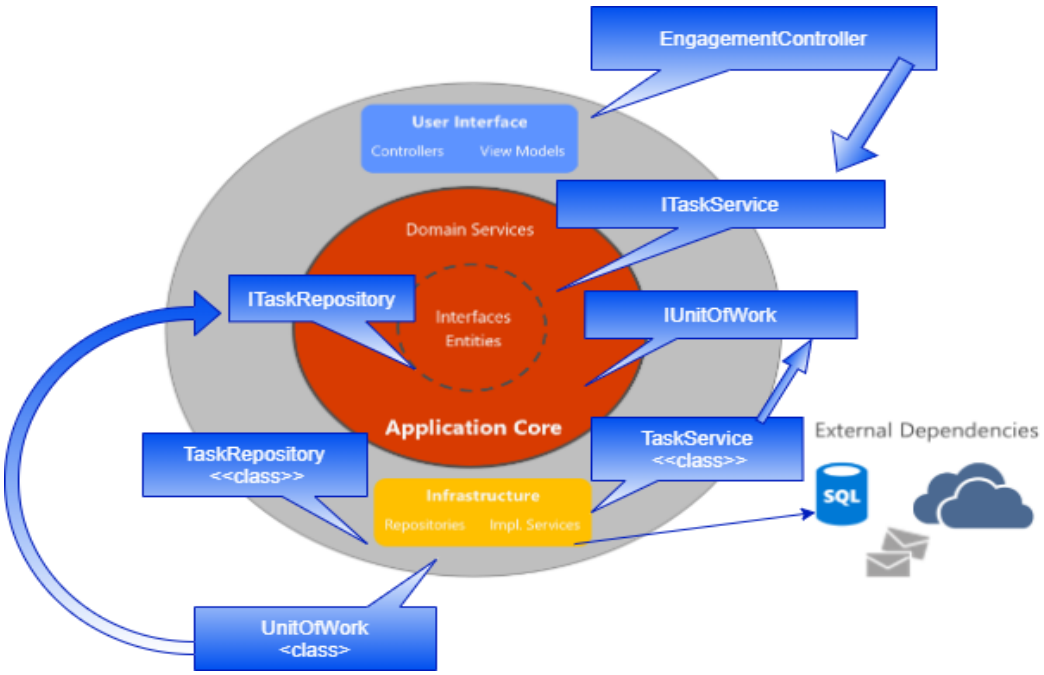

Figure 7: Practical examples on Clean Architecture; onion view

```
public class TaskEngagementService : ITaskEngagementService
   {
       private readonly IUnitOfWork unitOfWork;

       public TaskEngagementService(IUnitOfWork unitOfWork)
       {
           this.unitOfWork = unitOfWork;
       }

       public IEnumerable<TaskEngagement> SelectAll()
       {
           return unitOfWork.TaskEngagementRepository.SelectAll();
       }                    . . .
   }

  public class TaskEngagementController : Controller
   {
       private readonly IMilitaryDogService servicePsi;
       private readonly ITaskService serviceTasks;
       private readonly ITaskEngagementService serviceTaskEngagements;

      public TaskEngagementController(IMilitaryDog serviceMilitaryDogs,
             ITaskService serviceTasks, ITaskEngagementService serviceTaskEngagements)
       {
           this.serviceMilitaryDogs = serviceMilitaryDogs;
           this.serviceTaskEngagements = serviceTaskEngagements;
           this.serviceTasks = serviceTasks;
       }                  . . .
    }
```

4. CONCLUSION

When choosing to develop applications that are based on a layered architecture, an organization can have many possibilities but this approach also has several disadvantages. The aim is to create an architecture that enables effective communication between the components of the system. These components should not be tightly coupled because that could cause difficulties when changing or upgrading the application. Instead of being tightly coupled, each divided part should be independent which leads to a software system that is maintainable, robust, and flexible. Users have smart devices that run on different operating systems, so it is important to develop an application that can work with different operating systems. For an effective system, reusing existing solutions for new problems makes the system easier to adjust. These features of the architecture are desirable because they successfully solve the problem of tight coupling among the components, making these components more independent. Since the layered approach often leads to creating logical coupling across distributed environments, the disadvantages of this approach are related to

the implementation of this architecture, and for which projects should be applied. Layered architecture is the best practice to follow when there is a need to distribute the responsibilities of the software system .

According to Smith (2020), choosing the ASP .NET Core framework for the web application, an organization will develop an application with some of the key features such as high performance, cross-platform application and application with support for dependency injection and usage of MVC framework. These applications can run on different platforms, they improve the security of the applications, and make application maintainable. Modularity in these applications is achieved through the dependency injection. Most business organizations strive for an application development approach that results in a solution that is scalable, secure, robust, maintainable, and easy to manage, but on the other side, a solution that potentially leads to lower costs and targets specific platforms.

The traditional layered architecture raises fundamental issues of tight coupling and separation of concerns. In a way every layer depends on the next layer, all layers depend on a common infrastructure or some utilities. In the onion architecture business logic is completely encapsulated. Coupling is what affects maintainability and preventing parts of a system from being upgraded. Clean Architecture addresses the challenges faced with layered architectures (Martin, 2017). Any software system can react in an unexpected way to changes, which is why the importance of software testing is major, even for the simplest applications. Applications written to follow the principles of the Clean Architecture laid out in this paperwork should be maintainable and testable. By choosing to implement the application using the Onion architecture discussed in this paperwork, the problem with tight coupling will be successfully solved, and the application will be easy to upgrade in the future. This approach should be applied to the large applications with particular business complexity.

The simple example in this paper demonstrates the implementation of the Clean Architecture on the project with .NET Core platform, which gives a base template infrastructure of the next enterprise web application with the layered application. Depending on the goals and needs of the specific organization, layered architecture may be suitable for the development of business applications for that organization, while the same architecture may be unnecessarily too complex and lead to the failure of other organization's projects. The choice of software architecture is extremely important and depends on many factors such as the environment, specific client requirements, the ability of the environment to meet the requirements, and the quality of the workforce.

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OBSERVING SOFTWARE TESTING PROCESS THROUGH THE NEURAL NETWORKS' LENS – A SYSTEMATIC LITERATURE REVIEW

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Abstract: *Quality is an important aspect of developed software and is under tremendous influence of testing process quality. The objective of this study was to determine how neural networks are applied in the field of software testing process. Therefore, systematic literature review was conducted to extract the existing body of knowledge. Four scientific databases were chosen; search string, inclusion, exclusion and quality criteria were defined and final population had 27 papers. Despite variations in terms, most sources used neural networks in combination with other machine learning techniques and were focused on predicting faults/defects, readiness, reliability, self-admitted technical debt; two were focused on cost estimation, one was focused on test case prioritization and one on predicting cumulative time failure.*

Keywords*: neural network, test process, software, systematic literature review*

1. INTRODUCTION

Software development has become essential in everyday life; it is present in many critical systems e.g. bioinformatics, medical monitoring and control, military, air traffic control etc. (El-Sebakhy, 2009). Estimating software is challenging; estimators are "notorious" in software effort predictions, since estimations are performed in the early stages of development, when problems are still not completely revealed (Nassif, Ho, & Capretza, 2013). Software testing is of at-most-importance for quality assurance (Gondra, 2008), with budget and time saving potential, through early identification of defects and delivery of non-fault modules (Abaei, Selamat, & Fujita 2015). Software fault prediction predicts "fault proneness of future modules by using essential prediction metrics and historical fault data" (Erturk, & Akcapinar Sezer, 2015, p.1872). Estimating a module's fault-proneness minimizes cost and leads to more effective testing (Gondra, 2008). Many fault prediction approaches have been developed to improve testing process by pointing modules more prone to defects (Abaei et al. 2015). Parametric software reliability growth models (SRGMs) individually cannot give accurate predictions in all circumstances and are based on certain assumptions. Non-parametric models (e.g. neural network based models) predict software reliability from defect history, without any assumptions (Roy, Mahapatra, Rani, Pandey, & Dey, 2014). Problems occur when a company does not possess earlier versions of software projects, because supervised classification cannot be applied for defect detection (Abaei et al. 2015).

The main objective of this research is to investigate how neural networks are being applied in the field of software testing process and how successful this machine learning technique is. E.g. Catal (2011) conducted a systematic literature review (SLR) on software fault prediction, which included papers from 1995 till 2007 regarding neural networks. The 1995 study could not distinguish fault from non-fault prone modules. Afterwards, various neural networks were developed e.g. Ward, General Regression neural network and FALCON and were combined with Genetic Algorithms for better understanding. By conducting a SLR, the author of this paper wanted to focus on application of neural networks in the entire software testing process, since neural networks are appropriate when data are not abundant and domain is not very well understood (Gondra, 2008), and summarize the existing body of knowledge. This should provide an insight into tasks neural networks have to fulfill when applied in software testing, their success rate, as well as their potential when combined with other techniques. This review should also provide value to industry (e.g. shorter testing time, decrease in costs) and give future researchers directions as well.

After the Introduction, the rest of the paper has following structure: Section II presents research methodology (research questions, search strings, inclusion and exclusion criteria, chosen scientific databases and how the review was conducted); Section III extracts the review data and discusses findings, while Section IV concludes the paper.

2. RESEARCH METHODOLOGY

SLR is considered a crucial part of scientific research (Khan, Keung, Niazi, Hussain, & Zhang, 2017) focused on identification, evaluation and interpretation of available research relevant to (Kitchenham, 2004) a specific question, problem, phenomenon or area of interest. SLR has to include thoroughness and fairness; otherwise, its scientific value will be questionable (Kitchenham, 2004). SLRs require significant researchers' effort, but their main advantage is seen in gathering detailed information about a phenomenon in focus of a research. SLR's activities are divided into three main phases: planning a review, conducting a review and reporting review findings (Kitchenham, 2004).

2.1. Review Planning

The main objective of this SLR is to summarize the existing knowledge regarding software test process and neural networks and determine current trends in software testing through the neural network's lens.

2.1.1. Defining Research Questions

Based on the set objective, two research questions (RQ) were constructed. **RQ1:** *What were the main topics discussed in these papers?* **RQ2:** *What are current trends regarding application of neural networks in the field of software testing process?*

2.1.2. Defining Search Strings for Scientific Databases

To provide answers, a secondary study was conducted to investigate trends in neural networks in software testing process. Four electronic databases were chosen: IEEE xplore, AIS library, Science Direct and ACM Digital library. Research string was set as: "neural network" AND "test process" and applied in all four databases. The author decided to sacrifice alternative search queries in favor of electronic database diversity.

2.1.3. Defining Inclusion and Exclusion Criteria

There were no limitations regarding publishing period. Two publications types entered the initial population – journals and conferences. Published and approved papers were considered. Grey literature (e.g. blog posts, white papers) did not enter the initial population. Only studies which were focused on application of neural networks in the domain of software test process were examined. Studies that were not focused on these two areas were excluded. Language was not set as a barrier for entering the initial population.

2.1.4. Defining Quality Criteria

If a study is to enter in the review population, its quality has to be evaluated. Firstly, each study has to satisfy inclusion and exclusion criteria. Secondly, chosen scientific databases should provide papers that are either published or are to be published by respectable publishers e.g. Elsevier.

2.2. Conducting the Review

After applying the above constructed search string in all four databases, an initial population of 3.151 hits was built. Hits and search dates are presented: Science Direct (3.059 papers, March 4th 2020); ACM Digital Library (70 papers, April 13th 2020); IEEE xplore (12 papers, March 4th 2020) and AIS library (10 papers, April 13th 2020). Titles, keywords and abstracts for 3.151 papers were evaluated to ensure that studies do apply neural networks in software testing process and thus, are in function of answering research questions.

All articles were published in English completely, so language exclusion is not present and represents no threat to validity. However, since alternative queries were not conducted, this could be a threat to validity, do to potential omitting of other relevant research results. The second population included 1 paper from IEEE xplore, 10 from ACM Digital Library and 71 from Science Direct. All papers from AIS library were discarded. After "quick reading", papers that did not observe software testing through the prism of neural networks were excluded from the second population. Therefore, final population included 27 papers, which are under following references: [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28] and [29].

3. EXTRACTING AND DISCUSSING REVIEW RESULTS

This SLR was focused on observing the entire software testing process, but only through neural networks' lens till the year of 2020. Four databases were searched and selection criteria regarding respectable publishers and appropriate topics were applied, so final population had 27 papers that fulfilled set quality criteria. Answers to **RQ1** (*What were the main topics discussed in these papers?)* and **RQ2** (*What are current trends regarding application of neural networks in the field of software testing process?*) are complex and are given in the following paragraphs.

To ***predict software cumulative failure time***, Tian and Noore (2005a) explored evolutionary neural network, with multiple-delayed-input single-output architecture. Genetic algorithm was "used to globally optimize the number of the delayed input neurons" (Tian and Noore, 2005a, p.45) and neurons in the network's hidden layer. Levenberg-Marquardt algorithm was modified with Bayesian regularization to improve prediction. Performance was compared using real-time control and flight dynamic application data sets. The network's architecture greatly impacted its performance; the model adapted well to different projects and the goodness-of-fit and the next-step-predictability had higher prediction accuracy than existing neural network approaches.

Many researchers were focused on ***software reliability prediction***. Tian, & Noore (2005b, p.173) proposed an "on-line adaptive software reliability prediction model using evolutionary connectionist approach"; neural networks was "iteratively and dynamically reconfigured in real-time as new actual failure time data arrived" (Tian and Noore, 2005b, p.173). The network's performance was tested on four data sets and was concluded that this approach was robust and surpassed the performance with respect to next-step-predictability compared to neural networks for failure time prediction.

Software development is complex, so reliability models have to consider multiple parameters (Bai, Hu, Xie and Ng, 2005), (Bai, 2005). Bayesian network is adaptable to this type of problem, so Bai et al. (2005) and Bai (2005) successfully applied Markov Bayesian network. However, failure characteristics of software "often depend on the specific operation performed" and researchers missed that, so Bai (2005) developed extended Markov Bayesian network with focus on discrete-time failure data.

El-Sebakhy (2009) described learning algorithm of functional networks associativity model. Performances were compared with statistical regression, multilayer feed forward neural network and support vector machines. The results showed that functional network was more reliable, stable and accurate and outperformed other techniques in predicting software reliability, since it had the highest correlation coefficient and the lowest root mean squared error during testing and training. The author believes in future application of functional networks in risk analysis, maintainability and software cost prediction.

Roy et al. (2014) proposed a robust feed forward neural network based dynamic weighted combination model (PFFNNDWCM). Four SRGMs were combined "based on the dynamically evaluated weights determined by the learning algorithm" of feed forward neural network (Roy et al. p.629). Robust recurrent neural network based dynamic weighted combination model (PRNNDWCM) was proposed to give justifiability. They used real-coded genetic algorithm for neural networks' training. Three software failure data sets were used to compare predictability with existing neural network reliability models. Proposed models' performances were also compared with models as combinations of two or three out of four SRGMs. PFFNNDWCM and PRNNDWCM showed fairly accurate fitting and predictive capability when compared to other neural network based models. PRNNDWCM was more promising, because its' fitting and prediction errors were much less compared to PFFNNDWCM.

For *predicting reliability of component-based software systems (CBSSs)*, many mathematical and soft models have been developed. Tyagi and Sharma (2014) proposed an adaptive neuro-fuzzy inference system (ANFIS), based on two Soft Computing elements. ANFIS performance was compared with the fuzzy inference system (FIS) in various data sets and had better reliability prediction.

Jinyong and Ce (2018) used deep learning model based on recurrent neural network encoder–decoder to predict the number of software faults and assess software reliability. Jinyong and Ce's (2018) model "deepened the layer levels" and was adaptable for capturing training characteristics. An in-depth study and feature excavation showed model's suitable prediction performance. Experiments showed that their model had better prediction than other parameter and neural network models.

Software fault/defect detection was investigated by Hu, Xie, Ng and Levitin (2007) and was suggested that fault detection and correction should be investigated together and neural networks can do that. They applied recurrent neural networks to model two processes together. To provide robust predictions, "an extra factor

characterizing the dispersion of prediction repetitions was incorporated into the performance function" as Hu et al. (2007, p.332) pointed. Genetic algorithm was used for evolution of different configurations of neural network. Recurrent and feed forward neural networks and analytical models were compared using a real dataset.

Mahajana, Gupta and Bedi (2015) applied Bayesian Regularization for discovering defects before testing to decrease testing and thus, software project cost. Bayesian Regularization's purpose is minimizing a combination of squared errors and weights and establishing correct combination for generating efficient network. This model was applied on public dataset. Accuracy of Bayesian Regularization based neural networks was compared with Levenberg-Marquardt and Back Propagation algorithm for locating software defects. It was demonstrated that Bayesian Regularization had higher accuracy then Levenberg-Marquardt and Back Propagation algorithm.

Abaei et al. (2015) proposed an automated software fault detection model based on semi-supervised hybrid self-organizing map clustering and neural networks. Its advantage was "the ability to predict the label of the modules in a semi-supervised manner using software measurement threshold values in the absence of quality data" (Abaei et al., 2015, p.28). It did not need historical data and prediction improvement was related to learning from sample modules and software measurement threshold values. Expert's role was less critical and more supportive when identifying fault prone modules. Model was benchmarked with eight NASA industrial data sets and white-goods embedded controller software. False negative rate and overall error rate were improved in 80% and 60% of the cases respectively for NASA data sets. This model could be used as automated tool for testing guidance through prioritization of fault prone modules and decrease testing resources and improve software quality.

Predicting a ***software/module's fault/defect-proneness/tendency*** is in focus of many researchers. Gondra (2008) trained a neural network with software metric value history and number of errors. Sensitivity analysis on trained neural network was conducted to establish significance of individual software metrics in predicting fault-proneness. Most critical metrics formed neural network-based predictive model. Support Vector Machine performed binary classification (error or error-free). Effectiveness of neural networks and Support Vector Machines on a NASA data set was also compared. Gondra (2008) noticed that Support Vector Machine outperformed neural network in fault-proneness prediction, when it was presented as binary classification task, but pointed out that neural networks are very useful in "poorly understood domains" and that data scarcity was a problem, since software organizations are not willing to provide data.

Geng (2018) proposed a Deep Neural Network based on Bound Particle Swarm Optimization (BPSO) dimensionality reduction. Calculation framework of Deep Neural Network on BPSO prediction algorithm, 21 software fault measurement indexes and normalization processing method of these index values were presented. BPSO algorithm reduced dimensionality of software fault data set; particle position was presented by 0 or 1 to simplify data processing; Deep Neural Network algorithm was adopted for software fault tendency prediction. Experiments on four standard test sets (PC1, JM1, KC1 and KC3) were conducted to test the algorithm's performance. It was determined that this approach could effectively predict fault tendency and allocate developers towards soft modules.

Software fault/defect prediction (SDP) investigates fault proneness of modules that will require refactoring or detailed fault testing and is important for software planning. Erturk and Akcapinar Sezer (2015) applied ANFIS for fault prediction. Neural Network and Support Vector Machine were also built for performance comparison with ANFIS. Experimental data were collected from PROMISE repository. McCabe metrics were selected, due to their focus on programming effort. ROC-AUC was used as a performance measure. ANFIS enabled experts to manage data vagueness more directly, unlike neural networks. Support Vector Machine, neural networks and ANFIS achieved results in the following order: 0.7795, 0.8685 and 0.8573, and was concluded that Support Vector Machine and ANFIS achieve better results with three rather than four parameters.

For defect prediction, Miholca, Czibula and Gergely Czibula (2018) developed a supervised classification method - a non-linear hybrid (from gradual relational association rule mining and neural networks) that distinguishes defective from non-defective software. Experiments were conducted on 10 open-source data sets. Their method had better defect prediction results than most of previously proposed approaches.

Juneja (2019) predicted software faults for internal and external projects by developing fuzzy-filtered neuro-fuzzy framework with 3 primary phases. Firstly, effective metrics for fault prediction were identified and composite analytical observations of attributes were calculated with Information Gain and Gain Ratio. Secondly, most prominent features were chosen by applying fuzzy rules onto metrics. Thirdly, neuro-fuzzy classifier was applied on fuzzy-filtered training and test sets. Fault identification was based on inter-version

and inter-project evaluation. Previous projects became training sets; new projects became testing sets. Nine projects from PROMISE, PDE and JDT repositories participated in experiments. Framework achieved higher prediction accuracy, lesser error rate and significant AUC and Geometric Mean for inter-project and inter-version evaluations than Decision Tree, Random Tree, Random Forest, Naive Bayes and Multilevel Perceptron.

Two main challenges in SDP: “learning effective feature representation and addressing class imbalance” were solved by Xu, Li, Xu, Liu, Luo, Zhang, Zhang, Keung and Tang (2019, p.1) with Learning Deep Feature Representation based on defect data. Deep neural network was trained with hybrid loss function to learn feature representation. This function incorporated triplet loss and a weighted cross-entropy. Former loss preserved locality and learned feature representation; latter calculated penalties when real defect modules were classified as non-defect ones. This reduced class imbalance. Experiments were conducted on a dataset with 27 defect data (with three types of features); three traditional and three effort-aware indicators were used. Their model had better detection of defective modules, when compared to 27 baseline methods, except for Precision indicator.

Since SDP functions with grained units (e.g. module, class), developers have to locate defects, so Majd, Vahidi-Asl, Khalilian, Poorsarvi-Tehrani and Haghighi (2020) proposed Statement-Level Deep-learning model (SLDeep). They defined 32 statement-level metrics, applied long short-term memory as learning model and conducted experiments using 119,989 C/C++ programs within Code4Bench. Out of 2,356,458 code lines, 292,064 lines were faulty. Diverse set of programs and versions, written by thousands of developers meant that a model could be used for cross-project SDP. SLDeep successfully classified new fault-proneness statements (0.979, 0.570 and 0.702 for recall, precision and accuracy, respectively) and proved effectiveness for statement-level SDP. This approach takes the burden of searching faults of developers’ and makes defect prediction research more industry viable.

Ensemble methods exploit advantages of different techniques and give better binary fault prediction results (fault or non-fault), but these were not used for ***predicting the number of faults,*** so Singh Rathore and Kumar (2017) used a heterogeneous ensemble method (linear combination rule and a non-linear combination rule). Their approach had higher prediction accuracy and, despite various software fault datasets, prediction consistency. Results were evaluated with prediction at level l and measure of completeness. Ensemble methods, as opposed to individual fault prediction technique, have better performance when predicting the number of software faults. This approach will influence test resource allocation and rapid identification of majority of faults.

Continuous Integration/Continuous Deployment processes are extremely dynamical. Code-base can receive lots of commits per day, which makes testing “time-critical, yet resource-intensive”, so it has to be done effectively according to Philip, Bhagwan, Kumar, Maddila and Nagppan (2019, p.408). They presented FastLane for data-driven test minimization, that used light-weight machine learning models (e.g. Binary neural network), rich testing log (for period of 14 months, contained a < commit, test > pair: it contains test start and end time, host machine, the commit the test ran on and test outcome -“passed” or “failed”) and commit log (what time each commit was made, developer who made it, the reviewers of the commit and files modified) history to ***predict test outcomes*** (risky or safe). Tests did not have to be explicitly run, which is important for saving resources. Experiments on a large-scale email and collaboration platform service showed that FastLane saved nearly one fifth of testing time (18.04%) with accuracy of 99.99%.

Software effort prediction/estimation is challenging, due to the fact that many problems cannot be seen in the beginning, so Nassif et al. (2013) developed a log-linear regression model based on use case point model (UCP), to eliminate UCP limitations (software size and effort are linear; lack of team productivity). Multiple linear regression predicted productivity factor, which was additionally calibrated with Mamdani fuzzy logic approach; Multilayer perceptron (MLP) used software size and team productivity for software effort prediction. Their approach was better than the UCP model. MLP and log-linear regression were compared for different project sizes. For small projects, MLP surpassed log-linear regression model; for larger projects log-linear regression model gave better estimation results.

Budget for software testing is limited. Therefore, ***cost estimation*** is important, so Mittas, Papatheocharous, Angelis and Andreou (2015) improved cost estimation accuracy with semi-parametric models (SPMs – combination of non-parametric techniques with linear component). Non-parametric models included: Estimation by Analogy, neural network, Support Vector Machines and Locally Weighted Regression. SPMs’ cost estimations outperformed nonparametric models, especially where “both linear and non-linear relationship existed between software effort and the related cost drivers. Approach was validated through a statistical framework which uses multiple comparisons to rank and cluster the models examined in non-overlapping groups performing significantly different” Mittas et al. (2015, p.120).

Since misclassification of defect-prone modules generates higher cost than misclassification of non-defect-prone ones, Zheng (2010) boosted *defect prediction* neural network with three cost-sensitive algorithms. Threshold-moving pushed classification threshold towards not-fault-prone modules, so more fault-prone modules could be correctly classified. Two weight-updating algorithms incorporated misclassification costs "into the weight-update rule of boosting procedure such that the algorithms boosted more weights on the samples associated with misclassified defect-prone modules" Zheng (2010, p.4537). Performances were evaluated on four NASA datasets with Normalized Expected Cost of Misclassification. Threshold-moving algorithm is the most appropriate for building cost-sensitive software defect prediction models with boosted neural network, since it achieved lower misclassification costs, had higher tolerance for under/over-estimation of cost ratio and its application was easier.

Number of faults/defect still present, indicates if software is ready to be released. ***Predicting software readiness*** prevents releasing software too early or too late. Quah (2009) developed a readiness model for predicting: number of potential faults, estimated number of code changes for correction and estimated time for necessary changes. Product metrics were independent variables, whose selection depended on "the nature of source code with regards to architecture layers, types of faults and contribution factors of these metrics" (Quah, 2009, p.430). Neural network with genetic training strategy was applied; genetic algorithm had statistical estimator for showing usefulness of inputs. The model had three parts: prediction model for presentation of logic tier (58), business tier (178) and data access tier (37). Business tier had object-oriented and complexity software metrics; new metrics were proposed for logic and data access tier. Metrics were validated with data from real world applications. The main purpose of developed model was guidance through release management, since it had higher prediction accuracy than regression analysis.

Technical debt is a conscious stability (long) vs. benefits (short) trade-off and self-admitted technical debt (SATD) is used as identifier of technical debt and Ren, Xing, Xia, Lo, Wang and Grundy (2019) were focused on ***SATD prediction accuracy***. They proposed Convolutional neural network (CNN) which classified code comments as "SATD" or "non-SATD". CNN's architecture was analyzed for code comments' key phrases and patterns which reflected SATD, because Ren et al. (2019) wanted to improve clarity of predicted results. Their experiments identified 700 SATD based on 62,566 code comments from 10 open source Java projects (that belong to different domains and vary in number of contributors, size and complexity) and a user study with 150 comments from 3 more projects and have shown that their approach was better than traditional text-mining methods for SATD classification in terms of performance, generalizability, adaptability and clarity.

Deciding which test cases are the most important enables more rational allocation of scares testing resources, but ***prioritization of test cases*** was investigated only by Belli, Eminov and Gokce (2007). They applied model-based, coverage- and specification-oriented approach with preference degree. Preference degrees were based on events defined by several attributes (indirectly); relevant attributes had graphical representation (as a set of Event Sequence Graphs) and events were classified with unsupervised neural network clustering. Their model was suitable if a system under test is presented as a graph and nodes (events or sub-systems) have various levels of granularities (e.g. modules, classes). Since it was focused on test case ordering, it is applicable in cases of limited budget and timing. Belli et al. (2007, p.201) planned to apply their approach to more general testing problems, "e.g., to multiple-metrics-based testing where a family of software measures is used to generate tests".

When software testing is observed through the neural networks' lens, it can be noted that the first application of neural networks in 1995 was unsuccessful, so academia started developing different types of neural networks e.g. evolutionary, convolutional, functional, feed forward, recurrent etc. for this purpose.

Neural networks were combined with Genetic Algorithms for better understanding. Some authors developed hybrid approaches by combining Association Rules with neural networks. Others compared different neural networks (e.g. feed forward and recurrent neural network).
Some used different algorithms e.g. Bound Particle Swarm Optimization for neural networks. Others compared accuracy of neural networks when different algorithms were applied (e.g. Bayesian Regularization vs. Levenberg-Marquardt and Back Propagation algorithms).

Some authors compared neural networks with Support Vector Machine, Decision Tree, Random Forest etc. In some cases, e.g. Support Vector Machine outperformed neural networks; in others, neural networks achieved better results.

In the field of software testing, neural networks are primarily focused on building various defect/fault prediction models. Although various terms are used for this task (readiness, reliability, defect proneness), they are all focused on defect prediction, but from different perspective. Several papers were different, since

they observed number of faults, self-admitted technical debt, cost estimation, cumulative time failure, prediction of test outcomes, effort prediction and test case prioritization.

4. CONCLUSION

Quality, as an important aspect of developed software, is under tremendous influence of testing process quality. The objective of this study was to determine how neural networks are applied in the field of software testing process. Therefore, systematic literature review was conducted to extract the existing body of knowledge. Four scientific databases were chosen; search string, inclusion, exclusion and quality criteria were defined and final population had 27 papers.

Neural networks have gone a long way from not being capable to distinguish fault-prone from non-fault-prone modules to achieving high prediction accuracy. Despite variations in terms, most sources used neural networks in combination with other machine learning techniques and were focused on predicting software/module faults/defects, readiness, reliability; two were focused on cost estimation, one on self-admitted technical debt; one was focused on test case prioritization, one on predicting test outcomes, one on predicting effort and one on predicting cumulative time failure.

Application of neural networks in software testing will continue to grow, despite data scarcity (unwillingness of organizations to reveal data), since built predictive models influence on rational allocation of limited testing resources. In the future, it can be expected that neural networks will continue to be combined with other machine learning techniques. Software companies and researchers will have to find ways to overcome trust issues regarding relinquishing/using sensitive data in order to harness research benefits (e.g. prioritization of test cases, cost estimation) and more research should be conducted in the field of cost estimation, test case prioritization and prediction of effort and cumulative time failure.

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METHODS AND APPLICATIONS OF DATA SCIENCE IN BUSINESS AND SOCIETY

CONTENT

EVALUATION OF STRINGENCY DURING COVID-19 OUTBREAK IN EUROPE: CIDI

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Abstract: *The research presented in this paper focuses on the severity of measures that European governments have installed during the outbreak of COVID-19 pandemic in Europe. We strived to compare the European countries, giving the special focus to situation and in Serbia. The research kickoff was Oxford's Stringency Index. We modified the methodology of this index using the CIDI statistical approach, whose main characteristic is formulating data-driven weighting scheme, instead of originally used simple equal weights scheme. Results show that, for the observed period from March 16, to April 27, when the most of the Europe was in peak of its COVID-19 crisis, among 32 observed European counties, Serbia's governments introduced the most severe measures for pandemic suppression, followed by Italy and Croatia. The most relaxed measures were encountered in Norway, but taking into account that Sweden was excluded from the analysis. During this period most of the countries have started with mild measures, strengthening them up just when the pandemic started to take serious aftermath.*

Keywords*: Stringency Index, COVID-19, CIDI*

1. INTRODUCTION

The COVID-19 outbreak brought upon the world unprecedented number of casualties. Critiques have been vocal in advocating that countries have failed to response adequately (Lancet, 2020). One of the rationales for the slow response from governments around the world could be attributed to the lack of knowledge concerning the virus (Lisi et al., 2020). In the lack of the information, most countries followed the experience of the China and the measures they undertook to restrain the pandemic (Xu & Li, 2020). Measures such as quarantine, social distancing, and isolation of infected populations (Anderson et al., 2020) proved useful in containing the spread of the virus in China. Consequently, countries throughout the world put it place similar scenarios (Fernandes, 2020) aimed at minimizing the number of fatalities.

A range of initiatives has been pushed forward to captivate the magnitude of stringency actions performed by each country. As a possible solution in integrating actions of different measurement units, composite indicators positioned as a viable option. In particular, COVID-19 Stringency Index gathered much of the research frenzy (Cepaluni et al., 2020; Ferraresi et al., 2020; Jayatilleke et al., 2020).

2. METHODOLOGY

The methodology of this research is mainly based on the methodology for calculation of Stringency Index (Hale, Petherick, Phillips, & Webster, 2020b, 2020a). We have adjusted this specific index, using the data driven approach for creating a multivariate measure – the Composite I-distance Indicator (CIDI). The detailed insight into these methodologies is found below.

2.1. Stringency Index

The team from University of Oxford, Blavatnik School of Government have introduced the Oxford COVID-19 Government Response Tracker (OxCGRT), where they presented the specific index that calculates the severity of measures for suppression of COVID-19, which different governments have installed during the outbreak of the pandemic across the world. They presented this measure as the Stringency Index (Hale et al., 2020b, 2020a). The complete dataset that they handed out covers the time period from January 1, 2020, till May 8, 2020 (OxCGRT, 2020b), for 152 states.

Stringency Index (SI) is a composite measure that consists of the nine sub-indicators (OxCGRT, 2020a):

- School closing - Record closings of schools and universities
- Workplace closing - Record closings of workplaces

- Cancel public events - Record cancelling public events
- Restrictions on gatherings - Record limits on private gatherings
- Close public transport - Record closing of public transport
- Stay at home requirements - Record orders to "shelter-in-place" and otherwise confine to the home
- Restrictions on internal movement - Record restrictions on internal movement between cities/regions
- International travel controls - Record restrictions on international travel for foreign travelers
- Public information campaigns - Record presence of public info campaigns

The detailed methodology for calculation of SI can be found with Hale and his coauthors (Hale et al., 2020a). They have created nine continuous sub-indicators listed above, based on the records of worldwide governments' measures for suppression of COVID-19. The final composite SI represents the average value of nine sub-indicators, giving all the indicators the equal weight of one ninth, as shown in expression 1.

$$SI = \frac{1}{9}\sum_{j=1}^{9} I_j \tag{1}$$

SI is the Stringency Index, while I_j, $j=1..9$, are nine sub-indicators (Hale et al., 2020a).

2.2. CIDI

The Composite I-distance Indicator (CIDI) is the multivariate measure that suggests the additive method of combining the specific weighted sub-indicators (Dobrota, Bulajic, Bornmann, & Jeremic, 2016; Dobrota & Jeremic, 2017). The main characteristic of CIDI is that the weights exploited in this methodology are not expert-assigned nor simple equal weights (Dobrota et al., 2016; Dobrota, Martic, Bulajic, & Jeremic, 2015; Dobrota & Dobrota, 2016). The weights that CIDI proposes are data-driven weights that are calculated based on the I-distance methodology (Ivanović, 1977; Ivanovic & Fanchette, 1973). The weights calculation is given in expression 2 (Dobrota et al., 2016; Milosavljević, Dobrota, & Milanović, 2019; Milosevic, Dobrota, & Barjaktarovic Rakocevic, 2018).

$$w_i = \frac{r_i}{\sum_{j=1}^{k} r_j} \tag{2}$$

In this expression, w_i, $i=1..k$, is the data-driven weight, r_j, $j=1…k$, is the correlation coefficient between each observed sub-indicator and I-distance value (Jeremic, Bulajic, Martic, & Radojicic, 2011; Jovanovic, Jeremic, Savic, Bulajic, & Martic, 2012).

3. RESULTS

The kickoff of this research, as mentioned before, was Oxford's Stringency Index (SI) (Hale et al., 2020a, 2020b). The data available hold records of 152 countries (OxCGRT, 2020b).However, to narrow and systematize our research, we decided to focus on Europe and to examine and compare the European governments' responses to COVID-19 pandemic. Furthermore, we focused the special attention to the situation in Serbia, and comparison of Serbia with other countries. The observation period was set from Monday, March 16, when most of the European governments started to introduce restrictive measures, till April 27, 2020, monitoring each Monday in between. This can be considered as the most critical outbreak period of COVID-19 in Europe, since "on March 13, the WHO stated that Europe had become the new epicenter of the pandemic" (Sahu, 2020, p. 1; WHO, 2020). We did not examine the time period from April 27, till May 8, 2020, due to the large amount of missing data, causing our calculations to drop to zero.

We observed 32 European counties for which we found the available data (OxCGRT, 2020b). For example, there were no data for Montenegro or North Macedonia. Also, due to the fact that Sweden has brought in significantly lighter response measures for COVID-19, and that its results substantially differ compared to the other countries, it has not been observed in this research. The complete list of the observed countries can be found in Table 1.

The CIDI methodology was than applied to the selected reduced dataset, creating the SICIDI measures that, instead of using simple equal weights (Hale et al., 2020a), formulates the specific data-driven weight for each sub-indicator. We had seven timepoints observation period (Table 1), and CIDI methodology calculated data-driven weights for each timepoint separately.

The final results of SICIDI are given in Table 1.

Table 1: SICIDI results

Country	16.03.	23.03.	30.03	06.04.	13.04.	20.04.	27.04.	Ave.	Rank
Serbia	73.16	100.00	100.00	100.00	100.00	100.00	94.44	95.37	1
Italy	86.84	93.25	94.14	95.03	95.29	94.95	95.10	93.51	2
Croatia	49.30	95.90	95.81	95.45	96.00	95.45	91.75	88.52	3
Ukraine	72.53	88.68	88.59	87.74	89.66	88.07	91.25	86.65	4
France	61.88	87.00	86.14	86.81	86.39	89.00	93.73	84.42	5
Spain	80.66	75.79	87.34	87.58	84.31	85.10	90.06	84.41	6
Albania	86.77	81.27	80.51	80.78	82.57	85.88	88.61	83.77	7
Slovenia	56.27	79.96	90.95	90.51	91.29	87.57	89.41	83.71	8
Greece	58.78	86.03	86.92	87.32	86.39	87.93	89.27	83.23	9
Bosnia and Herzegovina	52.87	86.41	87.54	87.87	85.16	89.14	92.16	83.02	10
Cyprus	55.29	53.19	92.78	92.29	93.66	92.06	93.79	81.87	11
Romania	72.05	74.72	80.83	86.00	84.32	84.36	88.82	81.59	12
Portugal	38.44	85.32	86.67	87.19	88.73	84.61	88.22	79.88	13
Slovak Republic	82.73	77.58	77.88	77.84	87.10	76.60	79.28	79.86	14
Ireland	49.68	55.73	93.10	90.08	88.03	90.26	86.38	79.04	15
Denmark	81.00	79.22	80.12	79.87	77.97	75.20	NA	78.90	16
Austria	83.56	81.99	83.14	83.31	68.84	70.42	74.92	78.03	17
Moldova	59.97	48.82	89.71	89.70	91.55	79.55	84.04	77.62	18
Russia	41.32	48.56	89.80	89.98	88.65	90.34	93.12	77.40	19
Belgium	60.92	78.67	78.68	79.23	74.71	81.17	84.64	76.86	20
Netherlands	74.74	69.46	70.91	80.61	78.08	78.93	83.21	76.56	21
Hungary	77.59	66.07	73.08	74.17	74.49	78.30	79.56	74.75	22
United Kingdom	10.40	72.55	87.92	89.29	86.61	89.27	86.37	74.63	23
Turkey	59.76	62.91	76.07	77.26	79.89	82.97	80.85	74.24	24
Switzerland	50.64	75.20	77.34	78.95	71.81	77.05	76.76	72.54	25
Czech Republic	78.88	75.97	78.00	79.62	62.59	62.68	66.36	72.01	26
Poland	61.51	50.92	49.03	79.48	83.10	83.87	88.04	70.85	27
Finland	74.22	69.97	69.53	69.41	67.79	69.60	74.59	70.73	28
Germany	54.96	65.93	67.59	76.47	75.87	75.23	76.11	70.31	29
Estonia	63.37	51.18	75.61	76.80	72.14	77.74	70.88	69.67	30
Bulgaria	59.02	67.87	69.54	71.37	68.25	72.09	77.20	69.34	31
Norway	72.58	67.65	71.17	70.01	71.96	62.37	67.80	69.08	32

As can be noted from Table 1, some of the countries in Europe had lower measures in the beginning of the observed time period, heightening them up as the outbreak reinforced, as United Kingdom, Russia, Serbia, Croatia, Slovenia, etc. Other countries, as Romania, Bulgaria, Slovak Republic, Germany, and especially Finland and Norway had the more balanced level of SICIDI through this period of time. The explanation could be found in the fact that some of the governments have introduced the restrictive measures earlier, and kept them high during March and April, like Italy or Ukraine. Still, some of the countries had lower balanced level of SICIDI, like Finland or Norway. Austria, for example, have even lighten up the measures during this time period. The discussed differences, for the selected countries, can also be seen form Figure 1.

In order to gain a clear and outright picture of variation of European governments' responses to COVID19, we sought to compare the observed countries sternness. We calculated the average SICIDI for the complete surveyed period and ranked the countries. The most severe measures, during the most critical outbreak period, were taken in Serbia, followed by Italy, Croatia, Ukraine, France, and Spain. This result was quite expected for Italy, France, and Spain since the situation in those countries has been by far most critical (The Guardian, 2020a), especially in Italy. However, it was less expected for Serbia or Croatia. The least severe measures were taken in Finland, Germany, Estonia, Bulgaria, and Norway.

In Serbia, as can be seen from Table 1 and Figure 1, SICIDI has plunged to maximum of 100 soon after the state of the emergency was declared, and kept that way for more than 5 weeks. This value means that, in Serbia, schools were closed on all levels, all-but-essential workplaces were closed or redirected to work from home, all public events were canceled, people gatherings were restricted to 10 or less, public transport was closed, people were required to stay at home with minimal exceptions, internal movement restrictions were in place, borders were closed, and the public information campaigns were coordinated (OxCGRT, 2020a).

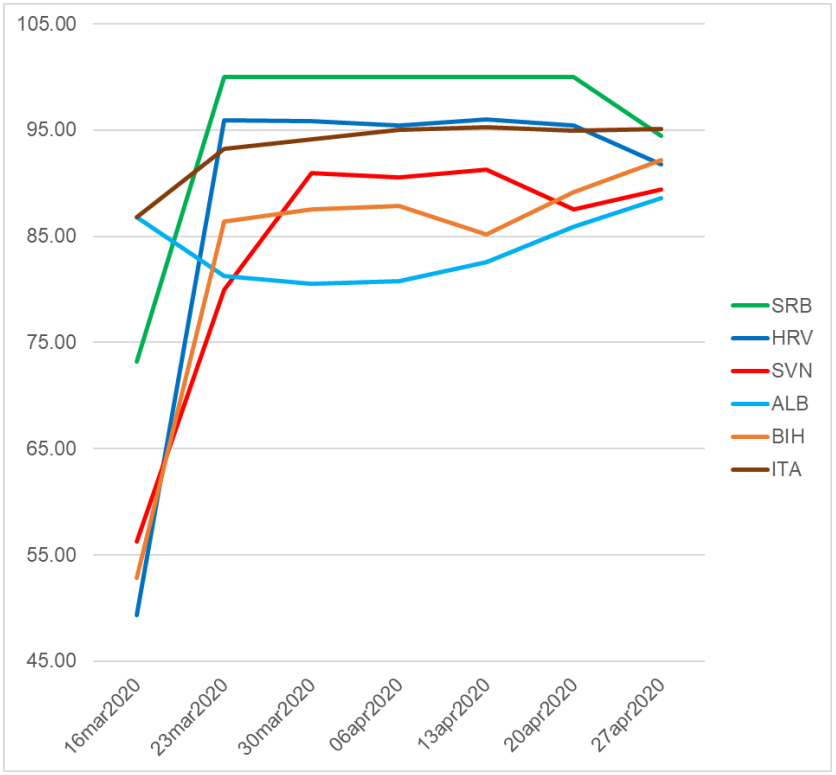

Figure 1: SICIDI of the selected countries

Figures 2 and 3 present the Europe heatmap of SICIDI on March 16 (Figure 1) and April 20 (Figure 2)[1]. It is evident, from these figures, that there were drastic changes in severity of taken measures in the period from mid of March till the end of April. For example, in comparison to other European countries, UK had noticeably low level of SICIDI on March 16, only 10.40 out of 100 (Figure 1).

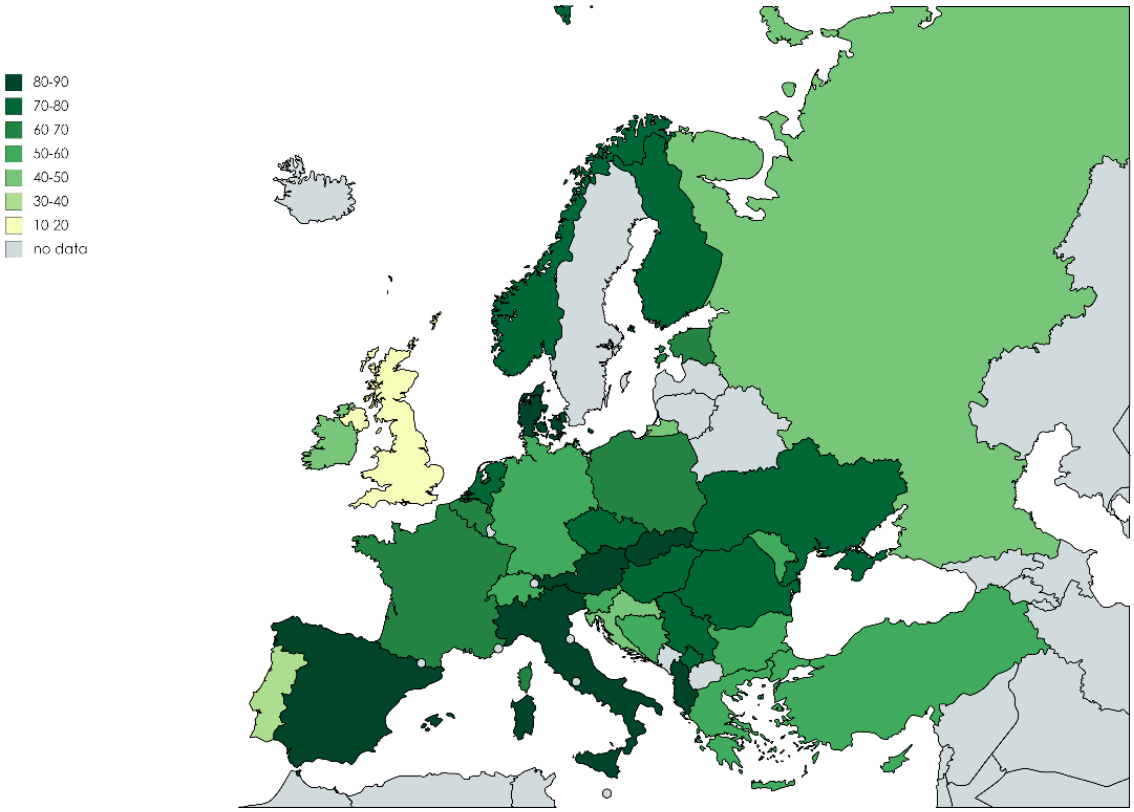

Figure 2: SICIDI Europe heatmap on March 16

[1] The data for Autonomous province Kosovo and Metohija are not included in the results for Serbia

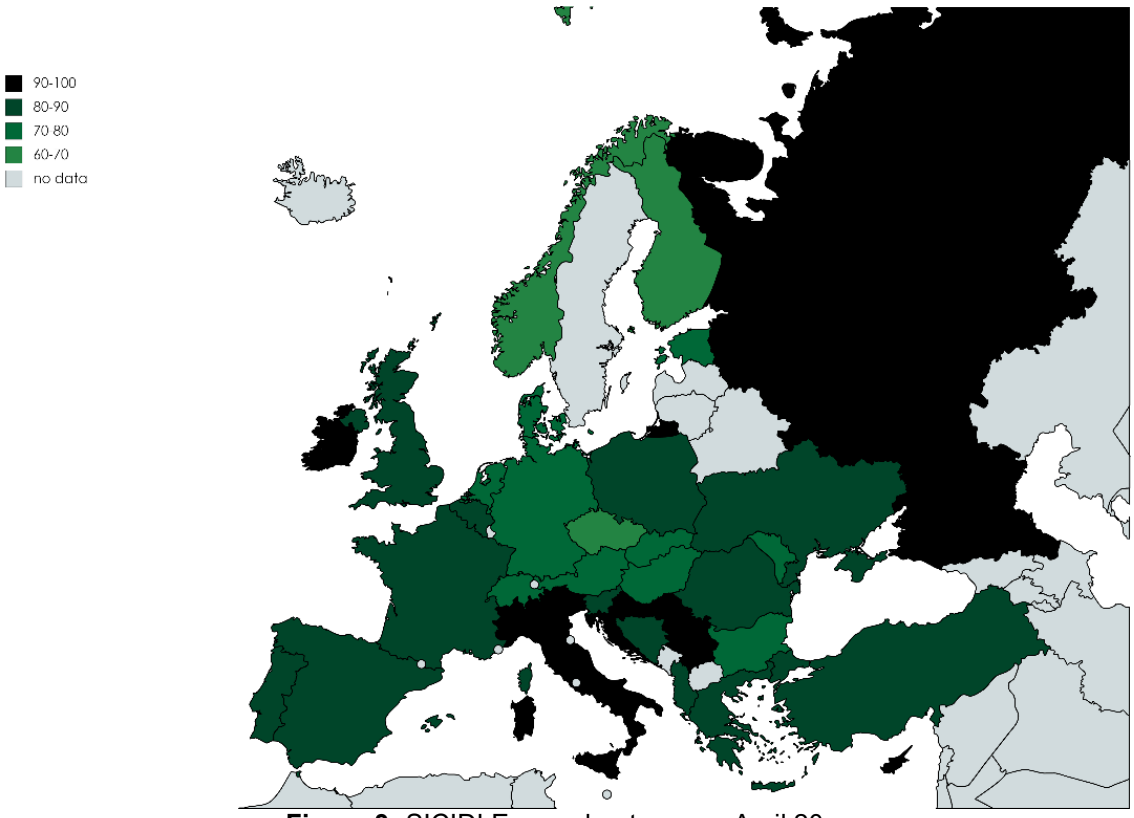

Figure 3: SICIDI Europe heatmap on April 20

On the other hand, they were forced to intensify their measures due to the abrupt increase in the number of COVID-19 cases (BBC News, 2020b), with the value of 89.27 on April 20 (Figure 2). As BBC reported in April, "The UK is likely to be among the European countries worst affected by coronavirus" (BBC News, 2020b). Russia is the similar example to UK, where they initially had very low value of SICIDI, 41.32 (Figure 1), being forced to intensify their measures as the time passed by, to over 90 at the end of the April (Figure 2). In Russia, more severe measures started to apply later, comparing to other European countries (Table 1).

4. DISCUSSION AND CONCLUSION

The COVID-19 has taken some serious casualties in Europe, as in rest of the world. Although the situation is lately heating up in Latin America and Middle East, it is slowly starting to alleviate in Europe. In this paper, we examined the time period when the situation with COVID-19 was at its most critical peak for most of the European countries. During this period most of the countries have started with mild measures, strengthening them up just when the pandemic started to take serious aftermath.

Up until now, Italy is among countries that have suffered "the world's deadliest outbreak of coronavirus" (WEF, 2020). As an aspect of a "bad luck", it was hit the first in Europe, and one can argue that it was hit the first and the hardest after the outbreak in China's Wuhan (Pisano, Sadun, & Zanini, 2020; Spina et al., 2020). In a very short time, Italy went from the first official detected case to a government decree that banned all migrations of citizens within the territory and closed all non-essential business and social activities. Italy was sad to had been knocked out by a "tsunami of unprecedented force", causing the unrestrainable surge of deaths. "The health care system struggles to deliver regular services - even pregnancy care and child delivery - while cemeteries are overwhelmed" (Nacoti et al., 2020, p. 2). In this regard, it is not surprising that Italy had such high values of SICIDI, keeping it high through the complete observed period, and leaving it so further on. Namely, while Italy had the highest level of SICIDI on the beginning, March 16, and on the end of the observed period, April 27, even though Serbia and Croatia have exceeded it along the way.

Pisano, Sadun, and Zanini (2020) argue that most of the European countries have repeated the errors made in Italy, "where the pandemic has turned into a disaster". This happened in spite of the expert's warnings that "The catastrophe unfolding in wealthy Lombardy could happen anywhere" (Nacoti et al., 2020). Similarly as in Italy, at the beginning, people minimized the problem, referring to COVID-19 as something "just like the flu" (Fagiolini, Cuomo, & Frank, 2020). Governments were trying to preserve the economy, reassuring people that some forms of social behavior were still safe and that they should nor change their habits (Fagiolini et al., 2020). In Serbia, for example, Covid-19 was referred to as "the funniest virus in history of viruses". On March

13, government in Serbia have reassured the public that the schools must stay open and that attending them was safe, only to declare a state of emergency a few days later, and close all the schools and universities.

UK and Russia are currently worst hit by the pandemic in Europe. For UK news were similar on the beginning of May: “UK overtakes Italy to become worst-hit European country” (Tidey & Bock, 2020) ; as well as at the end of May: “Data shows Britain has one of world’s highest rates of coronavirus deaths per capita” (The Guardian, 2020b). This is why in the beginning UK has such low values of SICIDI, that bounced rapidly and were kept on a high level in later days. Russia on the other hand is reporting unusually small percent of deaths, and seems to be relaxed regarding the pandemic. “Many citizens were surprised about the eased regulations because Russia… nowadays ranks first in the worldwide statistics of new infections and second in the absolute number of infected people” (DW, 2020). Lessons to learn from Italy were many; “hospitals might be the main Covid-19 carriers, as they are rapidly populated by infected patients, facilitating transmission to uninfected patients” (Nacoti et al., 2020, p. 3); “older patients are not being resuscitated and die alone without appropriate palliative care” (Nacoti et al., 2020, p. 2). It was up to the European governments to learn those lessons in time.

Situation in Serbia is indeed peculiar, comparing to the rest of the countries. By far most rigorous measures were introduces from March 23, till April 20. Many characterized those measures as unconstitutional (AKS, 2020; Beta, 2020), and the mystery is why they acted so stringently. The acts of Serbian government are repeatedly questioned. “At one point, Serbia's government introduced a "dog-walking hour" … for those in lockdown…” which vets condemned, saying that “skipping the evening walk could worsen the condition for the dogs with urinary problems” and “aggravate hygienic conditions in homes” (BBC News, 2020a).

The main limitation of this research comes from the fact that not all the countries in Europe reached the pandemic peak at the same time, thus it makes it a bit difficult to compare and put them all in one basket. However, the proposed methodological approach did its best to make them tantamount. Future research directions may include the cluster analysis of European countries, that considers SICIDI combined with the number of detected cases and deaths of COVID-19, as well as other related indicators.

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ANALYSIS OF STUDENTS' SATISFACTION AND PERCEIVED RISK WITH M-BANKING SERVICES

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Abstract: *Nowadays, it is almost impossible to imagine everyday life without a smartphone so the use of mobile applications in modern day business has become a necessity. The banking sector acknowledged the importance of allowing users to manage their finances simply and easily using their smartphones, so the mobile banking (m-banking) sector developed. This research aims to shed light on students' opinion on m-banking service, trust and perceived risk when using m-banking, and their satisfaction with the service. To provide the answers, a survey was conducted among the students at the University of Belgrade. The results indicate that the students are satisfied with the m-banking, but they think that they are not fully informed about the possibilities of the mobile banking service. Also, female and state-funded students have a certain level of distrust in the m-banking system. It is believed that the research results might signal the m-banking system in Serbia and particular banks how to address students and motivate them to adopt m-banking.*

Keywords*: mobile banking, youth market, consumer attitudes, perceived risk, perceived satisfaction*

1. INTRODUCTION

The Internet has brought many changes in various fields of life and business, including banking and banking services. The prevalence and development of Internet technology provided e-commerce, e-business, and innovative products and services to the market. Mobile banking (m-banking) is a service provided by banks that helps clients easily execute online transactions anyplace and anytime. Nowadays, most banks have platforms that allow bank clients to make payments, execute money transactions, transfer money between their accounts and check their account balance by only one click. That enabled clients to execute a large number of banking services by themselves, without going to the bank branch and with a significantly lower commission or no commission. Thanks to many benefits, clients in the developed countries have, in a large percent, shifted to m-banking (Sripalawat et al., 2011). The number of users of mobile banking applications is growing more and more every year, and according to recent forecasts by Bill Gates, by 2030 there will be over two billion users of m-banking in the world (Pymnts, 2015). All of these users will manage the money in their accounts and execute transactions via mobile phones (Sampaio et al., 2017).

M-banking apps have been largely adopted by banks to provide quick banking services (Chen et al., 2018). The Internet has had a strong impact on financial institutions by providing banking services users with facilities such as being able to access their accounts and execute the necessary transactions at any time, while also enabling banks to reduce their costs (Koenig-Lewis et al., 2010). The banking industry is one of the leading sectors in terms of acceptance and use of the Internet and mobile technology in consumer markets and it led to changes in the way services were provided. The development of electronic banking services through multiple electronic channels (e.g.offline, online and phone banking (Jun & Minjoon, 2016) has enabled the provision of new types of added value for customers (Laukkanen, 2007). The development of information technologies has a great impact on the banking sector because new payment methods and banking services that are user-friendly are constantly being developed (Akturan & Tezcan, 2012).

According to DataProt, in 2018 there were only 6.93% millennials who used the mobile banking services, which shows that despite a large number of opportunities, provided by mobile banking, it has not been sufficiently represented among young people (DataProt, 2020). Therefore, there is a large potential market for banks to seize. With the help of new technologies, artificial intelligence and machine learning, banks are expected to understand and keep pace with the banking needs of millennials. One of the challenges is to find the right balance between offering digital banking features and products while providing a personalised experience that indicates to the wishes and needs of millennials. When Generation Z started using banking services, it led to the need to take advantage of technological opportunities (Balance, 2020). As one way to engage millennials

to be their loyal customers, Forbes recommends banks to invest in mobile banking because „millennial are less worried about risk, less afraid of technology, and more focused on convenience than any other generation“ (Forbes, 2019). Banks need to realise clients' requirements about services, what impact this has on the way services are provided, and the clients' attitudes because a satisfied client is potentially loyal. With a better understanding of customer perception, banks can determine steps they need to follow to meet customers' preferences (Saghier & Nathan, 2013).

The aim of this research is to examine how different determinants of mobile banking affect student satisfaction with the use of m-banking apps of banks operating in Serbia. We looked at students' opinions on banking service, trust and perceived risk, satisfaction and WOM. Given that generations of current students will be the main users of banking services in a couple of years, it is important that banks consider their needs and adapt their business to the new lifestyle, preferences, and attitudes because in that way user's satisfaction and loyalty are achieved which is the key to success in today's turbulent business environment.

The paper is organised as follows: the second section features a brief overview on the determinants of adoption of m-banking, followed by the presentation of the current usage of m-banking in Serbia. Next, we present and elaborate on the research results, while the concluding remarks and the future directions of the study are given in the final chapter.

2. DETERMINANTS OF ADOPTION OF M-BANKING

In recent years, one of the important factors of competitiveness of banks has become the m-banking as a channel that allows payment via mobile phones, tablets and devices that have software that allows access to the Internet (Soleša & Brkić, 2019). Mobile banking has not only brought benefits and advantages to users of banking services, but also to banks as well. One of the most important advantages of m-banking is cheaper and more affordable service. When it comes to mobile banking, banks offer services at lower prices because the costs are lower in the field of human resources, but the services can be used at any location and at any time on the principle of 24/7/365 (Bradić-Martinović & Simović, 2016). There are a lot of factors that have an effect on adopting mobile banking by customers. There is an overview of some previous researches below that has examined the factors of m-banking acceptance.

Mobile banking provides banks with the opportunity to generate a new way of generating income. The new method of doing business also indicates modifying the marketing strategy in terms of adopting m-banking as an instrument of differentiation. Banks must monitor improvements of new information technologies, primarily mobile, to be leaders of innovations in m-banking. In addition to constantly developing the services they offer through m-banking, banks must guarantee that m-banking is reliable and secure to use. If the bank is constantly expanding the services available through mobile banking, it can motivate users to accept a new way of communicating with the bank (Sanader, 2014). The ease of use of the application is also one of the factors that is of great importance in user access to m-banking and the use of mobile payments (Liébana-Cabanillas et al., 2018).

Security has been one of the main concerns of online businesses in recent years. Companies are expected to defend the personal data of their customers during the process of transactions through the building security system. However, in a wireless context, different types of menaces increase the chance of a security breach or attack. Therefore, enhancing users' perceptions of security can raise customers' trust, reduce their perceptions of security threats and transaction risk, and thus strengthen their trust (Hsu et al., 2011). Risk and privacy problems have been classified as principal factors influencing the slower acceptance of m-banking (Govender & Sihlali, 2014). However, a study by Rammile and Nel (2012) showed that students do not consider the use of m-banking to be too risky. Another study by Kim et al. (2009) conducted at a University in South Korea showed that students had a relatively low level of confidence in m-banking and there has been a correlation between the relative perception of the benefits and the intention to use m-banking services. The same authors showed that the reputation of the bank that provided mobile banking services did not significantly affect the initial trust of users or their intention to use m-banking. Social influence has also proven to be one of the factors that is highly correlated with the intention of users to use m-banking (Savić & Pešterac, 2019).

Trust in the bank is a particularly important determinant of mobile banking. Confidence, as one of the components of accepting mobile banking, can be viewed from the aspect of the environment (in terms of trust in technology and infrastructure) and from the aspect of the institution itself (the bank that provides the service) (Lukić et al., 2019). Improving security and reducing the risk of using banking services via mobile devices also increases the client's trust in m-banking. Clients' trust in mobile banking is considered more dynamic than static as it may change from time to time. Therefore, building and maintaining trust in mobile banking can be quite difficult. The initial trust of clients who use m-banking apps is an important determinant that affects their entrance towards m-banking, as well as their tendency for reuse in the future (Chung & Kwon, 2009). Sarkar

et al. (2020) concluded that trust is positively correlated with many determinants that influence the acceptance of mobile banking such as satisfaction, loyalty and attitudes towards m-banking.

In research conducted by Sampaio et al. (2017) one aspect of observation relates to examining the relationship between satisfaction, loyalty and positive WOM. It was turned out that a positive relationship exists between satisfaction and positive WOM. Also, it is supposed that when performing transactions through the Internet banking service, there will be a more effective correlation between satisfaction and loyalty because the use of apps strengthens the correlation among banks and customers. According to the results of the study, the conclusion was that customers' satisfaction with using m-banking apps has confirmed to be an influential factor in strengthening trust, evolving loyalty, and creating positive WOM. Therefore, satisfaction with using m-banking applications can help customers increase trust in the bank, become more loyal to the bank and recommend the bank to others (Sampaio et al., 2017).

2.1. M-banking in Serbia

Mobile technology is developing rapidly in Serbia, so it is estimated that there is great potential for the development of mobile banking services because almost every client of the bank has a smartphone. Some researches indicate that less than half of the respondents had information about the offer of m-banking services of domestic banks (Hadžić & Mladenović, 2014). Soleša and Brkić (2019) state that the largest number of banks that provide mobile banking in Serbia offer the following types of services via mobile application: information about account balances and payment cards, information about loans and savings, (internal) transfer of funds, execution of exchange operations, locating branches, insight into the exchange rate list, review of statements, etc. Banks strive to improve and modernise their services, diversify them and make them attractive to customers.

Pavlović and Savić (2016) conducted a study in 2016, in which they analysed the impacts of security, financial cost, benefit and ease of use on the intention of customers in Serbia to use mobile banking services in the future. They also state that in previous researches, some authors have concluded that the main obstacle of adoption of mobile banking is related to the security issue. The authors of this study came to the conclusion that all variables they examined affect the usage intention of mobile banking. The most significant variable was the financial cost, but the least significant was the perceived benefit (Pavlović & Savić, 2016). In the study by Gašević et al. (2016) it was pointed out that the issue of data security is one of the biggest concerns for users in Serbia when it comes to electronic banking and it was shown that customers' satisfaction is most affected by security, ease of use and responsibility. When it comes to the Serbian market, trust in the entire banking system plays an important role, taking into account the previous bad experience with banks in transition countries (Lukić et al., 2019).

In a study conducted by Đorđević (2016) in south Serbia, it was concluded that bank clients who use mobile banking are mostly highly educated and that there is a strong correlation between the level of education of users and their use of mobile banking. In this research, it was shown that gender doesn't affect the use of m-banking.The results of research conducted by Ratković, Pavlović & Bajić (2017) showed that most of the respondents use the Internet and mobile banking, and they most often use this service to pay their bills. Most banks do not charge a commission for this service (payment of bills via the Internet and mobile banking). When it comes to the expectations that respondents have of mobile and Internet banking, most of them believe that these types of banking save time but consider that mobile and Internet banking should be safer and more secure. The research also showed that most of the respondents thought that the most important factor of using mobile banking was that they did not have to go to the bank. It turned out that the citizens of Serbia are familiar and ready to use the Internet and mobile banking in the future. Banks need to educate their employees so that they can help customers more easily adopt the use of the Internet and mobile banking. The young population in Serbia, which includes students, is more open to new technologies, but this does not guarantee that they will be satisfied with the current m-banking services (Lukić et al., 2019).

In Serbia, 23 out of 26 banks provide mobile banking services (Soleša & Brkić, 2019). Banca Intesa was the first bank to offer m-banking services on the Serbian market through the Intesa Mobi application (Radojević et al., 2016). According to the data published by National Bank of Serbia, at the end of 2019 the total number of clients who used mobile payments was 1 702 767, while the total number of open accounts was 8 696 114 (Narodna Banka Srbije, 2020), which means that 19.58% of clients used mobile banking services. Although mobile banking offers many advantages, only one-fifth of users who have open bank accounts use the services of m-banking, which is much less compared to the use of mobile banking in developed countries where this percentage averages 50-70% (Statista, 2020). Taking into account the rapid development of mobile technology in Serbia, it is estimated that there is great potential for the development of mobile banking services in our country (Todić & Dajić, 2018).

In this paper, three factors of mobile banking are observed: satisfaction, familiarity of respondents with mobile banking and trust and perceived risk. The research was conducted in order to determine whether gender or the way studies are funded affects the students' perception and opinion about the observed m-banking factors and whether banks differ in measured factors. It is important for banks to see in which fields they can be better when it comes to m-banking and to provide a personalised offer to different types of customers according to their preferences and needs in order to improve users' satisfaction. Educating clients about all possibilities of mobile banking is also one task for banks if they want to make their clients more satisfied and loyal.

3. RESEARCH RESULTS

3.1. Conducted survey

In order to provide answers to the raised questions, an online survey was designed and conducted. The survey accepted answers between 14th and 27th March 2020. The respondents were contacted through Facebook students' groups of different faculties of the University of Belgrade and on personal profiles of authors. After collection of the answers, SPSS 25 was used to perform statistical analysis. The survey consisted of the following sections: demographic characteristics, previous experience with banks and m-banking, attitudes towards risk of m-banking usage. The first section of the survey asked the respondents basic demographic information which included gender, age, place of residence, family income, personal income, and questions related to studies. The following section aimed at observing the satisfaction with the m-banking service. The next section had to goal to measure the level of trust in m-banking. Finally, we aimed to shed light on previous experience and WOM on m-banking.

3.2. Sample characteristics

After the survey was closed, we have collected 215 answers. More female students participated in the research, 164 (76.3%) compared to 51 (23.7%) male respondents. Such a gender disproportion could have been expected, having in mind that females are more open and interested to participate in online research (Smith, 2008). The average age of the respondents was 22.716, with a standard deviation of 1.983. The median age is 23, indicating that half of the respondents is on the last year of bachelor studies or above. Most of the respondents grew up in Belgrade (39.5%), followed by those who are from west Serbia (19.5%), central Serbia (13.0%), south Serbia (12,6%), and other regions. Most of the students are students of the fourth year of studies (34.0%), followed by those on the second and third year, 24.7% and 21.4%, respectfully. Most of the students are scholarship-funded (68.4%), while the rest are self-finance (31.6%).

When it comes to family income, most of the respondents said that their family income is above 100,000RSD (32.7%), followed by those with monthly income between 70,000 and 100,000RSD (21.9%). It should be noted that a large percentage of respondents did not want to answer this question, 16.7%. In this research, we wanted to obtain information on personal finance of the respondents. Therefore, we asked them whether they have personal sources of income. The largest per cent, 37.6% of the respondents, stated that they have no personal income. Almost a quarter of the respondents said they receive the national scholarship (23.5%), a fifth of them receives wage (20,1%), while 14.5% receives national study credit. Therefore, we can conclude that a large per cent of the respondents has some type of personal income.

3.3 Previous experience with banks and m-banking

The important question for further research analysis was whether the respondent has a bank account. From 215 respondents, 193 (89.8%) of them has an account. When it comes to the bank in which the students have their accounts, several banks stand out: UniCredit bank (45.6%), Telenor Bank (11.4%), Banca Intesa (9.3%), and OTP Bank (8.8%). Such a result could have been expected having in mind that the UniCredit bank is the official bank for disbursement of student scholarships and credits. Telenor Bank provides a very good online platform and a wide range of services when it comes to mobile banking. Banca Intesa is known for having a wide spectrum of services, especially regarding payments outside of Serbia. When it comes on the level of trust in the bank, on a scale from 1 to 5, it is 4.238, with the standard deviation of 0.800. This indicates that the students have trust in the banks in which they have their account, and the low standard deviation indicates that their opinions are coherent.

The next aspect that had to be more closely observed is whether students who have a bank account use m-banking. From 193 respondents with bank accounts, 158 (81.86%) of them uses m-banking platform. When it comes to the average amount of money transacted using m-banking, the largest number of respondents, 29.7%, said it is over 20,000 RSD, followed by 27.8% with transactions from 5,000-10,000 RSD. Having in mind that the respondents are students and that almost a third of them has transactions above 20,000 RSD, indicates that there is trust in the m-banking system.

Those who do not use m-banking stated that the main reason for such a decision is that they can easily do all their transactions in person and that there is no need for m-banking. Interestingly, seven respondents stated that they are not informed about the bank's service of m-banking. In the continuation of our study, we will place our focus on 158 respondents who have a bank account and use m-banking.

3.4. Students' opinion on m-banking service, trust and perceived risk, satisfaction and WOM

In our research, we decided to more closely explore three dimensions of students' opinion on m-banking: satisfaction with service, trust and perceived risk, and satisfaction with previous experience and WOM. Satisfaction with service was measured using five questions: *m-banking app is reliable, and it works without interruptions while I am using it, The m-banking app is easy and simple to use, m-banking allows me to execute transactions quickly, m-banking allows me to check my account balance at any time,* and *I am fully informed about the possibilities of the m-banking app* (Koštić, 2016). Next, to quantify trust and perceived risk we used the following five questions: *I trust in mobile technology and apps in general, m-banking is encrypted and safe to use, There is a possibility of fraud when using m-banking, There may be abuse by third parties,* and *Traditional banking is safer than m-banking* (International Finance Corporation, 2019) Finally, to observe satisfaction with the previous experience and WOM we used four questions: *m-banking provides all the banking services I need, m-banking fits into the lifestyle of students and youth, I am satisfied with m-banking services,* and *I would recommend m-banking to others* (Altobishi et al., 2018). All questions were measured on four-point and five-point Likert scales, whereas the answer "No answer " was coded 0.

Table 1: Descriptive statistics of the statements within three observed dimensions of m-banking service

Satisfaction with m-banking service		Trust and perceived risk		Satisfaction with the previous experience and WOM	
Question	Mean ± std	Question	Mean ± std	Question	Mean ± std
m-banking app is reliable and it works without interruptions while I am using it	3.516 ± 0.660	I trust in mobile technology and apps in general	3.399 ± 0.657	m-banking provides all the banking services I need	4.076 ± 1.056
m-banking app is easy and simple to use	3.703 ± 0.548	m-banking is encrypted and safe to use	3.381 ± 0.589	m-banking fits into the lifestyle of students and youth	4.595 ± 0.740
m-banking allows me to execute transactions quickly	3.759 ± 0.506	There is a possibility of fraud when using m-banking	2.506 ± 0.924	I am satisfied with m-banking services	4.538 ± 0.674
m-banking allows me to check my account balance at any time	3.873 ± 0.390	There may be abuse by third parties	2.727 ± 0.938	I would recommend m-banking to others	4.658 ± 0.694
I am fully informed about the possibilities of the m-banking app	3.052 ± 0.955	Traditional banking is safer than m-banking	2.090 ± 0.950		

The basic descriptive statistics per question per observed dimension is given in Table 1. When it comes to satisfaction with m-banking service, the highest average score of 3.873 is for question 4, which refers to the possibility to get insight into the account balance at any time. On the other hand, the lowest average score of 3.052 is for question 5, which referred to the familiarity of users with all the possibilities the application provides. This result indicates that the banks need to be more engaged in informing and educating student consumers about all the opportunities and services available to them through the m-banking application. Analysing the trust and perceived risk, students have a high level of trust in mobile technologies and apps in general and in the safety of using m-banking. The respected means for these two questions are 3.399 and 3.381. The students expressed disagreement with the statements that there is a possibility of fraud when using m-banking and that traditional banking is better than m-banking. Lower means for these questions indicate that student trust the m-banking and prefer it over traditional banking. Taking a closer look, the means for all the questions in the dimension satisfaction with the previous experience and WOM are above 4, on a scale from 1 to 5. This draws the conclusion that the students are very satisfied with m-banking and are highly prepared to recommend it to others. However, the question related to the satisfaction with services provided by m-banking has a slightly high standard deviation, indicating that the answers are not coherent.

Next, we wanted to observe whether male and female students have the same attitudes on the three observed dimensions of m-banking services. The two observed groups are unequal in size, but the Mann Whitney (MW) test provides stable results even in those cases (Lloyd, 2005). The statements for which a statistically significant difference was found are presented in Table 2. The results show that female respondents find the m-banking system more convenient and quick than male respondents. However, female respondents show slight distrust in technology and apps and believe that there is a possibility of fraud when using m-banking. Such a result could have been expected in a way as male respondents are more prone to accepting new banking and are more informed on it (Laukkanen & Pasanen, 2008).

Table 2: Mean and standard deviation per gender, Mann Whitney test statistics, and the direction of the observed difference

Question	Gender	Mean ± SD	MW test	Difference
m-banking allows me to execute transactions quickly	Male Female	3.341 ± 1.015 3.735 ± 0.593	-2.849**	Male < Female
I trust in mobile technology and apps in general	Male Female	3.561 ± 0.673 3.342 ± 0.645	-2.147*	Female < Male
There is a possibility of fraud when using m-banking	Male Female	2.317 ± 1.083 2.778 ± 0.974	-2.467*	Male < Female

Note: * p<0.05, ** p<0.01

We additionally wanted to see whether students whose studies are funded differently have the same attitudes on the three observed dimensions of m-banking services. Again, the MW test was used. Self-funded students believe that they are more informed on the possibilities than those who are state-funded. This could have been expected, as self-funded students have to pay the scholarship and other fees, and are believed to use the m-banking system more. The self-funded students have more trust in the mobile apps and m-banking and believe that there is a low risk of fraud. The state-funded students show less trust, but that could be explained by the fact that they are not completely informed about m-banking.

Table 3: Mean and standard deviation per type of finance, Mann Whitney test statistics, and the direction of the observed difference

Question	Type of funding	Mean ± SD	MW test	Difference
I am fully informed about the possibilities of the m-banking app	Self-funded State-funded	3.349 ± 0.997 2.835 ± 1.051	-2.849**	State-funded < Self-funded
I trust in mobile technology and apps in general	Self-funded State-funded	3.651 ± 0.572 3.304 ± 0.6646	-3.132*	State-funded < Self-funded
m-banking is encrypted and safe to use	Self-funded State-funded	3.395 ± 0.820 3.052 ± 1.091	-1.958*	State-funded < Self-funded
There is a possibility of fraud when using m-banking	Self-funded State-funded	1.674 ± 0.969 2.009 ± 1.104	-1.996*	Self-funded < State-funded

Next, we strived to compare the attitudes of students on m-banking based on the bank in which he/she has an account. As there were a lot of banks listed, we observed the UniCredit bank (74 respondents) and all other banks (84). The results are given in Table 4. The users of the UniCredit bank see the bank's app simple and easy to use, thus showing that the UniCredit's software solution is more user-friendly. However, the same respondents believe that they are not fully informed on all the possibilities of m-banking platform. The users of the UniCredit bank have more trust in the bank and its m-banking system but believe that it does not provide them with all the banking services they need.

Table 4: Mean and standard deviation per bank, Mann Whitney test statistics, and the direction of the observed difference

Question	Gender	Mean ± SD	MW test	Difference
m-banking app is easy and simple to use	UniCredit bank Other banks	3.730 ± 0.668 3.548 ± 0.798	-2.056*	Other banks < UniCredit bank
I am fully informed about the possibilities of the m-banking app	UniCredit bank Other banks	2.757 ± 1.096 3.167 ± 0.992	-2.563*	UniCredit bank < Other banks
There is a possibility of fraud when using m-banking	UniCredit bank Other banks	2.257 ± 1.021 2.607 ± 0.945	-2.182**	UniCredit bank < Other banks
m-banking provides all the banking services I need	UniCredit bank Other banks	3.784 ± 1.174 4.333 ± 0.868	-3.033*	UniCredit bank < Other banks

4. CONCLUSION

Based on the results of our research, we can conclude that students use mobile banking, and they are quite satisfied with the services. Insufficient information provided to students about the possibilities of mobile banking has proved to be a weakness of the current offer of mobile banking services in Serbia. It is believed that if

students were more informed about all the opportunities offered to them through m-banking, it would become even more popular among them, and they could adopt it in a higher percent. Most of the students have an open account in UniCredit bank but UniCredit bank, compared to other banks, has a lower level of student satisfaction in terms of their familiarity with m-banking. Therefore, Unicredit bank should provide more information to students about m-banking in order to increase their satisfaction and keep them as its future customers. Also, UniCredit bank should increase the number of services available through the m-banking app to make students more satisfied in future. Students who use UniCredit's banking services believe that there is less possibility of fraud when using mobile banking, which means that there is a satisfactory level of trust in the m-banking app. Also, it is recommended that UniCredit bank should work on informing and educating students about the possibilities of m-banking and supply more banking services to be available through m-banking in order to increase the general students' satisfaction and usage of m-banking services.

During our research and literature review, we could identify two possible future directions of the study. The first direction could be towards analysing churn among students using m-banking using data mining techniques such as in the work of Keramati et al. (2016). Another possible future study could be towards devising a conceptual model on the usage of m-banking and factors which impact the decision. The conceptual model could be verified using structural equation modelling, such as in the research of Alalwan et al. (2016).

We believe our research could provide additional insights on the level of students' satisfaction with m-banking, their perceived level of trust in it, but also on the issues related to m-banking that the banks in Serbia could tackle so as to increase the usage of m-banking services.

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MODELLING ENTREPRENEURIAL INTENTIONS AMONG STUDENTS IN SERBIA: A SEM APPROACH

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Abstract: *Newly created businesses foster economic growth and development. Accordingly, they present an object of increasing research interest. This paper proposes a conceptual model which aims to examine the factors which impact entrepreneurial intentions among university population in Serbia. To analyse the influence of desirability and feasibility on the entrepreneurial intention, we conducted Structural equation modelling (SEM) analysis. The obtained results proved that both factors have a positive statistically significant impact on students' entrepreneurial intention. Additionally, we confirmed that the higher students' entrepreneurial intention leads to a decision to pursue an entrepreneurial career after academic's studies. We believe that the model proposed herein can be of value for policymakers and educators by providing additional insights into the factors which impact the students' entrepreneurial intention and initiate further research on the topic.*

Keywords*: Entrepreneurial intention, Student population, Structural equation modelling, Entrepreneurial event model*

1. INTRODUCTION

Entrepreneurship can be defined as a purposeful action with a goal to establish and develop a profitable business (Dollinger & Lombard, 2008). Even in this elementary level of defining entrepreneurship, one can conclude that when starting a new business, an individual must first take the entrepreneurial initiative. Initiative means that an individual or team, having been brought to the state of readiness, begins to act (Dollinger & Lombard, 2008). Therefore, it is the first step in performing an action. Before the initiative, the individual expresses an entrepreneurial intention, which means that he or she has a desire or makes a plan to undertake an entrepreneurial activity. The underlying problem consists of determining a list of factors that have an impact on the level of entrepreneurial intention.

Regarding the considerable influence that the university education makes on a students' career choice, universities have the potential to shape future entrepreneurs (Gelard & Saleh, 2011). Péreznieto and Harding (2013) believe that every country must be aware of the fact that by investing in young people it actually invests in the future of the whole society. Promoting innovative talents and initiating the entrepreneurial mindset is one possible option for improving involvement of young people in the economic progress. Achieving this objective is partially the role of universities as drivers of entrepreneurship (Jabeen et al., 2017). According to that, some researchers argue that students are the most valuable source of future entrepreneurial business (Veciana et al., 2005), and hence this study strived to identify antecedents of the entrepreneurial intention of students in Serbia.

On the issue of starting a business among students in Serbia, some previous studies showed that students have rather positive attitudes towards the profession of entrepreneurs. Nevertheless, they have negative grades for the entrepreneurial climate in Serbia. According to that, the author claimed that the results indicated the need for a different education model that would help young people develop an entrepreneurial mindset (Melovic, 2013). Research conducted at the Faculty of Economics, University of Novi Sad showed that there is a statistically significant relationship between some personality characteristics and entrepreneurial intention of students. In the same study, gender and study orientation are proven to be significant factors in shaping the intention (Bjekic & Strugar Jelaca, 2019). In a comparative study in Serbia, Bosnia and Herzegovina and Croatia by Petkovic et al. (2018), the authors discovered that in Serbia, the impact of society and national culture is not supportive for entrepreneurship, or for a managerial avocation as well. Having in mind that there are high youth unemployment rates in Southeast Europe, including Serbia, this research is of significant interest since its final objective is stimulation of entrepreneurial activity.

Understanding these determinants allows professors and policymakers to gain a more detailed insight into the impact of judgements, viewpoints, and inspiration on the plan to become an entrepreneur (W. Wang et al., 2011). As a result, university programs focused on the field of entrepreneurship can be designed and conducted in a way that would increase the probability of their participants consequently starting a new business (W. Wang et al., 2011). Understanding the perception of today's youth can be an essential step to designing a more effective policy mechanism as well (Turker & Selcuk, 2009). Therefore, this study may have practical implications not only for educators but also for policymakers.

Next section, Literature review, discusses conceptual entrepreneurial intention models proposed in the previous studies. Section 3 presents the conceptual model used in this paper, posed hypotheses and the conducted survey on the entrepreneurial intentions among student population in Serbia. The following section provides the results of the survey and evaluates the hypotheses. Lastly, we analyse the findings and conclude the paper.

2. LITERATURE REVIEW

Based on the research of Mazzarol et al. (1999), the models of entrepreneurial intention can be classified into two core categories. The first one focuses on the entrepreneur and his personal characteristics, personality traits and human capital. Models belonging to this group are based on the premise that individuals that have a greater entrepreneurial human capital (which can be defined as the gender, age, skills, experience, education) express a higher intention to start their business venture. On the other hand, the second group focuses on the external factors, such as environment, culture, political and economic system. Authors proposing these models assume that starting a new business requires a lot of external resources, that can be found in the environment. The environment can metaphorically be presented as a pool of resources where every change in the pool leads to both qualitative and quantitative changes in the business venture, which consequently leads to changes in the entrepreneurial intention (Ngoc Khuong & Huu An, 2016).

Bird (1988) observes that the anticipation of entrepreneurial intention requires an examination of both groups of variables – personal traits and the environment. For instance, people with similar characteristics may behave differently when located in different environments, while some individuals with widely different personal traits may react in the same way if they belong to similar environments. As a result, the anticipation that relies only on personal or environmental factors would not be methodologically correct and hence can lead to the misleading conclusion (Fitzsimmons et al., 2011). In accordance with this view, Luhtje and Franke (2003) posit that entrepreneurial intention depends on personal characteristics and environmental factors. The authors assume that tendency to take risk and internal locus of control, as two main personality traits, might be linked with the attitude towards self-employment which is influenced by two context-dependent factors – perceived obstacles and support.

The next group of models that are widely used in this research field respect the above-mentioned statement which emphasises the importance of both groups of variables and their focus is on the intention-based model. Two widely accepted intention-based models are Shapero and Sokol's Entrepreneurial intention model and Ajzen's Theory of planned behaviour (Ngoc Khuong & Huu An, 2016). Shapero's model which relies on the Entrepreneurial event theory is founded on the fact that human behaviour is directed by inertia, meaning that an individual continues to act in the same way until he or she is interrupted by force outside itself (Krueger et al., 2000), called the trigger event or displacement event. According to this theory, external factors make an indirect influence on the intention. An entrepreneurial intention comes from two main aspects – perceived desirability and perceived feasibility with the reinforcement by a propensity to act upon opportunities (Ngoc Khuong & Huu An, 2016). Perceived desirability is defined as "the personal attractiveness of starting a business, including both intrapersonal and extrapersonal factors" (Shapero & Sokol, 1982).The perceived feasibility is specified as "the degree to which an individual believes in his or her capability of starting an entrepreneurial venture" (Shapero& Sokol, 1982). The same authors conceptualised propensity to act as the willingness to achieve control by taking an initiative, including voluntary aspects of an aim. Ajzen, in his Theory of planned behaviour, assumes that almost every behaviour is planned. Therefore, the decision to perform an action antecedes the behaviour. The specificity of this model is the inclusion of social factors since the majority of other models focuses only on personal factors. According to Ajzen (2012) the critical determinants of a behavioural intention are "personal attitude towards the outcomes of the behaviour, perceived social norms, and perceived behavioural control (self-efficacy)".The attitude toward performing the behaviour can be defined as "the perception or the judgment of an individual of performing a particular behaviour, the expected results and the impact of the outcome in many aspects, such as quality of life, independence, stress and personal wealth" (Shapero & Sokol, 1982). Perceived social norms or subjective norms include beliefs, norms and value systems held by other people who have a considerable

influence on an individual or whom they strongly admire (Ngoc Khuong & Huu An, 2016). The most significant social influence comes from a role model or a mentor - such as close friends or relatives (Shapero & Sokol, 1982). The third component, perceived behavioural control, reflects an individual's belief about the extent to which he or she is capable of conducting the planned behaviour.

Research conducted by Turker and Selcuk focused on the analysis of internal factors (such as inspiration and positive self-image) and external factors (support from others, educational attainment) and their influence on entrepreneurial readiness among the student population. In later studies, Turker proposed a modified model, which includes:

- Entrepreneurial education involves a set of competences and knowledge in the field of entrepreneurship acquired at the university. As reported by Garavan and O'Cinneide (1994), the lack of unanimity of the definition of entrepreneurship results in a diversity of entrepreneurial education programs. Wang and Wong (2004) showed that many business ideas of students are inhibited by inappropriate educational support.
- Structural support, includes broader political, social, economic and cultural context, accenting the influence of the political and economic system. For instance, the existence of entry barriers to an industry, which is recognised as a threat leads to people showing a lower tendency for entrepreneurship (Turker & Selcuk, 2009).
- Societal background was commonly included in the previous studies. Some authors claim that family context makes the strongest influence on an individuals' choice of profession right after personal characteristics (Henderson & Robertson, 2000). Financial and emotional support of friends and family can increase the possibility to start a new business.

Iakovleva and Kolvereid proposed a conceptual model of entrepreneurial intentions, which would consolidate the Theory of planned behaviour and Entrepreneurial event theory. They suggested that desirability and feasibility are a "function of attitudes, social norms, and perceived behavioural control, and that the intention depends on desirability and feasibility" (Iakovleva & Kolvereid, 2009).

Having gone through the existing literature, one can conclude that there are numerous publications about this topic and bibliometrics of these publications as well. For instance, Dolhey (2019) in his quantitative analysis claimed that the most important journal for this theme is *International Journal of Entrepreneurship and Small Business*; additionally, University of Sevilla is considered to be the most eminent institution in the same paper. Liñán and Fayolle (2015) identified five principal lines of specialisation in this research field that are equally important "core entrepreneurial intention model, personal-level variables, entrepreneurship education, context and institutions, and entrepreneurial process". They have also stated that there is potential for further studies and an in-depth comprehension of the decision-making.

3. METHODOLOGY

3.1 Conceptual model

A model upon which this research lies is based on the Entrepreneurial event model with a modification, regarding the view of Krueger et al. (2000) who sees entrepreneurial model primarily dependent on perceived feasibility and perceived desirability. Accordingly, this study is aligned with a predominant view that the entrepreneurial intention can be explained as a function of perceived desirability and feasibility. Subjective norms are also included in a model as a factor influencing both desirability and feasibility, as suggested in the Integrated model by Iakovleva and Kolvereid (2009). Using the intention as a sole determinant of the behaviour is scientifically verified by Ajzen (1991). The model which we herein propose is given in Figure 1.

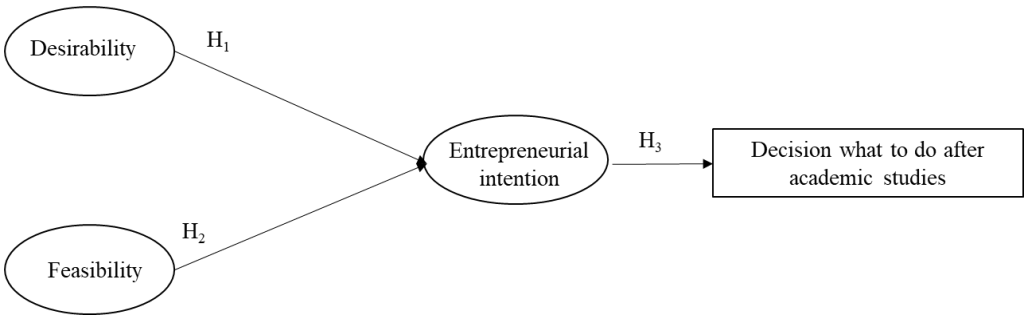

Figure 1: Proposed conceptual model of students' population entrepreneurial intention

Based on the literature and the results of previous studies, the proposed model lies on the following research hypotheses:

H1: Perceived desirability influences entrepreneurial intention.

The findings of the study of Dissanayake (2018) suggested that there is an impact of perceived desirability on entrepreneurial intention. Results from previous empirical studies have confirmed that perceived desirability is one of the main factors explaining entrepreneurial intentions (do Paço et al., 2011). This hypothesis has been tested and confirmed by Rajh et al. (2018), who examined the entrepreneurial intentions of students from four South-East European countries.

H2: Perceived feasibility influences entrepreneurial intention.

Previous studies showed that that perceived feasibility is significantly and positively related to social entrepreneurial intention. In the research conducted in Spain and Porto Rico by Veciana et al. (2005), students' perceptions of feasibility were negative and their entrepreneurial intentions were very low. As Dissanayake (2018) concluded in his study, under the perceived feasibility, the resources and opportunities available to an individual must, to some degree, dictate the possibility of behavioural achievement.

H3: Entrepreneurial intention influences entrepreneurial behaviour.

Generally, "the stronger the intention to engage in a behaviour, the more likely it should be its performance" (Ajzen, 1991). It is important to mention that intention towards behaviour can be reflected in behaviour only if an individual can independently decide whether to perform an action or not, meaning that the person can actually control his/her comportment (Ajzen, 1991).

3.2 Data analysis

In order to validate the devised model and to test the research hypothesis, we used the structural equation modelling (SEM) analysis. SEM analysis is a statistical multivariate analysis which encompasses the basis of factor analysis and regression analysis (Kline, 2005; Ullman & Bentler, 2003). The analysis is, therefore two-directional. First, it has the possibility of reducing the dimensionality of the observed phenomenon, while secondly, it allows the inspection of the relationship between the formed constructs. Having in mind the mutual advantages of the SEM analysis, this analysis is nowadays a commonly used statistical approach for validation and verification of conceptual models (Asparouhov & Muthén, 2009; Browne & Cudeck, 1993).

Based on the conducted literature review, we noticed that the SEM analysis had been previously used to test conceptual models based on students' attitude towards entrepreneurship. Chen and Lai (2010) analysed how personality traits and environmental cognition impact the attitude towards entrepreneurship among Taiwanese student population. Molaei et al. (2014) surveyed students in Teheran and measured how their entrepreneurial ideas and cognitive style impact entrepreneurial intention. Solesvik et al. (2012) created a conceptual model which encompasses constructs such as perceived desirability, entrepreneurial parents, age, and intention to become an entrepreneur. Led by these examples, we were encouraged to apply the SEM analysis.

4. RESULTS

4.1 Conducted survey

We collected the data using a questionnaire made as a combination of questions scientifically verified by different authors. Students responded to five sets of questions. Questions used in this study were previously implemented in several studies listed below.

The first set of questions is composed of general information about participants: their gender, age, residence, faculty, year of study, information about entrepreneurs in their close environment, plans what to do after university, and past work experience.

The second set of questions includes questions used for defining perceived desirability. It required from the respondents to indicate their level of agreement with the following sentences from 1 (total disagreement) to 4 (total agreement): *"Being an entrepreneur implies more advantages than disadvantages to me", "A career as entrepreneur is attractive to me",* and "*If I had the opportunity and resources, I would like to start a firm".* Another question in the same set refers to the perceived importance of listed motivational factors, including

following items: *"Opportunity to earn higher salary", "Work in dynamic and challenging environment",* and "*Creativity".* These questions have been previously used by Barba-Sánchez & Atienza-Sahuquillo (2012).

When it comes to perceived feasibility, students had to define to what extent they agreed with the following statements regarding their entrepreneurial capacity: "*To start a firm and keep it working would be easy for me", "I know the necessary practical details to start a firm",* and *"If I tried to start a firm, I would have a probability of succeeding", "I could successfully deal with potential problems and challenges as entrepreneur".*Additional questions in this section were: *"I am creative and full of ideas", "I have desire for challenges", and "I do not get discouraged when I fail".* These questions have been used by Liñán et al. (2015).

To measure entrepreneurial intention, we used the following statements: "*I am ready to do anything to be an entrepreneur", "I am determined to create a firm in the future",* and "*I have very seriously thought of starting a firm".* This set of questions was previously used by Liñán et al. (2015) as well.

The last question aimed to identify the entrepreneurial behaviour, based on student's decision on what to do after finishing current level of studies – starting a business, continuing with education, or become employed in a company. One must notice that their decision is not completely equal to the actual behaviour; therefore, we believe it can be considered as an approximation of performing an action. This question was a part of the survey conducted by Liñán et al. (2015).

4.2 Sample characteristics

An online survey about entrepreneurial intentions among students in Serbia was conducted between April and May 2020. The survey was completed by 315 students from faculties of the University of Belgrade, Serbia. The sampling technique that has been used is a self-administered questionnaire.

A vast majority of respondents were female, 70.5% of the sample. Such a result could have been expected having in mind that there are more female students enrolled at the University of Belgrade (University of Belgrade, 2020). The mean age of the respondents is 22.407, with the standard deviation of 2.267. Most of the respondents come from Belgrade (42.5%), followed by those from large towns in Serbia (32.4%). Taking a closer look on the study year, most of the respondents is on fourth (last) year of studies, 25.2%, followed by those who are on the second year (22.9%), first year (18.5%), third year (16.6%), while the rest are on masters or PhD studies. The distribution of respondents between years of study is balanced. The student who participated in the survey are mostly from Faculty of Organizational Sciences (33.3%) and Faculty of Philology (24.1%), while the rest are from the remaining faculties of the University of Belgrade.

Besides providing descriptive information of the respondents' characteristics, we present the respondents' previous contact and opinion on entrepreneurship. More than half of the respondents (58.6%) come from the environment where at least one close relative or friend has already gone in entrepreneurship. Most of the respondents, 31.2%, stated that they have some work experience (not full time and not practice), while 20.4% has done some work in practice. Interestingly, 11 respondents (3.5%) said that they had started their own job previously. Results show that more than half of the respondents (50.7%) consider initial capital to be the most significant barrier when staring an own business, followed by lack of perspective (18.7%) and lack of information (18.7%). Regulation is believed to be the critical problem for 7.3% respondents, while the rest of the participants (4.8%) mention other barriers, such as corruption and lack of education. It is interesting to compare these results with findings of Omerbegovic-Bjelovic et al. (2016), where young entrepreneurs stated that the most significant reason for their discontent were lack of support, followed by lack of capability and low profit. Exactly half of the respondents plans to get a job in a company after finishing faculty, 21.6% plans to continue specialisation, while 16.9% intends to become an entrepreneur. The rest have other plans which they did not specify.

Crosstabulation test was performed to explore the relation between gender and perception of entrepreneurial barriers. The relation between these variables was not significant, χ^2 (4, N = 314) = 8.788, p = 0.067, which is in contrast with the finding of Shinnar et al. (2012) that indicates significant gender differences in barriers perceptions. We additionally explored the relation between the previous contact with entrepreneurship and future plans after finishing the academic studies. Again, there was no significant relation between the two variables, χ^2 (3, N = 314) = 3.750, p = 0.029, which accords with the findings of Rakicevic et al. (2014), who pointed out that the difference could be seen only in perceived ability. Also, gender proved to have no statistically significant impact on future plans after finishing the academic studies (χ^2 (3, N = 314) = 5.544, p = 0.136).

4.3 Verification of the conceptual model

Before conducting the SEM analysis, the literature suggests inspecting the internal consistency of the proposed latent constructs using Cronbach's alpha (Cronbach, 1951). This metric measures the level up to which the measured variables within a construct measure the same phenomenon. The Cronbach's alpha is measured on a scale from 0 to 1, while the acceptable levels are between 0.70 and 0.95 (Tavakol & Dennick, 2011).

The first construct *Desirability,* consists of six variables, has the Cronbach's alpha 0.696. The next construct, *Feasibility*, consists of seven variables, has the Cronbach's alpha 0.668. The construct *Entrepreneurial intention* consists of three variables and has the highest internal consistency of 0.880. The obtained metrics of internal consistency for the first two constructs are marginally acceptable. Therefore, we continue with the analysis.

The initial model did not fit to the data (Chi-square=373.431, df=117, p<0.000, RMSEA=0.084, CFI=0.845, TLI=0.820). To improve the model fit, paths which were not statistically significant were removed. One variable was removed – communication skills. Additionally, we used modification indices to fine-tune our model. A detailed analysis of the final model is given in Table 1. The chosen absolute fit indices, chi-square and the goodness-of-fit index (GFI) are above the thresholds, as well as two comparative indexes, Comparative Fit Index (CFI) and Tucker–Lewis index (TLI). The root-mean-square-error-of-approximation (RMSEA) is on the threshold value. Therefore, we can say that the devised conceptual model is acceptable and that the data have a good fit to the model.

Table 1: Cutoff criteria for several fit indices (based on Hsu (2013)), the index values of the final model, and model fit

Index	***General rule for acceptable fit***	***Value***	***Model fit***
χ^2	*The smaller the better*	*177.608, df=96*	
GFI	*>0.9*	*0.939*	*Yes*
RMSEA	*<0.05*	*0.052*	*Yes*
CFI	*>0.9*	*0.949*	*Yes*
TLI	*>0.9*	*0.937*	*Yes*

The construct *Entrepreneurial intention* has two predictors, *Desirability* and *Feasibility.* The obtained standardised regression coefficients are 0.585 and 0.386, respectfully. Both coefficients are positive and medium strength. The obtained coefficients indicate that the more the student believes in the feasibility and the more he/she is attracted to the idea of becoming an entrepreneur, the higher will his/her intention to become an entrepreneur be. The coefficient of determination for this model is 0.743, indicating that two predictors explain 74.3% of the variability of *Entrepreneurial intention.*

We also wanted to see whether *Entrepreneurial intention* has a statistically significant impact on the respondents' plans after completing academic studies. The result indicates that *Entrepreneurial intention* has a negative statistically significant impact, -0.165. The negative coefficient can be explained by the coding of the outcome variable. Namely, 1 was coded as starting entrepreneurship, while other options were get a job in a company, continuing education, and other. Therefore, the negative coefficient indicates that the higher *Entrepreneurial intention,* the more the student is thinking towards starting entrepreneurship. The obtained R square for this model is low, just 2.7%, indicating there are other factors which impact the students' plans after completing academic studies.

5. DISCUSSION AND CONCLUSION

Predicting entrepreneurial activities is becoming essential since entrepreneurship is a critical component of economic progress, innovativeness and unemployment reduction. As Lüthje and Franke (2003) posit, aspects such as the globalisation and reconfiguration of major corporations force individuals to consider entrepreneurship as a suitable option instead of employment. "Since today's youth are the possible future business owners, better comprehension of their impressions and opinions can help in expansion of the body of knowledge which could consequently lead to the improvement of existing policy tools (Turker & Selcuk, 2009).

This study tried to provide clarification on the issue of different factors having an impact on the decision to become an entrepreneur. Our results show that the perceived feasibility and desirability have a significant impact on the entrepreneurial intention of students in Serbia, which accords with previous studies conducted by do Paço et al. (2011) and Barba-Sánchez et al. (2012). When it comes to entrepreneurial intention as a predictor of behaviour, the significant association is confirmed as well; however, it cannot be responsible for a highly considerable proportion of variance in behaviour, which differs to results of Ajzen (1991). It could be

explained with the fact that a question used to determine future behaviour *("Decision what to do after finishing academic studies*") is in fact only an approximation of performance, meaning that it is not equivalent to actual behaviour that will be performed in the future. Our findings also indicate that there is no significant difference between genders in their perception of entrepreneurial barriers, which is not in in line with the results of Shinnar et al.(2012), who, however, claim that the gap is not consistent across cultures.

The preliminary findings allow both universities and policymakers to identify determining factors of entrepreneurial intentions among students. As a result, they should aim to strengthen the entrepreneurial mindset through adopting entrepreneurial culture into the education system, helping students` entrepreneurial initiatives at early stages and creating awareness of entrepreneurship in the society.

Several issues could be tackled in future studies. First is the sample. Namely, the survey was conducted on one Serbian university, University of Belgrade. To obtain a bigger picture, it would be of interest to repeat the survey at the University of Novi Sad or University of Niš. Also, covering more Universities will enable us to compare the obtained results.Furthermore, it seems relevant to include a comparison between private and public universities so as to determine whether the university environment influences entrepreneurial intentions.Another possible direction of future related studies could be the inclusion of other constructs in the model such as: perceived social support, perceived skill and talent, entrepreneurial education, and others. Considering the fact that there are significant differences between students regarding their country of origin as reported by Subotic et al. (2018), future studies could include a comparison between students from Serbia and neighboring countries, such as Montenegro or Bosnia and Herzegovina.

In the days of economic recession, many individuals will consider starting their own business and it is of high importance for both policymakers and educators to better understand how to communicate with them; complete development of entrepreneurship implies a strong need for improved structural support in Serbia (Petkovic et al., 2018). We hope that the presented model will motivate researchers to continue discovering the factors which impact the students' decision to engage in entrepreneurship, and by doing so, increase the effectiveness of specific initiatives aimed at promoting entrepreneurship.

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EFFECTS OF DATA PREPROCESSING FOR FAIRNESS IN MACHINE LEARNING

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Abstract: *When creating a machine learning model today, fairness represents a big concern. This paper takes into consideration two groups of fairness, individual and group, as well as the impact of their increase on the reduction of model accuracy. We have decided to focus on data preprocessing techniques to provide fair data based on which the model would make a fair decision. Two techniques were used, one that assigns weights to observations in the data at hand based on their possible effect on fairness, and another that adjusts the data at hand in such a manner that unfairness is removed. To measure and compare the difference in predictive model performance and predictive model fairness before and after applying data preprocessing techniques two data sets were used, Adult and Compas. We have shown that group fairness increased each time after both fairness improvement techniques were applied, while individual fairness both increased and decreased. Additionally, predictive performance decreased, but not significantly. More specifically, predictive model accuracy reduced up to 3%, but the disparate impact has improved significantly.*

Keywords*: Machine learning, Algorithm Fairness, Data Preprocessing, Individual Fairness, Group Fairness*

1. INTRODUCTION

Machine learning models are used daily, from business use cases where descriptive and predictive models are used for campaigns or churn prediction, up to more sensitive use cases such as medicine where the goal is to predict mortality of a patient. Every time the goal is to support decision-making, i.e. making the process faster, more accurate and less expensive. However, with the development of data privacy issues and regulations, there is a growing issue for machine learning models about systematic errors regarding certain subgroups of people. Namely, machine learning models have already shown examples of unwanted discrimination based on gender, race, or religion in various domains of applications (Barocas & Selbst, 2016).

Although the goal of the machine learning models can be discrimination, for example for classification tasks, where one creates a model that performs statistical discrimination regarding the output attribute (or label attribute) having available input attributes. For example, one tries to find patterns in data that explain why a client leaves a company (churn) or why a client takes another product (cross-sell). However, if unwanted bias exists in data at hand, the machine learning model will inherit unwanted bias and most probably amplify it (Veale & Binns, 2017). Therefore, machine learning models can lead to unethical decisions that can be subject to legal consequences (Wigan & Clarke, 2013).

This problem is challenging from both ethical points of view and a mathematical point of view. Namely, unwanted discrimination is often regarded as the fairness of the decision-making process (Schweitzer & Gibson, 2008) which is dependent on the context of the problem, as well as from the consequences of the decision. From a mathematical point of view, one would like to have a strict definition of fairness that can be easily incorporated in the model learning process (Corbett-Davies et al., 2017). Additional problems arose from the source of unfairness. Namely, most of the unfairness of the decision-making process occurs accidentally or without the knowledge of the decision-maker (Barocas & Selbst, 2016). One can find this defined as disparate impact. More specifically, disparate impact occurs when the decision-making process is based on a context (i.e. input attributes) needed for decision-making but results in an unfair decision or disproportional impact on specific subgroups of people. For example, females receive fewer incentives compared to men. Another common definition of fairness is disparate treatment. Disparate treatment is a situation where discrimination of certain subgroups is intentional, i.e. in the hiring process, provided admission test contains questions only certain people had education for (Furnish, 1981). Both unintended and intended unfairness in decision-making if given to a machine learning algorithm will result in an unfair model. Therefore, one needs to account for possible bias in data at hand and try to prevent unfair decisions.

In this paper, we have decided to focus on data preprocessing techniques for fairness. Namely, unfairness-in unfairness-out principles have already been shown in the literature and by modifying the data one can provide fair data to the algorithm which will hopefully lead to a fair decision. However, fairness has a cost. It is often associated that better values of fairness goal function lead to lower values of the accuracy of the model. Therefore, we set the goal of the paper as measuring the effect of the data preprocessing techniques for fairness on several well-known machine learning algorithms and measuring both fairness and accuracy of the model. The experiments are conducted on the two common datasets which are known to be unfair toward certain subgroups, one of them being Compas dataset (Larson et al., 2016) where Afro-Americans are discriminated, and Adult dataset (Kohavi, 1996) where females are discriminated. The results suggest that one can achieve greater fairness without sacrificing the predictive accuracy of the model by much.

The paper is structured as follows. In Section 2 we define fairness and literature review. Then, in Section 3 we provide a methodology of our approach, followed by an experimental setup. In Section 4 we provide results and discussion, while Section 5 concludes the paper.

2. RELATED WORK

A literature review consists of two parts. The first part will mathematically describe fairness, while the second part will relate to unfairness mitigation in machine learning.

2.1. Fairness in Machine Learning

In the literature, one can find two categories of fairness in machine learning. Those are group fairness and individual fairness (Kleinberg et al., 2018). Group unfairness is defined as systematic discrimination in decision-making based on a sensitive attribute (i.e. race or gender). Since groups have multiple individuals, the effects of the decision are calculated for the group using the average values of the output. On the other hand, one individual can be discriminated against if the same values of the input attributes receive different results (impact or treatment). This is called individual fairness.

If we have label attribute y and sensitive attribute s then we can define disparate impact (Zafar et al, 2015). Disparate impact is regarded as unintentional discrimination of the decision-making process that can be observed by looking at the sensitive attribute. The mathematical formulation is given in equation (1):

$$p(y = 1|s = 1) = p(y = 1|s = 0) \tag{1}$$

This can be interpreted that the discriminated group $(s = 1)$ and privileged group $(s = 0)$ should have approximately the same probability of the label attribute y. Therefore, one can calculate the disparate impact for the data at hand and observe if a disparate impact exists. This can be used to check if the data collection process is flawed, and favors a certain subgroup. To check the predictive model one can use the predicted value of label attribute $\hat{y}$. Mathematically, (2):

$$p(\hat{y}|s = 1) - p(\hat{y}|s = 0) \tag{2}$$

However, a more common definition of disparate impact is in relative terms instead of absolute, using (3):

$$DI = \frac{p(\hat{y}|s = 1)}{p(\hat{y}|s = 0)} \tag{3}$$

Using U.S. Equal Employment Opportunity Commission “80%-rule” (Biddle, 2006) this value should be between 0.8 and 1.2.

Other measures of group fairness are used in practice, such as equality of opportunity (Hardt et al., 2016) that states that every individual no matter if in a sensitive group or not should have an equal chance of getting a desirable outcome. Group fairness gained a lot of interest due to racial and gender discrimination across the world. More specifically, disparate treatment and disparate impact made by decision-makers led to flawed data collection processes where a privileged group gain more benefits. (Dwork & Ilvento, 2018)

However, being fair on the group level does not ensure fairness on the individual level. Individual fairness by definition requires that similar individuals must result in a similar decision (Sharifi-Malvajerdi et al., 2019). Formally, if one defines distance metric $d(\cdot,\cdot)$ and i and j are similar instances under distance metric ($d(i,j)$ is small) then their predictions are similar, i.e. $\hat{y}_i|X_i, s_i \approx \hat{y}_j|X_j, s_j$. Common measure of individual fairness is *consistency* (Zemel et al., 2013). Consistency is calculated using (4):

$$C = \frac{1}{n * neighbours} \sum_{i=1}^{n} \left| \hat{y}_i - \sum_{j \in N_{neighbours}(x_i)} \hat{y}_j \right| \quad (4)$$

where n present number of instances, $neighbors$ parameter representing a number of neighbors. More specifically, prediction obtained from the model needs to be as similar to predictions that are given to the most similar instances. One can interpret consistency as the likelihood of the predictive model or, more specifically, the variance of the predictive model. If small changes in the input attribute result in the changes in predictions then one can conclude that variance in the predictions exists and that model will most probably overfit.

If data is flawed, two possible scenarios can occur. First, both privileged and unprivileged groups have similar input attributes, but the model gets different results for them. In this case, both disparate impact and consistency will show that unwanted discrimination is present. This seldom happens for machine learning models, since patterns are learned from data. Therefore, similar inputs will lead to a similar output. Other, more likely, the scenario is that there are differences in the input attributes between privileged and discriminated groups based on which predictive algorithm manages to make statistical discrimination for the output attribute and thus create unwanted discrimination. From the individual fairness point of view, the predictive model will be fair, since similar input will lead to a similar output. However, from a group fairness point of view, the predictive model will be unfair. Having this in mind, individual and group fairness, if input data is flawed between groups, have opposing goals. Higher satisfaction of one notion of fairness will lead to lower satisfaction of other notions of fairness.

2.2. Unfairness Mitigation techniques

Intuitively, one would like to achieve the best possible model without unwanted discrimination. The first approach that was tested was *fairness through unawareness* (Chen et al., 2019). This approach assumes that an algorithm will be fair as long as sensitive attribute s is not used for model learning and in decision-making. Despite its simplicity, fairness through unawareness there may be proxy attributes which identify sensitive attribute and this makes predictive model unfair. For example, by knowing the place of living, one can derive the race of the individual. Therefore, this approach has been criticized.

Having above mentioned in mind, *fairness through awareness* is a way needed to achieve fairness in the machine learning model. Three approaches can be found in the literature to achieve fair machine learning models: 1) Pre-processing techniques, 2) In-processing techniques, and 3) Post-processing techniques.

In pre-processing techniques, one tries to reduce or completely remove the source of discrimination in the original dataset. The simplest approach is to remove attributes that correlate with the sensitive attributes above some threshold. Removing attributes that are correlated to sensitive attributes seems like a good solution. However, this may lead to removing attributes that explain the output attribute thus hinder predictive performance. Additionally, attribute interaction and subspaces that create unwanted discrimination are left unseen due to linear dependency that is observed through correlation. This approach has been tested and the results did manage to improve fairness, with a cost to predictive accuracy (Kamiran & Calders, 2012). One can use mutual information on the part of the input space (Kamiran & Calders, 2012) to solve the identified issue. Another common preprocessing technique is to *massage the label attribute*, i.e. change values of the output attribute that can “cause” unfairness to occur (Kamiran & Calders, 2009). Massaging the output attribute is considered as an intrusive approach, which changes data distribution toward fair models but at a cost of data accuracy, and consequently less accurate predictive model. Also, one can assign a weight to each instance in the learning process that will increase the importance of a sensitive group and thus making the decision-making model fairer (Glauner et al., 2018). Assigning weights to the instances is not intrusive, does not change the data distribution but gives a signal to the learning algorithm to give more importance to the discrimination.

Another approach is to change the learning algorithm to be aware of the possible discrimination, thus simultaneously maximize predictive performance and minimize unfairness in the process of predictive model learning. These techniques are called in-processing techniques. The most common approach is regularization. This approach adds another term to the objective function (loss function) which accounts for fairness. One such approach is *Prejudice removal* that uses a true value of label attribute y and sensitive attribute s and adds regularization term (5):

$$\sum_{(x_i, s_i \in \mathcal{D})} \sum_{y \in \{0,1\}} p(y|x_i, s_i; \theta) \ln \frac{p(y|s_i)}{p(y)} \quad (5)$$

where x present instances whose corresponding sensitive attribute is equal to s, and $\hat{y}$ is predicted value of y obtained based on values of input attributes X, sensitive attribute s, and associated weights of the attributes θ. The first part of the function calculates the probability that an instance will be y that is used as the intensity of measure of discrimination (right part of the function). This regularization function is formulated to solve for the equality of opportunity fairness measure. However, the resulting model can be unfair since additional hyper-parameter must be learned for satisfactory fairness. Another approach can be found in (Radovanović et al., 2020). Two functions are added as constraints to the logistic regression model (6, 7):

$$\frac{1}{n}\sum_{i=1}^{n}\left((s_i - \bar{s}) * \theta^T x_i\right) + c \geq 0 \tag{6}$$

$$\frac{1}{n}\sum_{i=1}^{n}\left((s_i - \bar{s})(y_i - \bar{y}) * \theta^T x_i\right) + c \geq 0 \tag{7}$$

where c present hyper-parameter explaining allowable disparate impact and equality of opportunity, θ^T weights associated with input attributes, and $\bar{s}$ the average value of a sensitive attribute which can take values 0 (discriminated group) and 1 (privileged group). Equation (6 constrains logistic regression to create unwanted discrimination in terms of disparate impact, while equation (7) constrains logistic regression to create unwanted discrimination in terms of unequal opportunity. Also, one can find other in-processing approaches in the literature such as *adversarial learning* which controls model accuracy and adversary's ability to determine the sensitive attribute from the predictions thus creating the fair classifier (Zhang et al., 2018).

Finally, one can find examples of post-processing techniques that focus on adjusting predictions to make predictions as fair as possible. One can calibrate obtained probability scores to get fair predictions. This can be done analytically (Pleiss et al., 2017) or using linear programming techniques (Hardt et al., 2016).

Based on the literature review and notions of fairness the belief of the authors is that pre-processing is the best way to achieve fairness. Namely, principle *unfairness-in unfairness-out* in other techniques (in-processing and out-processing) will lead to unsatisfactory solutions. If unfairness is not cleansed before the learning process, unwanted discrimination can be observed in the predictions no matter the in-processing or out-processing technique. Therefore, this paper will deal with the effects of pre-processing techniques on fairness and predictive accuracy.

3. METHODOLOGY

The main idea of this paper is to measure and compare the difference in predictive model performance and predictive model fairness before and after applying data preprocessing techniques. Based on the literature review, one can deduce that trade-off between predictive accuracy and fairness must be made. We wanted to test several hypotheses that pre-processing techniques for fairness can improve fairness with satisfactory predictive performance. Since there are two notions of fairness, group and individual, we inspect both of them. Pre-processing techniques that were tested are reweighing (Kamiran & Calders, 2012) and disparate impact remover (Feldman et al., 2015).

Reweighing is a technique that assigns weight to instances that are more likely to create unwanted discrimination. Namely, instances of a privileged class and a more common output value will tend to create a bias toward that combination. To compensate for the bias, one can use chi-square like measure and assign a weight to each instance that regularizes the impact of each instance to the predictive performance. Mathematically, each instance gets a weight presented in equation (8).

$$w(x_i) = \frac{p_{exp}(s = s_i \wedge y = y_i)}{p_{obs}(s = s_i \wedge y = y_i)} \tag{8}$$

where $p_{exp}(s = s_i \wedge y = y_i)$ present expected probability that such an instance will be in the dataset and is calculated as $\frac{|\{X \in D | s_i = s\}|}{|D|} * \frac{|\{X \in D | y_i = y\}|}{|D|}$ (D present dataset, s present discriminated sensitive attribute, y output attribute). This can be interpreted as a number of times sensitive attribute and output attributes are observed in the dataset. Also, $p_{obs}(s = s_i \wedge y = y_i)$ present observed probability of sensitive attribute and output attribute and is calculated as $\frac{\left|\{X \in D | s_i = s \wedge y_i = y\}\right|}{|D|}$ (Kamiran & Calders, 2012).

Disparate impact remover performs geometric repair of the data at hand in such a manner to remove disparate impact. This is done by constructing a dataset which is similar, but not identical to the data at hand and with

one major difference. The resulting dataset will not have a disparate impact on any input attribute. The process of creating a new dataset is based on the information theory (KL divergence of two datasets) and is complicated. Therefore, interested readers are referred to (Feldman et al., 2015) for a more detailed description.

Both techniques are implemented in IBM's AIF360 framework, which is used in this research (Bellamy et al., 2018).

These techniques were tested using several learning algorithms and compared with the performances without pre-processing techniques. More specifically, we tested naïve Bayes (NB), logistic regression (LR), random forest (RF), and neural networks (NN) as learning algorithms. Expected results, based on the literature review, is that predictive performance will hinder, but the fairness (both individual and group) will improve for every learning algorithm.

To evaluate predictive performance, we utilize the area under the curve (*AUC*). This measure calculates the area under the curve that is obtained using values of true positive rate and false-positive rate for every possible decision threshold value. It can be interpreted as the probability that the random positive example has a greater predicted probability than a random negative example. Since probability (or confidence) score is not that important for AUC, but that positive example has a higher predicted probability compared to a negative example one can relate AUC with the Mann-Whitney U test. The random classifier would have 0.5 for AUC. Values closer to one are better (Branco et al., 2016). We used an additional evaluation measure called the area under the precision-recall curve (*AUPRC*). AUPRC is interpreted using the relation of true positive rate (recall) and precision. Namely, AUPRC can be viewed as a probability of positive example among those examples whose output values exceed a randomly selected threshold. Higher values of AUPRC suggest that the predictive model has greater power discriminating positive and negative examples (Boyd et al, 2013).

As a measure of fairness, we utilize disparate impact (*DI*) as presented in equation (3) and consistency (*C*) which is presented in equation (4). For consistency measure, we used five closest neighbours based on which individual fairness metric was calculated. One would like to have a value of DI as close to one. Lower values and higher values indicate unfairness. One must note that measure is not symmetric, i.e. DI equal to 0.5 is as unfair as DI equal to 2, even though the first case is closer to value one than the latter case. Acceptable values for DI is, according to the 80% rule between 0.8 and 1.2. For consistency, one would like to have consistency equal to one, which is the highest possible value. Acceptable value for the consistency is between 0.9 and 1. (Barocas & Selbst, 2016)

The experiments are performed on two well-known datasets: Adult and Compas. Adult (Kohavi, 1996) is a dataset that involves predicting personal income levels as above or below $50,000 per year based on personal details (e.g., relationship, education level, etc.). It is believed that the female gender is discriminated compared to the male gender in this dataset. More specifically, men are having higher average earnings compared to women leading to higher tax paid, but also some benefits from the system. Therefore, one would like to reduce the gender gap and create a prediction model that does not create gender inequality. Compas (Larson et al., 2016) is a dataset used for predicting whether the perpetrator will repeat the crime or not based on personal details and crime details. Due to various reasons (i.e. Afro-Americans commit more crimes), predictive systems create discriminative predictions toward Afro-Americans, thus sentencing Afro-Americans more often (compared to Caucasians). Both datasets have a high class imbalance and high fairness imbalance. More specifically, the Adult dataset has three times (~0.25 is the average value of the output attribute) more instances that have below $50,000 per year earnings and disparate impact without any model is 0.358 meaning that there are more than twice more males having above $50,000 per year in percentage compared to women. The situation is better with the Compas dataset. Namely, the class imbalance is ~0.45 (45% of the people re-offend) while disparate impact without any model is 0.813.

Experiments are conducted using ten-fold cross-validation on both datasets with inner cross-validation for hyper-parameter optimization. This means that the dataset is split into ten subsets. The model is trained on nine subsets, while tested on the remaining one. The process is repeated ten times, such that each time a different test subset is used. We report average scores and standard deviations for AUC and AUPRC, as well as DI and C obtained on the test dataset.

4. RESULTS AND DISCUSSION

First, we present results obtained on the Adult dataset without any preprocessing technique applied in Table 1. As one can observe predictive performance, based on AUC, the models obtained from the learning algorithms are above 0.75 that ranks models in the group of useful ones. Also, AUPRC suggests that models are twice as better than random models. However, disparate impact (group fairness metrics) are worse than

overall disparate impact. These results are in accordance with the assumption that the learning algorithm will inherit unwanted bias and amplify it (Veale & Binns, 2017). Individual fairness is marginally good. Namely, scores of C(onsistency) is around 0.9 which is a borderline good result.

Table 1: Results for the Adult dataset – no pre-processing

Algorithm	AUC	AUPRC	DI	C
NB	0.779 +/- 0.010	0.471 +/- 0.024	0.338 +/- 0.043	0.928 +/- 0.002
LR	0.757 +/- 0.010	0.526 +/- 0.016	0.219 +/- 0.016	0.934 +/- 0.004
RF	0.769 +/- 0.009	0.542 +/- 0.012	0.281 +/- 0.016	0.882 +/- 0.005
NN	0.768 +/- 0.012	0.531 +/- 0.011	0.305 +/- 0.034	0.909 +/- 0.005

After reweighing, one can observe the results in Table 2. The performance of the neural network remained the same since instance weighting did not gain any effects on the learning process. However, other algorithms have lower predictive performance, i.e. naïve Bayes algorithm have 1.2% lower AUC and 0.5% lower AUPRC, but DI has improved for 14.8%. It is worth to notice that C is slightly lower (for 0.02). Similar is observed with other algorithms, except for the random forest algorithm, which has the same or similar predictive performance with a slight improvement of group fairness metric. It is worth noting that logistic regression had the highest gain in DI (>30%) with the cost of the predictive performance of 1% in AUC.

Table 2: Results for the Adult dataset – reweighing

Algorithm	AUC	AUPRC	DI	C
NB	0.767 +/- 0.014	0.466 +/- 0.033	0.496 +/- 0.073	0.926 +/- 0.003
LR	0.741 +/- 0.009	0.510 +/- 0.011	0.526 +/- 0.051	0.930 +/- 0.006
RF	0.769 +/- 0.012	0.541 +/- 0.017	0.287 +/- 0.023	0.882 +/- 0.004
NN	0.768 +/- 0.012	0.531 +/- 0.011	0.305 +/- 0.034	0.909 +/- 0.005

Finally, after disparate impact removal, we obtained the results presented in Table 3. Disparate impact removal had a better effect on DI for the models, except for LR.

Table 3: Results for the Adult dataset – disparate impact removal

Algorithm	AUC	AUPRC	DI	C
NB	0.772 +/- 0.012	0.462 +/- 0.031	0.456 +/- 0.075	0.927 +/- 0.004
LR	0.742 +/- 0.015	0.517 +/- 0.015	0.296 +/- 0.031	0.936 +/- 0.005
RF	0.745 +/- 0.019	0.512 +/- 0.021	0.412 +/- 0.094	0.892 +/- 0.010
NN	0.762 +/- 0.017	0.526 +/- 0.015	0.352 +/- 0.034	0.912 +/- 0.006

We can conclude that after the application of data preprocessing techniques model fairness increased while model accuracy decreased, which is in line with the initial hypothesis. More specifically, group fairness metrics have improved, while individual fairness metrics hinder slightly. However, even though the improvement was made the group fairness metrics are still not on the satisfactory level (DI > 0.8 and DI < 1.2).

Similar findings are observed on the Compas dataset. Results without pre-processing for fairness are presented in Table 4. The predictive performance of the initial models is barely useful for any decision-making, just being better than random predictions. Disparate impact suggests that the model is highly unfair toward Afro-Americans, but the consistency of the model is borderline satisfactory except for the RF which is unsatisfactory.

Table 4: Results for the Compas dataset – no pre-processing

Algorithm	AUC	AUPRC	DI	C
NB	0.623 +/- 0.012	0.549 +/- 0.020	2.465 +/- 0.398	0.918 +/- 0.008
LR	0.668 +/- 0.011	0.575 +/- 0.019	1.659 +/- 0.206	0.937 +/- 0.004
RF	0.650 +/- 0.014	0.553 +/- 0.020	1.353 +/- 0.091	0.756 +/- 0.014
NN	0.685 +/- 0.019	0.588 +/- 0.027	1.646 +/- 0.153	0.893 +/- 0.006

After reweighing group fairness has improved (Table 5). Interesting results have been obtained. Namely, both predictive performance and fairness have improved. The predictive performance of each algorithm remained at least the same or even better after reweighing for both AUC and AUPRC. Group fairness has improved, and logistic regression algorithm after reweighing managed to reach inside allowable group fairness values. However, individual fairness slightly deteriorated.

Table 5: Results for the Compas dataset – reweighing

Algorithm	AUC	AUPRC	DI	C
NB	0.624 +/- 0.012	0.551 +/- 0.021	2.126 +/- 0.276	0.917 +/- 0.007
LR	0.668 +/- 0.011	0.575 +/- 0.021	1.105 +/- 0.089	0.936 +/- 0.007
RF	0.654 +/- 0.014	0.557 +/- 0.025	1.290 +/- 0.119	0.753 +/- 0.015
NN	0.685 +/- 0.019	0.588 +/- 0.027	1.646 +/- 0.153	0.893 +/- 0.006

Finally, results after disparate impact removal technique we obtained the results presented in Table 6. Using this technique impacted the predictive performance of the algorithms reducing it up to 2% for AUC and AUPRC. However, DI has improved greatly, having RF inside allowable values. Interestingly, individual fairness improved.

Table 6: Results for the Compas dataset – disparate impact removal

Algorithm	AUC	AUPRC	DI	C
NB	0.605 +/- 0.020	0.535 +/- 0.023	1.355 +/- 0.121	0.935 +/- 0.007
LR	0.663 +/- 0.010	0.574 +/- 0.019	1.454 +/- 0.092	0.931 +/- 0.007
RF	0.623 +/- 0.031	0.533 +/- 0.032	1.177 +/- 0.121	0.792 +/- 0.025
NN	0.668 +/- 0.012	0.576 +/- 0.020	1.335 +/- 0.086	0.892 +/- 0.016

After the end of the experiments on both data sets, we can see that group fairness increased each time after both fairness improvement techniques were applied, while individual fairness both increased and decreased. This performance is expected and explained. Namely, there are differences in the input attributes in the data at hand between privileged and discriminated groups based on which predictive algorithm manages to make statistical discrimination for the output attribute and thus creates unwanted discrimination. From the individual fairness point of view, predictive models are fair, since similar input will lead to a similar output. However, from a group fairness point of view, predictive models are unfair. Therefore, there is a trade-off between these two types of fairness. Another thing we can observe from these results is the decrease in model accuracy that is not significant. Having experimented in mind and given discussion, we can conclude that pre-processing techniques for fairness improve fairness with satisfactory predictive performance. More specifically, group fairness is improved, having similar individual fairness. It is worth mentioning that this approach does not solve the problem of fairness, but softens the effects of unfairness available in the data at hand.

5. CONCLUSION

In this paper, we experimented with pre-processing techniques to achieve fair predictive models. We tested two pre-processing techniques, one that adjusts original data in such a manner that unfairness is removed and another which assigns importance to the instances based on their possible effects on the unfairness. Since there are two notions of fairness, individual and group fairness, both were tested. These approaches were tested on the two well-known datasets Adult and Compas. These datasets are used because they had a great impact on the development of fairness in algorithmic decision-making and are commonly used as benchmark datasets. We tested the effects of the pre-processing techniques on four learning algorithms. Namely, naïve Bayes, logistic regression, random forest, and neural networks.

We have shown that group fairness increased each time after both fairness improvement technique was applied, while individual fairness both increased and decreased. Additionally, predictive performance decreased, but not significantly. More specifically, AUC and AUPRC reduced up to 3%, but DI has improved significantly.

As a part of future work, we would like to extend our research to more approaches and more datasets to derive more general conclusions.

ACKNOWLEDGEMENT

This work was supported in part by the ONR/ONR Global under Grant N62909-19-1-2008.

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CAN WE ADJUST PREDICTIONS TO BE FAIR? POSTPROCESSING OF THE PREDICTION MODEL

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Abstract: *Predictive models are today used in many applications, from healthcare to banking. With the rise of the data privacy and protection, questions about the impact and the fairness of the algorithmic decision-making on individual and group of people arose. However, many predictive models are already in use. Therefore, their fairness should be estimated and predictions should be adjusted to be as fair as possible. In this paper, we applied three post-processing techniques to improve the fairness of logistic regression on the Adult dataset that is known for gender inequality. Specifically, equal odds calibrated equal odds and reject option classifier were applied to achieve the best possible fairness for the data at hand. We have shown that these techniques improve fairness metrics, i.e. disparate impact and equal opportunity with low cost of predictive performance in terms of F1 measure. It has been shown that one can achieve a 5% lower F1 score while achieving ~40% and ~60% greater fairness metrics in terms of disparate impact and equal opportunity.*

Keywords*: Algorithmic decision-making, Algorithmic Fairness, Post-processing Techniques*

1. INTRODUCTION

Predictive analytics is being increasingly used in several domains, from healthcare, medicine up to business-related use-cases. The goal of predictive analytics is to create a model which utilizes prior experience obtained from the historical data and make the best possible decision. These models are considered to be of greater benefit compared to human expert because they take into consideration more factors influencing the decision than human is capable to process and, at the same time, create a decision that is less subjective (Larose & Larose, 2015). However, in the process of the maximization of the predictive accuracy these algorithms sometimes systematically discriminate specific subgroups of people, thus making decisions unethical and often prone to legal consequences (Barocas & Selbst, 2016). Having this in mind, one would like to have both an accurate and fair predictive model. Accuracy can be defined using some of the well-known predictive metrics while being fair is very hard to define and calculate. Therefore, a new theoretical and practical research area emerged called fair algorithmic decision-making, where the goal is to build the best possible predictive model having fairness constraints satisfied.

In the context of algorithmic decision-making, fairness is formulated as the absence of any favoritism toward an individual or a group based on the property of that individual or a group that is not related to the decision-making process. The formulation can be defined also as systematic discrimination toward an individual or a group based on the property of that individual or a group that is not related to the decision-making process (Ntoutsi et al., 2020). It is worth noticing that, from a mathematical point of view, there is no clear definition of fairness in decision-making. In addition, fairness (regardless of the measure used) and predictive accuracy are often conflicted, i.e. higher predictive accuracy results in lower fairness and vice-versa (Glauner et al., 2018).

This paper deals with the problem of maximizing fairness of the predictive model that is already built and used. Therefore, the process of the predictive model learning and creation is unaware of the potential fairness issue and the goal is to adjust predictions to get the best possible predictive performance while having some notion of fairness satisfied as much as possible for the data at hand. The problem is considered as a challenging one in the machine learning and social science community. The main reason is the source of unfairness, whose origin is not known (Chen et al., 2019). Namely, decision-makers can be a source of unfairness making systematic discrimination toward certain subgroups of the people. For example, one can favor male candidates in the selection process for the job openings. Therefore, male candidates will be privileged groups while female candidates will be considered as discriminated candidates. However, the source of unfairness can be more subtle. For example, decision-maker is influenced by some attributes that are correlated with gender, such as

working experience. Female candidates have overall less working experience (due to various reasons) and therefore decision-making process will favor male candidates. The additional problem is that predictive models are unaware of the existing bias in data and often amplifies it (Veale & Binns, 2017).

We will investigate the effects of the post-processing techniques to obtain greater fairness of the predictive model. More specifically, we will adjust scores obtained from the predictive model to get a predictive model that is fairer. This will come with a cost of lower predictive accuracy. Therefore, we want to answer the question of how much can be sacrifice predictive accuracy to achieve greater fairness. The experiments are conducted on dataset Adult (Kohavi, 1996) known for gender unfairness.

The remainder of the paper is structured as follows. In Section 2 we provide a literature review that contains a review of the papers regarding fairness in predictive modeling. Section 3 will provide a methodology and experimental setup. In Section 4 we provide results and discussion of the results, while Section 5 concludes the paper.

2. LITERATURE REVIEW

Many known applications of predictive modeling resulted in unfair decisions. In the job hiring process, employers increasingly use candidate screening. Software for these tasks uses attributes such as affiliation, education, age, gender, job experience, etc. to calculate a score that indicates whether a candidate is suitable for the job opening. It is estimated that market size for job screening is estimated at $500 million in 2014, growing at a rate of 10% to 15% per year (Weber & Dwoskin, 2014). Bias in such systems leads to rejecting a candidate because of the gender, religion, or age (property that person cannot control) thus hurting a brand and image of the employer. Software platform XING had the problem of unwanted bias, where less qualified male candidates were ranked higher compared to more qualified female candidates (Lahoti et al., 2019). Discrimination regarding race can be found in criminal risk assessment software. Algorithmic decision-making tools for such purposes such as COMPAS (Dieterich et al., 2016), PSA (Majdara & Nematollahi, 2008), and SAVRY (Meyers & Schmidt, 2008) can result in biased treatment of individuals based on race. More specifically, African-Americans have a higher probability of being imprisoned, compared to Caucasians (Dieterich et al., 2016). Discrimination can be even noticed in online recommendation engines. Recommender system for promoting jobs in Science, Technology, Engineering, and Mathematics called STEM is unfair showing more advertisements to male users than female users (Lambrecht & Tucker, 2019). Also, the Google Ad system has a similar gender bias problem. It has been shown that after changing the gender in settings, male Google users receive more adds for higher-paying jobs and career coaching services compared to female Google users (Datta et al., 2015).

Although one can feel that results are unfair, the challenge is to quantify unfairness, measure it, and decide that the decision-making model is unfair. In the literature, one can find two broad notions of fairness. The first one is called *individual fairness*. A decision-making model is said to be individually fair if similar individuals obtain similar results of the algorithmic decision-making model (Sharifi-Malvajerdi et al., 2019). If one removes attributes that can create unwanted discrimination (i.e. gender, race) from the data at hand before the model learning phase individual fairness will be very high. For example, male and female candidates with the same input attributes related to the problem that is being solved will result in the same decision. Therefore, gender will not influence the decision. Since this notion of fairness will be satisfied if these attributes are removed from the dataset, we will ignore this notion of fairness.

The second notion of fairness is called *group fairness*. Group unfairness is often defined as systematic discrimination obtained from the algorithmic decision-making model based on an attribute that individuals cannot control (i.e. race or gender). The source of group unfairness can have multiple origins. Most often the data and data collection process is biased (i.e. more male candidates are being employed overall, minorities or disabled individuals have lower access to education resulting in lower values of an attribute used in the decision-making process). It is a common belief that unwanted discrimination occurs accidentally (without the knowledge of the decision-maker). One can find this as a disparate impact. More specifically, disparate impact is unintended discrimination in the decision-making process that can be explained by observing accuracy or errors of the sensitive attribute (i.e. gender or race) (Zafar et al., 2015). If we define output attribute y, prediction obtained from the algorithmic decision-making model $\hat{y}$ and sensitive attribute s then disparate impact is defined as given in equation (1):

$$DI = \frac{p(\hat{y} = 1|s = 1)}{p(\hat{y} = 1|s = 0)} \tag{1}$$

Namely, disparate impact (DI) presents a ratio of probabilities that the decision-making model will predict positive output for the discriminated group ($s = 1$) and privileged group ($s = 0$). One would like that this ratio

is close to one. However, the slightly lower and slightly higher result is acceptable due to randomness in data. More specifically, one can use the U.S. Equal Employment Opportunity Commission “80%-rule” (Biddle, 2006) that states that DI should be between 0.8 and 1.2.

Another measure for group fairness that is less rigor that DI is called equal opportunity (EQ). Instead of forcing a decision-making model to have approximately the same proportion of discriminated and privileged group individuals, one can focus only on the output of interest. The mathematical formulation is given in equation (2).

$$EQ = \frac{p(\hat{y} = 1|y = 1, s = 1)}{p(\hat{y} = 1|y = 1, s = 0)} \quad (2)$$

Once one knows how to measure the unfairness of the algorithmic decision-making model, one must be able to mitigate the source of unfairness in data. Intuitively, one could achieve fairness through unawareness (Chen et al., 2019). Namely, one could learn a predictive model without the usage of sensitive attributes s. However, there may be proxy attributes in data that can identify sensitive attributes and thus make predictive model unfair. Therefore, one needs to be aware of the sensitive attribute s in order to achieve fairness. One can use 1) Pre-processing techniques, 2) In-processing techniques, and 3) Post-processing techniques for that purpose.

Pre-processing techniques aim to reduce or remove the source of discrimination in the data at hand before learning a predictive model. Approaches such as removing attributes that are correlated with the sensitive attribute (Kamiran & Calders, 2009), massaging the output attribute (Kamiran & Calders, 2012), transforming values of an attribute such that they cannot be explained using sensitive attributes have been developed (Feldman et al., 2015). Although this approach is appealing, one can post a question regarding data accuracy and thus results obtained using such an approach.

In-processing techniques try to modify learning algorithms to simultaneously maximize predictive performance and minimize unfairness without any intervention from the data analyst. Most commonly, regularization terms are added to the goal function of the learning algorithm (Kamishima et al., 2012). This approach reduces the complexity of the decision-making model by penalizing for unfairness. Another approach that is commonly used is adversarial learning (Zhang et al., 2018). Namely, two goal functions are being learned at the same time in such a manner that parameters of the model utilizes a gradient of the accuracy goal function and adjust it for the gradients of the fairness function.

Finally, one can utilize post-processing techniques. Those techniques adjust predictions to make predictions as fair as possible. One can analytically find the best possible threshold for fairness measure of interest (Pleiss et al., 2017), or utilize linear programming for score adjustment (Hardt et al., 2016). More about these techniques in the following section.

Having the literature review in mind, this paper will deal with the post-processing techniques for scores and predictions adjustments. The main reason is the fact that the majority of the prediction models are already deployed and one can influence only prediction scores. Additionally, prediction algorithms are often considered as black-box algorithms and, thus, one cannot adjust the algorithm to be fair.

3. METHODOLOGY

In this paper, we investigate the effects of the fairness post-processing techniques on the predictive model performance. The trade-off between predictive accuracy and group fairness measures exists, and therefore we want to improve the fairness of the predictive model with small cost on the predictive accuracy. As measures of accuracy, we will use F1 measure, but accuracy, precision, and recall will be presented, while as measures of fairness we will use the above-mentioned disparate impact and equal opportunity. Post-processing techniques that are used in this paper are Equalized odds post-processing (Hardt et al., 2016), Calibrated equalized odds (Pleiss et al., 2017), and Reject option classification (Kamiran et al., 2012). Every technique is available in the Python package (Bellamy et al., 2018).

Equal odds (EO) is a technique that solves a linear problem that finds the best possible decision threshold such that equal odds will be maximized. In other words, this technique does not take into account predictive accuracy, but loops over possible decision threshold values and returns the best one in terms of equal odds. Therefore, it is expected that this approach returns the best possible fairness value for the data at hand. (Hardt et al., 2016)

Calibrated equalized odds (CEO) is a post-processing technique that calibrates prediction model output to find probabilities with which to change predictions. First, one will divide predictive model scores (i.e. predicted

probabilities that output will be achieved) for privileged (h_1) and discriminated group (h_2). It can be observed that the expected value of the predictive model for h_1 and h_2 can differ. If we denote the predictive model with g then $g(h_1) \geq g(h_2)$. The goal of this technique is to calibrate obtained probability scores from the predictive model for the discriminated group such that $g(h_1) = g(\tilde{h}_2)$. To get such calibration one will, for a random subsample of the discriminated individual (with probability α), adjust probability score by changing it to achieve the same average probability score for both discriminated and privileged groups. Mathematically, this is presented in equation (3) and (4).

$$\tilde{h}_2 = \begin{cases} h^{\mu_2}(x) = \mu_2, \ \ with\ probability\ \alpha \\ h_2(x), with\ probability\ 1-\alpha \end{cases} \tag{3}$$

$$\alpha = \frac{g(h_1) - g(h_2)}{g(h^{\mu_2}) - g(h_2)} \tag{4}$$

Namely, probability score is constructed such that $g(h_2) \leq\ g(h_1) \leq\ g(h^{\mu_2})$. If one wants to achieve equalized odds then $g(h_1) =\ g(h^{\mu_2})$. Based on that one can calculate α, or a percentage of instances of the discriminated class that needs to be adjusted. These instances are assigned with the probability that corresponds to the average output rate that is observed in data. This algorithm is claimed to be "optimal" because one cannot find a better classifier that achieves $g(h_1) = g(h_2)$. After adjustment of the prediction scores, the decision threshold is selected by obtaining the best value of the F1 score on the training subset. (Pleiss et al., 2017)

Reject option classifier (ROC) calculates a band that envelops the decision threshold and gives positive outcomes to the discriminated group and negative outcome to the privileged group. More specifically, if probability scores are close to zero or one than the predictive model is certain of the outcome. However, when the probability score of the predictive model is close to the decision threshold (most often 0.5) then the certainty of the decision is not high. This is called a critical region. In the critical region, one is more prone to make an error. Therefore, in this area, one can give a positive outcome to the discriminated group, while giving a negative outcome to the privileged group. This approach can be questioned about the intuition, but this approach is available in the literature and practice. The task is to find the width of the critical region. For that purpose, an optimization procedure that minimizes expected loss of classification is used. (Kamiran et al., 2012)

These techniques are tested using a logistic regression algorithm. Therefore, the results obtained using the above-mentioned techniques are compared to the results obtained from fairness unaware logistic regression (baseline method). The baseline approach uses a common approach in predictive modeling in terms of choosing the decision threshold. Namely, maximization of accuracy. Therefore, the decision threshold of the baseline method will select the threshold that maximizes the F1 score. The experiment is conducted using 10-fold cross-validation. This means that the dataset is divided into 10 random samples, and the model is learned 10 times such that 9 samples are used for predictive model training and the remaining one for model testing. We report the average value of measures of interest, as well as standard deviation obtained on the test samples. As already mentioned the predictive performance is measured using F1 measure, which is calculated as a harmonic mean of the precision and recall, which are also reported alongside predictive accuracy. As a measure of fairness, we use disparate impact (*DI*) and equal opportunity (*EQ*).

The experiments are conducted on the Adult (Kohavi, 1996) dataset. Adult dataset regards the problem of predicting the earning of an individual. More specifically, the dataset aims at predicting personal income levels as above or below $50,000 per year based on personal details (e.g., relationship, education level, etc.). Insurance companies (for creating insurance packages) can use this predictive model, as well as tax administration (for inspection purposes). It can be observed in the data that the female gender is discriminated compared to the male gender. In other words, male gender instances are having higher average earnings compared to female gender instances leading to higher tax paid, but also some benefits from the system. Therefore, one would like to reduce the gender gap and create a prediction model that does not create gender inequality. Based on the initial data one can calculate the disparate impact that is equal to 0.358 meaning that there are more than twice more male instances having above $50,000 per year in percentage compared to female instances.

4. RESULTS AND DISCUSSION

Results obtained using baseline logistic regression and proposed three post-processing techniques are presented in Table 1 and Table 2. Table 1 presents predictive accuracy performances, while Table 2 presents fairness metrics. The best performing model by the measure of interest is denoted in bold letters.

Table 1: Predictive accuracy of the baseline approach and applied post-processing techniques

Technique	Accuracy	Precision	Recall	F1
Baseline	0.792 ± 0.006	0.650 ± 0.030	**0.293 ± 0.014**	**0.404 ± 0.018**
EO	0.380 ± 0.003	0.002 ± 0.000	0.003 ± 0.000	0.002 ± 0.000
CEO	0.795 ± 0.006	**1.000 ± 0.000**	0.150 ± 0.012	0.261 ± 0.018
ROC	**0.798 ± 0.006**	0.721 ± 0.030	0.261 ± 0.010	0.383 ± 0.014

As one can notice, the baseline model has the best performing model in terms of F1 measure (a measure that combines precision and recall), as well as in recall. The performances of the baseline model can be interpreted as that on average its accuracy is 79.2%, and when the predictive model predicts that person will have high earnings than it will be correct in 65.0% of the cases, and this model identifies 29.3% of all high earners. Models obtained after post-processing techniques have lower values of F1 score, as well as precision and recall. Models obtained from CEO and ROC do have higher accuracy scores, due to a higher number of true negatives that are identified.

Table 2: Fairness measures of the baseline approach and applied post-processing techniques

Technique	DI	EQ
Baseline	0.282 ± 0.039	0.188 ± 0.039
EO	**0.635 ± 0.021**	**1.000 ± 0.000**
CEO	0.398 ± 0.040	0.293 ± 0.040
ROC	0.393 ± 0.044	0.300 ± 0.042

The best performing technique is the equal odds post-processing. Namely, this technique has achieved the best possible value for measure equal opportunity (the same proportion of female and male instances that earn more than $50,000 and are predicted to earn more than $50,000). Also, the value of disparate impact for the EO is the best possible for the data at hand. Post-processing techniques CEO and ROC did achieve an increase in DI and EQ compared to the baseline approach. It can be observed that ROC is better in terms of EQ, while CEO is better in terms of DI.

Based on the results it can be observed that trade-off is made between predictive accuracy and fairness metrics. Post-processing technique EO optimizes for equal opportunity (EQ) without taking into account predictive accuracy. Namely, this technique searches for the decision threshold for which the best EQ is obtained. Therefore, it was expected that this technique has the best fairness metrics. However, due to that fact, this technique obtains the lowest predictive performance measures. On the other side, the baseline method has the best performing predictive accuracy, but the lowest fairness metrics.

Post-processing techniques CEO and ROC present techniques that reduce predictive accuracy while improves fairness metrics. It can be observed that CEO has slightly greater accuracy, but has improved precision 1.539 times. However, recall is reduced 1.953 times and F1 is reduced 1.548 times. Similarly, ROC technique has slightly greater accuracy and 1.109 times greater precision, but 1.123 times lower recall and 1.055 times lower F1 score. However, when looking fairness metrics CEO technique improves fairness metrics 1.411 and 1.559 times for DI and EQ, respectively, compared to the baseline approach. Similarly, ROC improves 1.394 and 1.596 times for DI and EQ, respectively, compared to the baseline approach.

Having obtained results in mind, one can conclude that post-processing techniques improves fairness metrics, but with the cost of predictive accuracy. For the Adult dataset, the most suitable technique is ROC, or the technique where decisions (within the band that envelops the decision threshold) of the privileged instances are turned to a negative value of the output, while discriminated instances are turned to a positive value of the output. However, CEO technique is also very usable. One can obtain slightly lower predictive performance while obtaining fairer results. However, one should have in mind that these models are still subject to legal compliance due to the low values of DI and EQ.

5. CONCLUSION

In this paper, we experimented with the post-processing techniques to achieve fair predictive models. We tested three post-processing. One post-processing technique, called equal odds, is intuitive and finds the best decision threshold for equal opportunity. Another technique calibrated equalized odds, obtain the best possible model for the data at hand regarding equal odds and disparate impact. Calibration of prediction scores obtained from this method is “optimal” in terms that one cannot achieve better fairness metrics with the same level of errors of I and II type. The third technique that was applied, reject option classifier, finds the width of the band around decision threshold for which decision is changed (privileged group instances are assigned with the negative output and discriminated group instances are assigned with the positive output). The

experiments are performed on the Adult dataset. This dataset is used because of the impact on the development of fairness in algorithmic decision-making.

It can be shown from the results that post-processing techniques improve fairness with the cost of predictive accuracy. The cost of achieving total fairness (using equal odds technique) is very high in terms of predictive performance, but trade-off techniques (calibrated equalized odds and reject option classifier) can have up to 5% lower predictive accuracy in terms of F1 measure but improves fairness by ~40% and ~60% in terms of disparate impact and equal opportunity.

In future work, we would like to generate Pareto front based on predictive performance and fairness metrics and allow human decision-makers to inspect possible trade-offs and decide on predictions that will satisfy both legal and business perspectives.

ACKNOWLEDGEMENT

This work was supported in part by the ONR/ONR Global under Grant N62909-19-1-2008.

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FUSION OF CROWD AND EXPERT KNOWLEDGE BASED ON FEATURE EMBEDDINGS AND CLUSTERING IN CROWD VOTING SETTING

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Abstract: *In recent years we are witnessing expansion of crowd participation in many decision-making problems (ranking, participatory budgeting, data labeling, product testing, etc.). In this research, we address the problem of fusion of crowd and expert knowledge for ranking problems. We argue that both experts and crowd are important in collective decision-making and that the combination of these two can lead to better decisions and more satisfaction and welfare for both sides. In this paper, we extend recently proposed framework for integration of expert and crowd knowledge by proposing two novel machine learning based methods for ranking. Experimental evaluation of newly proposed methods on real-world data showed promising results in terms of both crowd and expert satisfaction compared to recently developed models.*

Keywords*: Crowd Voting, Experts, Machine Learning, Clustering, Matrix Factorization.*

1. INTRODUCTION

Collective decision-making refers to process where many people are making joint decision. In that process, by synergy effects of a digital collaboration the crowd exchange opinions, experiences, and knowledge on the web and can contribute to collective decisions known in the literature as collective intelligence and “wisdom of the crowd” (Yu et al., 2018). On the other hand, experts are individuals with developed intuition and reasoning for complex problem solving (Bennet & Bennet, 2008). Solving complex problems or problems from a particular field (e.g. technical, ethical, etc.) is traditionally entrusted to expert voting. Well-known decision-making methods, for example, multi-criteria decision-making methods require experts for the weighting of criteria and ranking of alternatives (Mandic et al., 2015).

“Wisdom of Crowd” is in recent times heavily exploited for solving many problems like ranking, selection, participatory budgeting, making recommendations, and decision making in general. Benefits of inclusion of crowd opinions, ranks, behavior led to many successful applications in wide range of industry applications: retail, internet sales, social networks, web search, contest winner selection, ranking, and similar. Additionally crowed if frequently engaged in social processes through participatory budgeting, crowd voting, and other.

However, recognition of patterns and extraction of knowledge from the data collected from crowd posses a significant challenge. Some of the major problems are:

- Incompetence, lack of interest, favoritism, and manipulation of the crowd for problem at hand (Dodevska, 2019)
- Bias in ordinal voting systems (Lees & Welty, 2019),
- Sparse and imbalanced data generated from crowd votes (Jung & Lease, 2012),
- Etc.

Also, there are difficulties on the experts side to reach consensus, especially in the case of multidisciplinary decision making where availability of expertise is not a guarantee of its use (Jackson, 1996)

We hypothesize that many of the problems that arise from aggregation and knowledge extraction from crowd generated data may be resolved by exploiting expert knowledge. However, a common problem with collection of expert knowledge is that experts' time is expensive and that in real-world settings in most cases only a

limited number of experts may be included (if any). This further opens the problem of expert bias and/or awareness of all factors that are influencing the problem at hand.

Previous research presented in (Kovacevic et al., 2020), authors addressed this problem by proposing CrEx-Wisdom framework for integration of expert and crowd knowledge (even with a single or limited number of experts) that tries to address many problems of crowd voting quality by exploitation of experts knowledge, while pre-serving advantages of "Wisdom of Crowd" and "Collective Intelligence". The main problem with ranking methods proposed in (Kovacevic et al., 2020) was that they were based on weighting crowd votes based on similarity with expert voters. This led to an increase in expert satisfaction with the final ranking but a decrease in satisfaction of crowd. In order to address this problem, in this paper, we present two machine learning based methods that extend method repository from CrEx-Wisdom framework. Methods are based on matrix factorization techniques for identification of latent feature spaces and clustering algorithms. Latent feature spaces allow resolution of sparsity problem and allows high-quality definition of notion of similarity between experts and crowd based on their preferences expressed through voting. Clustering techniques allow quantification of level of consensus between experts and crowd voters as well as quality of votes. Our experiments show that proposed methods outperform methods proposed in (Kovacevic et al., 2020) and that allow a simultaneous increase of satisfaction of both expert and crowd voters.

2. BACKGRAOUND

In this section, we will provide short explanation of framework presented in (Kovacevic et al., 2020) as well as literature review on similar methods and frameworks.

2.1. Framework for expert-crowd voting

Methods proposed in this research are extending recently proposed in (Kovacevic et al., 2020) CrEx-Wisdom (Crowd and Expert Wisdom) framework for fusion of experts and crowd "Wisdom" for problems of participatory voting and ranking.

The main idea of this framework is to enable fusion of expert knowledge and crowd "wisdom" by validating crowd votes using experts. Another important aspect is to model the agreement of both experts and crowd as well as their mutual agreement.
General data and process can be described in the following way (Kovacevic et al., 2020):

- Experts and crowd are providing votes (ranks, grades, etc.) that are stored in a sparse format.
- Votes of both expert and crowd groups are aggregated in one dataset.
- Latent features (embeddings) are identified based on machine learning (matrix factorization based collaborative filtering) methods.
- Based on the latent space of features agreement between experts and crowd (and their mutual agreement) is quantified with machine learning methods such as clustering and outlier detection.
- Based on estimated agreement levels votes of both experts and crowd are weighted on an individual level (each voter may have unique weight).
- Votes are aggregated based on traditional methods (e.g. weighted majority) and converted to ranks or grades.
- After aggregation expert satisfaction and crowd satisfaction are measured, and a Pareto front of non-dominated solutions is generated.

The described data flow is shown in Figure 1.

The CrEx-Wisdom framework gives a general approach for the fusion of crowd and expert votes in terms of selection of methods and techniques in each step.

CrEx-Wisdom framework is based on identification of latent features based on crowd and expert votes. This means that it enables definition of similarity between voters even if they didn't vote for the same alternatives. This approach is heavily exploited and showed cutting edge results in modern recommender systems (movies, sales, social networks, etc.) (Bokde et al., 2015). The central technique for identification of latent features in CrEx-Wisdom framework is matrix factorization. Matrix factorization assumes that each user (voter) could be described through a set of *k* features (latent factors) and by analogy each alternative (item) could be also described by the same set of *k* features.

Besides matrix factorization, one of key machine learning techniques in this research, we used the well known K-means algorithm (Lloyd, 1982) (clustering) and Isolation forest (Liu et al., 2008) (outlier detection) for estimation of voters agreement (density, variance), but we acknowledge that other types of algorithms may be used and possibly achieve even better results. However, this investigation is out of the scope of this research

since the objective is to show the value of integration of crowd and expert votes with the machine learning approach.

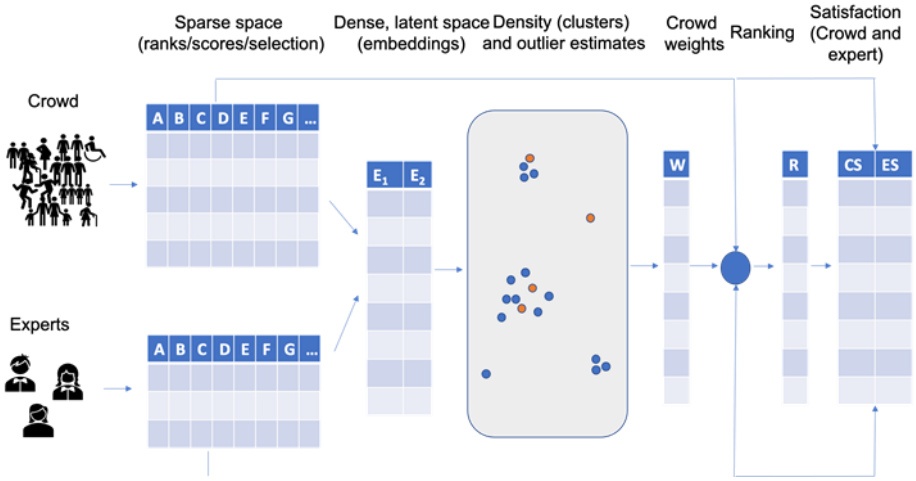

Figure 1: CrEx-Wisdom framework – data flow (Kovacevic et al., 2020)

2.2. Literature Review

Recently several exhaustive and comprehensive reviews about crowd voting and crowdsources problems were published. One such work that gives a systematic review of scholarly articles published since 2000 on Collective Intelligence (CI) platforms was recently done by (Suran et al., 2020). On the other side, (Aitamurto et al., 2017) examine in detail demographic characteristics, motivation, and crowd expectations in an off-road traffic law reform in Finland.

(Dodevska et al., 2020) provided detailed review and analyses of the advantages and disadvantages of expert-based and crowd-based decision making systems.

In this literature review, we will focus only on research that is closest to current research with a focus on similarities and differences and compatibility between similar approaches and the one proposed in this paper.

The usage of matrix factorization in CI is not a new idea. Jung and Lease (2012) are using matrix factorization in order to fill in missing values in crowd judgments. The majority of the voters in the CI process express their judgments for only several alternatives (out of a much larger set of alternatives). Consequently, decision-making process yields undesirable solutions. As a part of the solution, one can employ probabilistic matrix factorization techniques. As a result, votes are going to be imputed with the most probable values. By having a full voters data matrix more reliable solutions can be obtained.

More often usage of matrix factorization is to investigate crowd characteristics and for validation of the crowd. Garcia and Klein (2017) proposed pBOL method for filtering crowdsourced ideas based on crowd evaluation. This is achieved by creating a predictive model based on latent features that predict the opinion of each expert about the crowdsourced idea. In order to reduce false negatives, the task is transformed from selecting good ideas to eliminating the poor ones. Compared to pBOL, our framework is used for crowd and expert weighting (instead of filtering), thus allowing automated estimation of the importance of crowd votes as well as aggregation of the final solution.

It is worth to mention SmartCrowd framework proposed by (Bhatt et al., 2019) that allows 1) characterization of the participants using their social media posts with summary word vectors, 2) clustering of the participants based on these vectors, and 3) sampling of the participants from these clusters, maximizing multiple diversity measures to form final diverse crowds. They show that SmartCrowd generates diverse crowds and that they outperform random crowds. They estimate the diversity based on external data (tweets). In a sense, this research also tries to estimate the diversity of crowds but with respect to both crowd and expert members and without external information.

Expert identification in crowdsourcing platforms is a common problem. Such an example one can find in (Hill & Ready-Campbell, 2011), where authors assign a weight to voters for stock pick decisions. They used stock pick votes from a widely used online financial newsletter on previous voting as well as additional information (i.e. sentiment analysis from social media). Data is inserted in a genetic algorithm that produces a probability that a crowd voter is an expert. As a result, predictions of “experts from crowd” are used for evaluation. They

showed better average performance than the S&P 500 in terms of overall and risk-adjusted returns. Since this approach assumes historical data and additional information about crowd (which is rarely the case in CI), we propose an unsupervised method that allows the weighting and aggregation of crowed and expert votes without a collection of additional data. Our approach is based on similarity matching of experts and crowds. It is expected to have a better decision-making process with greater satisfaction of both crowd and experts.

It is important to note that the bias in crowd-voting systems can exist. Lees and Welty (2019) investigate the influence of bias in crowd-voting systems with a special focus on ordinal voting for restaurant rating. They showed that ordinal rankings (for example: 1 to 5) often converge to an indistinguishable rating, since there is a trend in certain cities for the majority of restaurants to all have a four-star rating. They also showed that the rating can be influenced by the number of voters. Finally, they showed that bias in data can be represented as preference and thus used for getting more information about users. Based on their research and assumptions, they suggest explicit models for better personalization and more informative ratings. Because the performance of methods is highly dependent on skew and bias in the data, (Lees & Welty, 2019) findings are highly applicable in our work.

3. PROPOSED METHODS FOR EXPERT-CROWD VOTE WEIGHTING

In previous work (Kovacevic et al., 2020) authors proposed methods for crowd voter weighting based on their similarity with expert voters. This means that crowd votes are weighted more if they are more similar to one or more experts, or expert clusters. These methods showed promising results in terms of reducing an influence of “non-informed” crowd voters as well as outlier experts in multi-expert setting. However, these methods had two major drawbacks. First, overall crowd satisfaction could not be improved compared to a situation where only crowd votes. Second, methods did not consider the level of grouping between crowd and experts. In some cases that led to situations where crowd grouped around isolated expert (or a small number of experts) had the same vote weights as the crowd grouped around the majority of experts. In this research, we propose two methods that addressed the aforementioned problems.

3.1. Cluster quality based weighting

In order to address the problem of giving high voting weights to crowd members that are close to isolated experts, but also to the experts that do not have high level of agreement between themselves, we propose a weighting procedure based on clustering of both experts and crowd members. This method accounts for the following factors:

- cluster quality: measures level of agreement between experts and crowd within cluster.
- cluster size: measures number of voters (experts and crowd) within cluster.
- cluster diversity: measures level of representation of both experts and crowd (in order to avoid over-representation of a single type of voters).

Based on described factors voting and assigned clusters weights are assigned to voters based on following formula (1):

$$V_W = Q * S * D \tag{1}$$

Where:
V_W - voters weight;
Q – cluster quality;
S – cluster size;
D – cluster diversity.

The size of the cluster is just the number of voters that belong to that cluster (regardless of their group). Cluster quality can be measured with standard internal clustering evaluation measures (e.g. compactness, Silhouette index, etc.). In methods proposed in this research, we use compactness (a total distance of all points of a cluster to its centroid) since it is used for the optimization of K-means algorithm that is used for clustering. Formula is given in (2). For calculation of cluster diversity in general different information theoretic measures can be used. In proposed methods, we used Shannon entropy given in (3).

$$Q = \sum_{i=1}^{k} \sum_{j \in C_i} d(x, c_i) \tag{2}$$

Where:
Q – cluster quality;
k – number of clusters;
C - cluster
c_i – centroid of i_{th} cluster;
x – elements of cluster.

$$D = -\sum_{i}^{n} p_i \, log_2(p_i) \quad (3)$$

Where:
n – number of different categorical values (in our case two possible values – expert or crowd);
p_i – observed probability of a given categorical value.

Since the factors described above are measured on different scales, final cluster weight is represented as the product of the normalized factors as given in (1). Finally, each user gets weight based on the quality measure of the cluster that it belongs to. This means that every vote of a user is multiplied by an assigned weight (V_w) and thus every vote is weighted before summation of votes. This approach hypothesizes that if we have a compact cluster with approximately the same number of expert and crowd users and that cluster is large enough, the satisfaction of both groups (expert and crowd) can be better.

3.2. Preference prediction based rank aggregation

This method is based on rank prediction for each voter-alternative pair. The main idea of this method is to use collaborative filtering (and feature embeddings) for estimation of voters' preferences towards alternatives that they didn't vote for. This is important for crowd voting aggregation methods since in many situations (especially when there is a large number of offered alternatives) voters may disregard alternatives that they have preference for. This may be caused by the lack of concentration interest etc. Another important aspect of this approach in context of CrEx-Wisdom framework is that it allows expert and crowd satisfaction simultaneously, that was not the case with previous methods (expert satisfaction was increased, while crowd satisfaction was decreased).

In order to achieve the goal of simultaneous improvement of expert and crowd, we use preference predictions instead of crowd weights that are derived from similarity to experts. Proposed method is consisted of 3 steps:

- Create feature embeddings for voters and alternatives based on votes from both crowd and experts.
- Based on feature embeddings predict preferences of each voter (expert and crowd) towards each alternative.
- Aggregate predicted preferences and create final ranking.

Even though many matrix factorization techniques exist, because of scalability and speed, we use Alternating Least Squares (ALS) proposed in (Takács & Tikk, 2012) for identification of latent features and predictions. ALS model is described in (4):

$$\hat{r}_{ui} = x_y^T \cdot y_i = \sum_k x_{uk} \, y_{ki} \quad (4)$$

Where:
$\hat{r}_{ui}$ – prediction for the true ranking r_{ui};
y_i (x_u^T) – column (row) vector of latent low-dimensional vectors (embeddings) obtained by ALS algorithm.

Loss function used for optimization is based on minimization of the square of the difference between all points the data (D). To avoid overfitting, two regularization terms have been added at the end of the loss function. Loss function of ALS is given in (5) :

$$L = \sum_{u,i \in D} (r_{ui} - x_u^T \cdot y_i)^2 + \lambda_x \sum_u \|x_u\|^2 + \lambda_y \sum_u \|y_i\|^2 \quad (5)$$

4. EXPERIMENTAL EVALUATION

In order to evaluate proposed methods, we used real-world data from the Eurovision song contest. Data contains crowd votes aggregated for each country, and expert votes form several experts from each country aggregated and represented as one. There are three years of data (2016, 2017, and 2018) for all types of events (two semifinals and grand final). In grand finale the number of given alternatives to choose from is 26 countries that have the right to vote in grand-final is 42. Two semifinals are split so that the number of countries that can vote is 21 each and they have the option to choose from 18 available songs. In a current Eurovision contest, a decision is made by weighting evenly crowd and expert votes.

4.1. Experimental setup

In order to find latent features (embeddings) of voters and alternatives (songs), Alternating Least Squares (ALS) algorithm is optimized using Mean Absolute Error. Training is conducted on expert and crowd votes at the same time by splitting data on test and train set to avoid overfitting. Greed search of hyperparameters is

done. After the model was fitted, and the best parameters were found, weight for each crowd voter is determined by using similarity with expert latent factor data. These embeddings are used as a basis for both methods.

For the cluster quality based weighting method we used K-means algorithm where we optimized the number of clusters for every data set using the Silhouette index as a measure of clusters quality. K++ method is used for cluster initialization and Euclidean distance for measuring distance.

As a benchmark methods, we compare how the satisfaction of each group (experts and crowd) is compared to the current Eurovision voting system as well as methods from (Kovacevic et al., 2020).

4.2. Evaluation measure

In order to provide fair performance comparison with benchmark models, we adopted one of the presented measures of Satisfaction in (Kovacevic et al., 2020) the average points difference metric (6), that represent average points difference from winning combination of alternatives. This means that smaller this difference is, the crowd/expert is more satisfied with the final combination of ranks.

$$avg\ PD = \frac{1}{m}\sum_{i=1}^{m}\sum_{j=1}^{n}|x_{wj} - x_{ij}| \tag{6}$$

Where:
m –Number of voters;
n – Number of alternatives;
x_{wj} - Winning alternative points at rank j;
x_{ij} - Alternative points of i-th user at rank j.

4.3. Results and discussion

First, we analyzed relative changes in crowd and expert satisfaction compared to satisfaction obtained on current Eurosong ranking procedure. Figure 2 shows relative change of satisfaction for expert and crowd voters for all models (y-axis) and all events (x-axis), where *ClustQuality* and *All predicted* represent newly proposed methods. It can be seen that all previous methods always increase expert satisfaction at the expense of crowd satisfaction. Whereas, new methods have shown that this situation can be completely different. Using cluster quality measure as weight we can conclude that there are several events where clusters with mostly crowd voters are more compact and hence results are in favor of crowd (e.g. first semifinal 2016, second semifinal 2017). On the other hand, ALS predictions in several cases have shown that it is possible to find the combination of alternatives that would satisfy both sides more (e.g. second semifinal 2017, first semifinal 2018).

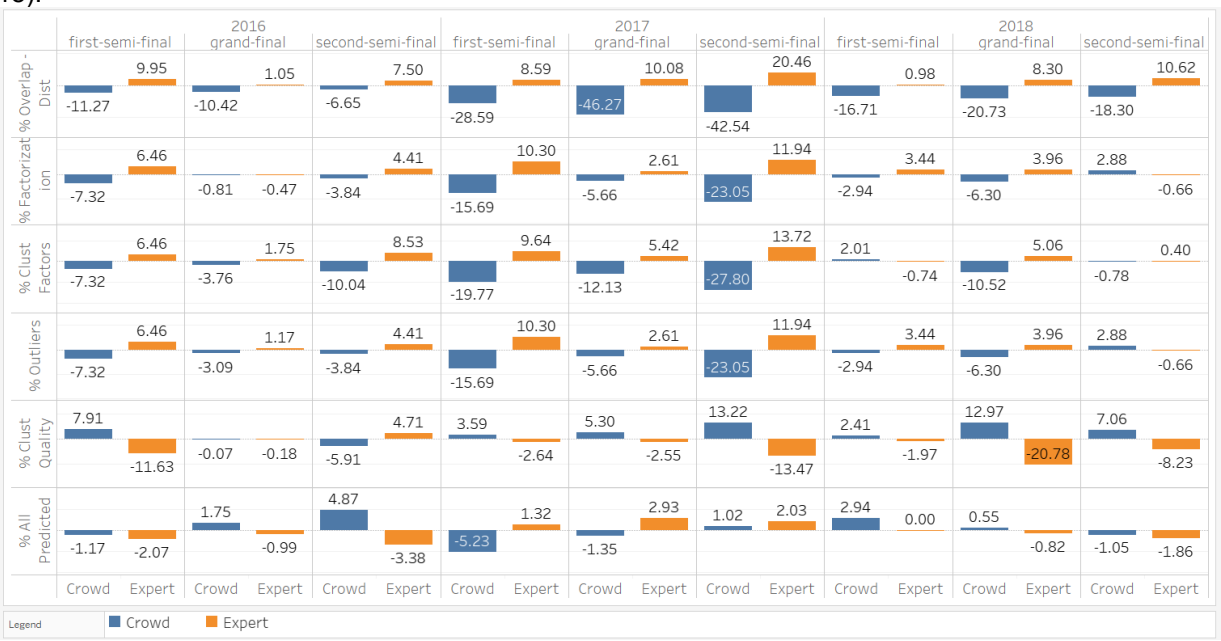

Figure 2: Detailed Results of methods used in "CrEx-Wisdom" framework

For the sake of clarity results from Figure 2 are summarized In Table 1 as a sum of relative changes of expert and crowd satisfaction for each method (columns) and each event (rows). Here, higher values are better since

positive values are obtained if the method succeeds to increase the satisfaction of both groups or to increase one satisfaction more than decrease another. It can be seen from Table 1 that newly proposed methods in most cases outperform all other methods.

Table 1: Results of summarized expert-crowd satisfaction change

Year	Event	Overlap	Factorization	Factors Clust	Outliers	Cluster QA	Predict ALS
2016	first-semi-final	-1.33	**-0.86**	**-0.86**	**-0.86**	-3.72	-3.24
2016	grand-final	-9.36	-1.27	-2.01	-1.92	-0.24	**0.75**
2016	second-semi-final	0.85	0.57	-1.51	0.57	-1.20	**1.49**
2017	first-semi-final	-20.01	-5.38	-10.13	-5.38	**0.95**	-3.91
2017	grand-final	-36.19	-3.05	-6.71	-3.05	**2.75**	1.59
2017	second-semi-final	-22.08	-11.11	-14.07	-11.11	-0.25	**3.05**
2018	first-semi-final	-15.73	0.50	1.27	0.50	0.44	**2.94**
2018	grand-final	-12.43	-2.34	-5.46	-2.34	-7.81	-0.27
2018	second-semi-final	-7.68	**2.21**	-0.39	**2.21**	-1.17	-2.90

Since, the goal of this research is essentially multi-objective (maximization both crowd and expert satisfaction) we conducted additional analyses in Pareto terms. In cases where objectives are in disagreement, decision makers have to chose non-dominated solution based on their preferences towards different objectives. This is why we simulated decision makers preferences towards crowd and expert voters by assigning weights to aggregated expert and crowd votes (for all methods including current Eurosong method), and measured satisfaction of both groups. Weights are shown in Table 2.

Table 2: Weights for crowd and expert voters

Group	Weights										
Expert	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Crowd	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0

Figure 3 shows crowd satisfaction (y-axis) and experts satisfaction (x-axis) for different methods (color) and all weight combinations. Since crowd and expert satisfaction is measured as total distance between final ranks with voter ranks, smaller values are better (the best solutions are presented in the lower-left part of Figure 3). Due to a large number of points, we present the best performing method from (Kovacevic et al., 2020) research (named Factorization in a legend) along with two newly proposed methods (*clust_quality*, and *All-predicted*) and Eurovision contest voting referred as *No Method*. It can be seen, that in most cases, *All-predicted* method (purple) produced many non-dominated solutions that are satisfactory by both objectives. Additionally, it can be seen that other embedding based methods are in many cases dominant compared to the current voting system (green).

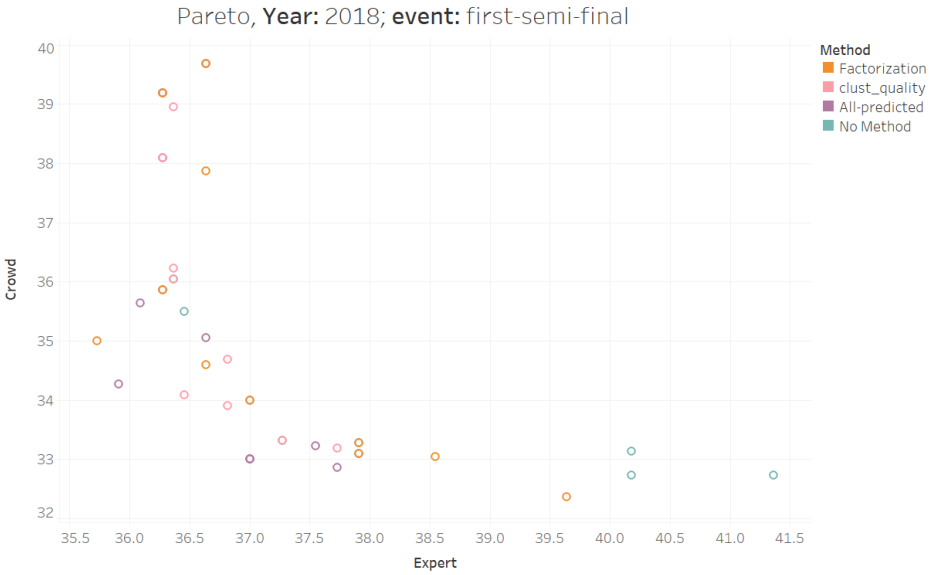

Figure 3: Pareto front of selected methods

5. CONCLUSION AND FUTURE WORK

In this paper, we proposed two machine learning based methods that utilize expert and crowd opinions for ranking problems. Methods are developed as a part of recently developed CrEx-Wisdom framework and it is shown that newly proposed methods can improve the satisfaction of both crowd and expert voters in a process of collective decision-making. In future work, we plan to evaluate existing methods on different industry problems. Additionally, we plan to adapt them for solving participatory budgeting problems.

ACKNOWLEDGMENTS

This paper is a result of the project ONR - N62909-19-1-2008 supported by the Office for Naval Research, the United States: *Aggregating computational algorithms and human decision-making preferences in multi-agent settings.*

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DECISION MAKING WITH FAIR RANKING

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Abstract: *Ranking is a responsible process because it involves working with sensitive attributes that can discriminate alternatives. Due to the availability of a large amount of data for automated processing, ranking is increasingly in use in decision making. Therefore, concepts of algorithmic fairness in the field of classification in machine learning find their place in fair ranking methods. This paper provides an overview of fair ranking terms, fair ranking challenges, and fair ranking algorithms from the state-of-the-art literature.*

Keywords*: decision making, fair ranking, algorithmic fairness, discrimination*

1. INTRODUCTION

Ranking is at the core of decision making. Decision-makers first rank alternatives according to a set of criteria and then choose the best or top k best alternatives. Ranking is part of the standard procedure of many decision-making established methods, for example, ranking options according to their obtained utility in the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) or in the Analytic Hierarchy Process (AHP). It can also provide input data in decision-making processes. In collective decision making, decision-makers can easily collect data by using an ordinal scale. For example, voters can rank alternatives according to some single-winner voting rules (e.g., Borda, Condorcet) or multi-winner voting rules (e.g., Chamberlin-Courant), or participants can rank options in questionnaires (e.g., by using the Lickert scale).

Because ranking simplifies decision-making information (Kulhman et al., 2019), it has frequent applications. Ranking objects can be universities (Johnes, 2018), researchers and research teams (Vavryčuk, 2018), job applicants (Encheva, 2019), etc. Also, an increasing number of algorithms process online data based on which personalized recommended systems provide users with ranked options according to their preferences. However, since simplicity produces inequity (Kleinberg & Mullainathan, 2019), ranking from the viewpoint of ethical consideration of algorithmic discriminatory bias is the focus of interest in the field of fair machine learning.

Machine learning algorithms can deepen the already existing bias among historical data. Considering *sensitive* attributes (such as race, gender, age, religion, ethnicity, health status, income, etc.), they learn from already presented discriminatory practices and embed them into future decisions. Even acting against intentional discrimination does not guarantee to eliminate bias. In the case of excluding *sensitive* attributes from consideration (for which *protected* attributes is a synonym in the law), there is still a correlation in the data (Hajian et al., 2016). For example, regardless of gender hiding, occupation-gender associations from historic human-like biases still exist (Caliskan et al., 2017); therefore, a proxy for the *protected* attribute. Eliminating *sensitive* attributes can, on the contrary, additionally harm already disadvantaged groups (Corbett-Davies & Goel, 2018). Hence, ranking models used in automated decision making demand development of fairness ranking measures to protect underprivileged groups appropriately.

The paper aims to contribute to the existing corpus of knowledge in the field of fair ranking, by summarizing fair ranking terms, identifying challenges of fair ranking, and resuming proposed algorithms from the state-of-the-art literature. Conclusion remarks contain guidelines for further work to support the efforts in this field.

2. RELATED WORK

Fairness doctrine acts against discrimination of minority groups (group-level fairness) or individuals (individual fairness). In machine learning, fairness principally focuses on the classification outcome of observed subjects (e.g., an applicant is awarded funds or not). Group-level fairness techniques include a set of criteria that support the equalization of positive outcomes across groups (e.g., *demographic parity* or *statistical parity* criterion requires equality in the proportion of positive outcomes across sub-populations). Here, a feature (i.e., *sensitive* attribute) divides the population into two or more disjoint groups, from which at least one is disadvantaged because of past discriminatory stereotypes that become a part of wrongly grounded predictions.

Individual fairness advocates consistency, in the sense that similar individuals should have similar outcomes. One example of individual fairness measure is *counterfactual fairness.* According to Kusner et al. (2017), it requires the same predictions for an individual in the actual world and a counterfactual world (where the individual is a member of a different demographic group).

Gajane and Pechenizkiy (2017) point out that algorithmic fairness in machine learning except considering parity in impact (i.e., result), can also require equality in treatment (i.e., the process of classification). For example, *unawareness* (or *„anti-classification"*) requires not explicitly usage of *sensitive* attributes in the decision-making process. Also, algorithmic fairness can focus on accuracy and errors. For example, *equalized odds* require equal accuracy – *true-positive rates* and *false-positive rates* across all groups (Hardt et al., 2018). The same authors introduce *equal opportunity* that imposes an equal *true-positive rate* independently from the group membership. C*alibration* observes applicants with a specified risk score (Corbett-Davies & Goel, 2018); it requires equal *false-negative rates* among them.

2.1. Fair ranking terms

A fair ranking is a ranking without discrimination of ranked items, with particular emphasis on items that belong to disadvantaged/protected groups. Having that in mind, according to Castillo (2019), the fair ranking should satisfy at least the following conditions:
It should avoid statistical bias (which means sufficient presence of items across groups);

- It should fulfill individual fairness (which demands a consistent treatment of similar items); and
- It should provide a proper representation of items in the ranked population.

Literature about fair ranking includes various terms – criteria, metrics, and measures (listed and defined in Table 1). Kuhlman et al. (2019) present the following criteria: *rank equality*, *rank calibration*, and *rank parity*, and supporting pairwise error metrics for two observed groups that compare the actual ranking and the learned ranking. Zehlike et al. (2017) suggest a fair top-k ranking set of criteria: *selection utility*, *ordering utility*, and *ranked group fairness*. Different metrics are in circulation, for example, for search (Wang et al., 2013). Yang & Stoyanovich (2017) provide three measures of *statistical parity* (for more information, please see Table 1). Concerning the actors, Burke (2017) identifies several criteria in recommendation systems. Castillo (2019) distinguishes attention-based and probability-based measures.

Table 1: Fair ranking terms

Name of the term	What does it present?	Definition	Author(s)
Rank equality	Criterion	"No group should be unfairly privileged or penalized compared to another group" when ranking.	Kuhlman et al. (2019, p. 2939)
Rank equality error	Measure	It represents the ratio of the number of discordant mixed pairs and the total number of mixed pairs (which include one object from each group).	Kuhlman et al. (2019)
Rank calibration	Criterion	A probabilistic classifier should predict the ranking of objects from each group appropriately.	Kuhlman et al. (2019)
Rank calibration error	Measure	It represents the ratio of the number of discordant pairs that contain objects from the target group and the total number of pairs that contain at least one object from the target group.	Kuhlman et al. (2019)
Rank parity	Criterion	*Statistical parity* in the top-k prefix of a ranking.	Yang and Stoyanovich (2017), Kuhlman et al. (2019)
Rank parity error	Measure	It represents the ratio of the number of pairs from the learned ranking that favors one group over another, and the total number of mixed pairs.	Kuhlman et al. (2019)
Selection utility	Criterion	Each top-k applicant is more qualified compared to each applicant outside of the top-k.	Zehlike et al. (2017)
Ordering utility	Criterion	Top-k applicants "should be ordered by decreasing qualifications."	Zehlike et al. (2017, p. 1572)
Ranked group fairness	Criterion	Top-k applicants "should fairly represent the protected group."	Zehlike et al. (2017, p. 1572)

Normalized discounted cumulative gain (NDCG)	Metrics	It represents a normalization of DCG measure, which is a weighted sum of relevance degree of ranked items. Commonly used in the search, the weight represents a decreasing function of object rank (i.e., position).	Wang et al. (2013)
Rank drop	Metrics	It shows the maximum number of positions that one object has lost on the ranked list.	Kuhlman et al. (2019)
Normalized discounted difference (*rND*)	Measures	It calculates the difference in the proportion of applicants from the protected group between top-k and the overall population.	Yang and Stoyanovich (2017)
Normalized discounted KL-divergence (*rKL*)	Measures	It calculates the expectation of the difference of protected group membership between top-k and the overall population.	Yang and Stoyanovich (2017)
Normalized discounted ratio (*rRD*)	Measures	It is similar to *rND*, but it can be applied only if the protected group numerically encompasses at most 50% of the population (i.e., a smaller part), and when fairness probability is less than 0.5.	Yang and Stoyanovich (2017)
C-fairness	Criterion	It requires fairness for consumers (or subjects), considering the disparate impact of the recommendation on their protected classes.	Burke (2017)
P-fairness	Criterion	It requires fairness for providers (or objects) only.	Burke (2017)
CP-fairness	Criterion	It requires fairness for both consumers and providers, which is a case in the reciprocal recommendation or when both belong to protected groups.	Burke (2017)
Attention-based measures	Measures	They measure whether actual or potential attention (e.g., the fairness of exposure (Singh and Joachims, 2018) vs. disparate treatment).	Castillo (2019)
Probability-based measures	Measures	They measure deviations between the expected and observed characteristics of the ranking.	Castillo (2019)

3. CHALLENGES OF FAIR RANKING

Several problems of fair ranking impose essential limitations in the literature:

- The design of ranking systems should suit the ranking issue (Asudeh et al., 2019), so there are no guarantees for universal solutions.
- Ranking accuracy is often important for all positions in the rankings, not just among the top k ranks (Kuhlman et al., 2019). One such situation is applying for funds when applicants on positions below the line remain without funds. Still, if they received funds, then the significance of their positions/ranks becomes less important.
- Measuring errors in ranking models requires metrics according to the task (Kuhlman et al., 2019), for example, binary notation of classes for *true-positive rate* and *true-negative rate*, and development of fair metrics for ranking objects - e.g., researchers, etc.
- The ranking process is susceptible. Singh and Joachims (2018, p. 2220) point out that even “small differences in item relevance can cause a large difference in exposure and therefore economic opportunity across groups.”
- Transparency of ranking models and explainable rankings become increasingly important requirements. Many recommendation systems have their ranking algorithms. However, the question arises as to the transparency of ranking procedures. How does the rank join the ranking objects? What is behind the rank? Does it justify the quality in terms of meeting the prescribed ranking criteria? Although transparency would help build trust, it is still rare in search engines and web platforms (Castillo, 2019).
- Gajane and Pechenizkiy (2017) conclude that it is difficult to quantify and mathematically formalize social issues (e.g., such as unequal access to resources). However, they stress the importance of finding a way to incorporate those issues in fairness formalizations.
- It is essential to know what you try to rank because the accurate and understandable ranking models are not possible without extensive and proper knowledge about details of ranking objects (Schoenhagen, 2019). So, ranking systems should first effectively elicit data from users in order to satisfy their needs (Schoenhagen, 2019).
- Harmonizing individual and group fair metrics at the same time is a challenging task, and often unattainable. Therefore, in many cases, it is justified to define an acceptable threshold. But again, the question remains on what basis experts define those thresholds.

4. FAIR RANKING ALGORITHMS

Various fair ranking algorithms (and related methods/frameworks/approaches) from the literature aim to resolve fair ranking problems. Table 2 summarizes some of them.

Table 2: Fair ranking algorithms

Name of algorithm	What does it do?	Author(s)
FARE (Fair Auditing based on Rank Error)	It provides fairness diagnostics for error-based fairness criteria customized for ranking.	Kuhlman et al. (2019)
FA*IR	It is a post-processing method and algorithm for solving the problem of fair top-k ranking.	Zehlike et al. (2017)
DELTR (Disparate Exposure in Learning to Rank)	It is an in-processing approach that addresses the potential issue of disparate exposure when ranking.	Zehlike et al. (2020a)
FairSearch	It is an open-source library that provides fairness in ranked search results.	Zehlike et al. (2020b)
Ranking with Fairness Constraints	It is a linear time approximation algorithm of constrained ranking maximization problem used for processing ethical data.	Celis et al. (2017)
Designing Fair Ranking Schemes	It provides scoring ranking functions that use a weighted sum of numeric attribute values.	Asudeh et al. (2019)
Fairness of Exposure in Rankings	It allows expression of fairness constraints on rankings concerning exposure allocation.	Singh and Joachims (2018)
iFair	It advocates for individual fairness.	Lahoti et al. (2019)

5. CONCLUSION REMARKS

The use of ranks simplifies information for decision-makers, but the process of assigning ranks to objects is undoubtedly not a simple one. Fair ranking is a complex task, as there are different forms and sources of discrimination, and therefore different criteria and measures. This paper gives an overview of them. To overcome the identified challenges in this area, Figure 1 shows guidelines for in-processing steps of the decision-making process with fair ranking.

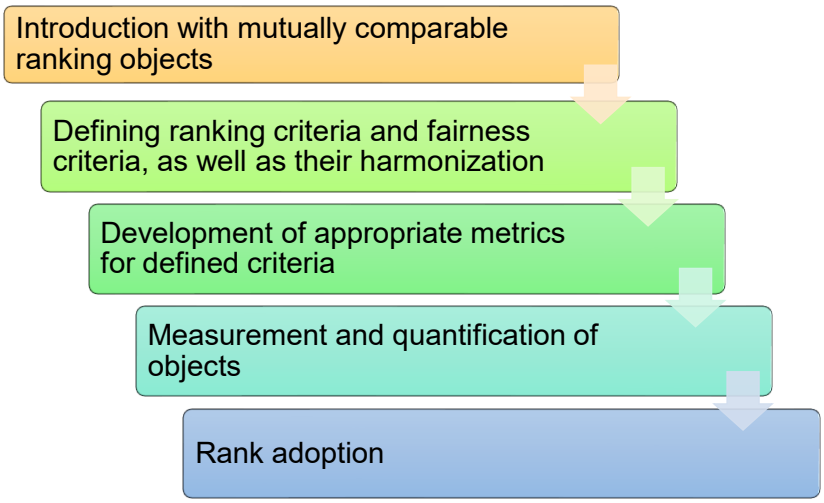

Figure 1: In-processing steps of the decision-making process with fair ranking

The ability to find and rank data in the age of the Internet and Big data is a great advantage (Schoenhagen, 2019) but, at the same time, a responsibility. The paper points out some of the prominent algorithms in this area. Therefore, fair machine learning has a task to prevent further development of algorithmic discriminatory practices.

ACKNOWLEDGMENTS

This paper is the result of the project ONR - N62909-19-1-2008 supported by the Office of Naval Research, the United States: *Aggregating computational algorithms and human decision-making preferences in multi-*

agent settings. The Ministry of Education, Science and Technological Development of the Republic of Serbia also supports the paper.

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DYNAMICS AND CLUSTERS OF THE EUROPEAN PARLIAMENT VOTING RESULTS. HOW DOES THE EUROPE VOTE?

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Abstract: *The European Parliament elections are one of a kind phenomenon in the world's political system. Having in mind that the European parliament is the vital part of the European Union, the importance of these elections is undeniable. However, the process is very specific since the voters from 28 countries are choosing their representatives from different national and political environments. Yet, they are forming a mutual political body that will shape the European politics. In this paper, we examine the dynamics of the 2019 voting outcomes. Based on the Spearman's correlation coefficient, we inspect if voting results for a specific political group affect the results for some other, based on the sample from 28 EU countries voting results. In addition, by using Ward's linkage, we analyze if it is possible to group the countries into clusters based on the voting outcomes. The results indicate that there is a statistically significant correlation between some parties. Also, the hierarchical cluster analysis gave 7 clusters that indicate that the voting results are similarly classified as the level of economic development and perception of the EU within the country. These results can be used in the process of the campaign for the next elections and suggest the parties where to put more effort when promoting their political programmes. In order to obtain more relevant results, the research should be verified by examining the results of the previous and future elections.*

Keywords*: European Parliament, voting system, political parties, cluster analysis*

1. INTRODUCTION

The European parliament represents the vital part of European Union. Together with the Council of Ministers and the European Commission, European parliament constitutes the legislative power of the European Union. Even though, the very beginning of the Parliament goes to 1952, since the 1970, European Parliament has very important role. Together with the European Council, they had control over the European Union budget. With the greater power, responsibilities are also increased. Every five years from the 1979, parliament has been elected through the elections by its citizens. The European Parliament elections are one of a kind phenomenon in the world's political system. Having in mind that the European parliament is the vital part of the European Union, the importance of these elections is undeniable. Consequently, it is very interesting to observe the dynamics of the voting outcomes. In spite the fact that the turnout of elections through the years has dropped, the results from this year are promising. Total number of the members of European parliament is 751, which represent more than 512 million people from 28-member countries. It should be mentioned than this number will be reduced to 705 after the leaving of the United Kingdom from the European Union.

Voting for the members of the European parliament is usually organized in the end of May, but the dates are different in each country. Total number of members from each country is depends on the surface of each country, and thus the most members (votes) are from Germany (96), while the Cyprus, Estonia, Luxembourg and Malta has the lowest number of members (6). The European parliament elections are very specific since they are performed in 28 different national and political environments. Yet, they are forming a mutual political body that will shape the European politics. This paper examines how the voting results differ among the member countries, the dynamics of the 2019 voting results and whether the voting results for a specific political group affect the results for some other. The paper examines whether it is possible to make clusters of countries based on the voting results. Having in mind the proposed research questions, the paper is structured as follows: Section 2 gives the literature review that explains the purpose and specific characteristics of the European parliament elections, Section 3 presents the latest results and explains

details on the collected data and methodology, Section 4 provides the results and discussion on the obtained results. In the end, Section 5 gives the concluding remarks.

2. LITERATURE REVIEW - HOW DOES THE EUROPEAN PARLIAMENT WORK?

European Parliament is a very specific governmental body, since its role is different than the national parliament of country. The main roles of the EU parliament are (European Parliament, 2016; Deutsche Welle, 2017):

- Co-legislator (with Council) – adopts and amends legislative proposals and decides on the EU budget
- Supervisor – monitors the implementation of the budget and work of the EU commission and other bodies.
- Mediator – communicates with national parliaments of member states for getting their feedback and inputs.

The Parliament has 751 members from 7 political groups that are participating in the work of 22 committees (European Parliament, 2019). This specific body is in the typology of multi-level political systems classified as interlocking and collegial executive political system (Hix, 1998). This means that the EU parliament is a system where the central and state governments share executive functions with “dual leadership” system (Hix, 1998). From another perspective, collegial institutional design signifies that executive authority is nominally accountable to a legislative majority. In this kind of system, the process of election is a challenging activity and it demands properly defined system of rules and activities. European parties have very specific challenge to reach cohesion since their members are nationally decentralized. It is important to emphasize that members are not individuals, but the national political organizations (Hrbek, 2012). Thus, communication and networking are crucial activities that aim to provide coherent organizational structure. However, the voters’ behavior is very interesting as a phenomenon to be observed in this kind of voting system. Generally, citizens do not have much knowledge of the implemented policies at European parties (Franklin & Hobolt, 2015). Marsh and Mikhaylov (2010) state that “Elections were meant to help to establish a common identity among the peoples of Europe, to legitimise policy through the normal electoral processes and provide a public space within which Europeans could exert a more direct control over their collective future”. On the other hand, European elections are somewhat not meaningful in terms of the executive power, since national institutions have greater executive authority than the European for most fields of public policies (Hix, 1998). Nevertheless, representatives of the parties use these elections to evaluate their local agendas at the national level. The results of these election do not affect the national environment or governments in any way, so there is also no direct effect on the national policy and circumstances, which, consequently implies low turnout since many Europeans are not interested in taking part in the European elections (Franklin & Hobolt, 2015; Marsh & Mikhaylov, 2010). Due to these circumstances, in 2019 some states (i.e. Belgium and Luxembourg) have had laws that made voting mandatory for all eligible voters (Russo, 2018; Besch, & Scuto, 2019). In comparison with the last elections from 2014 where turnout was 42.61%, this year it was more than 50%, or even more precisely 50.97%. Lowest turnout was in Slovakia with the 22.74%, but still better than the elections from 2014 where only 13.05% of citizens from Slovakia voted. Traditionally, citizens of Belgium are the most responsible with these elections and their turnout for last election was 88.47%. Increased turnout in 2019 comparing to elections from 2014 is evident, but the biggest positive difference regarding turnout was made by Poland (21.85%), Spain (20.49%) and Romania (18.63%). On the other hand, negative turnout was noticed in Bulgaria (-5.01%), Ireland (-2.74%), Italy (-2.72%), Portugal (-2.27%), Malta (-2.1%), Luxembourg (-1.45%), Greece (-1.45%) and Belgium (-1.17%) (European Parliament, 2019b). Some authors claim that the citizens will be more interested in taking participation in EU elections if the authorities make it more personalized and if the candidates are more exposed in media (Gattermann & De Vreese, 2017).

In addition, Franklin & Hobolt (2015) claim that there are two main factors that affect the result of the elections:

1. Voters do not vote for the parties that they normally vote for in European elections, and
2. There is a high level of abstention that affects some parties more than others.

In this paper, we will examine the 2019 European Parliament election results. We will examine the correlation between the number of seats within a country and votes for a specific political group. In addition, we will perform a cluster analysis based on the election results to observe if there is a voting pattern in some group of countries.

3. METHODS

In order to analyze the results of 2019 European elections, official election results were taken from the Election results website (European Parliament, 2019b). Data used for analysis represents the number of

seats in the European Parliament for a political group within a country and indicate how many seats each political group received from each EU country. Data used for the analysis is shown in Table 1. Based on the results displayed in Table 1 we can see that the countries with the largest surface also have the highest number of seats in the European Parliament. Thus, Germany has 96 seats (12.78% of the total number of seats), followed by France with 74 seats, Italy and United Kingdom with 73 seats. On the other hand, Cyprus, Luxemburg, and Malta have only 6 seats.

Table 1: Number of seats in the European Parliament by political group and country

Country	EPP	S&D	ECR	RE	GUE/ NGL	Greens/EFA	ID	NI	Seats
Austria	7	5		1		2	3		**18**
Belgium	4	3	3	4	1	3	3		**21**
Bulgaria	7	5	2	3					**17**
Croatia	4	3	1	1				2	**11**
Cyprus	2	2			2				**6**
Czechia	5		4	6	1	3	2		**21**
Denmark	1	3		5	1	2	1		**13**
Estonia		2		3			1		**6**
Finland	3	2		3	1	2	2		**13**
France	8	5		21	6	12	22		**74**
Germany	29	16	1	7	6	25	11	1	**96**
Greece	8	2	1		6			4	**21**
Hungary	13	5		2				1	**21**
Ireland	4			1	4	2			**11**
Italy	7	19	5				28	14	**73**
Latvia	2	2	2	1		1			**8**
Lithuania	4	2	1	2		2			**11**
Luxembourg	2	1		2		1			**6**
Malta	2	4							**6**
Netherlands	6	6	4	6	1	3			**26**
Poland	17	8	26						**51**
Portugal	7	9			4	1			**21**
Romania	14	10		8					**32**
Slovakia	4	3	2	2				2	**13**
Slovenia	4	2		2					**8**
Spain	12	20	3	8	6	2		3	**54**
Sweden	6	5	3	3	1	2			**20**
UK		10	4	17	1	11		30	**73**
EU	**182**	**154**	**62**	**108**	**41**	**74**	**73**	**57**	**751**

Note: **EPP** - Group of the European People's Party (Christian Democrats), **S&D** - Group of the Progressive Alliance of Socialists and Democrats in the European Parliament, **RE** - Renew Europe group, **Greens/EFA** - Group of the Greens/European Free Alliance, **ID** - Identity and Democracy, **ECR** - European Conservatives and Reformists Group, **GUE/NGL** - Confederal Group of the European United Left - Nordic Green Left, **NI** - Non-attached Members.
Source: European Parliament (2019)

In terms of seats won by each political group, The Group of the European People's Party won almost a quarter of the total number of seats, which is 182 seats in European Parliament. The second political group with the most seats is The Group of the Progressive Alliance of Socialists and Democrats in the European Parliament with 154 seats. On the other hand, 57 seats (7.59% of total seats) are occupied by members who did not join any established political group.

Prior to the data processing, the data displayed in the Table 1 has been standardized by dividing the numbers of seats each country gave to a political group by the total number of seats that country have. With standardization of values, problem of the drastic difference in the number of seats held by large and small countries has been avoided.

For the analysis of the collected data, we used statistical software package IBM SPSS 24 (IBM Corp, 2016). In order to evaluate the characteristics of the sample, we used descriptive statistics. The Kolmogorov-Smirnov test was used to determine whether the standardized values for each political group were normally distributed (Vukovic & Bulajic, 2014). Since data were not distributed normally and sample size is small ($n<30$), nonparametric Spearman's rho correlation was used to indicate if the correlation between two political groups is statistically significant (where $p<0.05$ is considered significant at the 95% confidence level and $p<0.01$ is considered significant at the 99% confidence level) (Cohen, 1988).

Additionally, we wanted to group countries into specific clusters based on the percentage of seats given to the political groups. Thus, we used a hierarchical classification using Ward's linkage (Kovačić, 1994).

4. RESULTS

In order to examine the 2019 European election results, we performed a standardization of initial values given in the Table 1. This process transformed data to a scale from 0 to 1, showing the percentage of seats that each country gave to political parties relative to the total number of seats country had. The transformed data is shown in Table 2.

Table 2: EU countries' standardized data

Country	EPP	S&D	ECR	RE	GUE/NGL	Greens/EFA	ID	NI
Austria	0.389	0.278	0.000	0.056	0.000	0.111	0.167	0.000
Belgium	0.190	0.143	0.143	0.190	0.048	0.143	0.143	0.000
Bulgaria	0.412	0.294	0.118	0.176	0.000	0.000	0.000	0.000
Croatia	0.364	0.273	0.091	0.091	0.000	0.000	0.000	0.182
Cyprus	0.333	0.333	0.000	0.000	0.333	0.000	0.000	0.000
Czech Rep.	0.238	0.000	0.190	0.286	0.048	0.143	0.095	0.000
Denmark	0.077	0.231	0.000	0.385	0.077	0.154	0.077	0.000
Estonia	0.000	0.333	0.000	0.500	0.000	0.000	0.167	0.000
Finland	0.231	0.154	0.000	0.231	0.077	0.154	0.154	0.000
France	0.108	0.068	0.000	0.284	0.081	0.162	0.297	0.000
Germany	0.302	0.167	0.010	0.073	0.063	0.260	0.115	0.010
Greece	0.381	0.095	0.048	0.000	0.286	0.000	0.000	0.190
Hungary	0.619	0.238	0.000	0.095	0.000	0.000	0.000	0.048
Ireland	0.364	0.000	0.000	0.091	0.364	0.182	0.000	0.000
Italy	0.096	0.260	0.068	0.000	0.000	0.000	0.384	0.192
Latvia	0.250	0.250	0.250	0.125	0.000	0.125	0.000	0.000
Lithuania	0.364	0.182	0.091	0.182	0.000	0.182	0.000	0.000
Luxembourg	0.333	0.167	0.000	0.333	0.000	0.167	0.000	0.000
Malta	0.333	0.667	0.000	0.000	0.000	0.000	0.000	0.000
Netherlands	0.231	0.231	0.154	0.231	0.038	0.115	0.000	0.000
Poland	0.333	0.157	0.510	0.000	0.000	0.000	0.000	0.000
Portugal	0.333	0.429	0.000	0.000	0.190	0.048	0.000	0.000
Romania	0.438	0.313	0.000	0.250	0.000	0.000	0.000	0.000
Slovakia	0.308	0.231	0.154	0.154	0.000	0.000	0.000	0.154
Slovenia	0.500	0.250	0.000	0.250	0.000	0.000	0.000	0.000
Spain	0.222	0.370	0.056	0.148	0.111	0.037	0.000	0.056
Sweden	0.300	0.250	0.150	0.150	0.050	0.100	0.000	0.000
UK	0.000	0.137	0.055	0.233	0.014	0.151	0.000	0.411
EU	**0.242**	**0.205**	**0.083**	**0.144**	**0.055**	**0.099**	**0.097**	**0.076**

Based on the values in Table 2, we can see that only Germany has allocated its seats to each of the political groups along with non-attached members. Regarding the largest number of seats, Group of the European People's Party (30.2%) and Group of the Greens/European Free Alliance (26%) took more than 50% of the seats Germany has. France allocated most of its seats to Renew Europe group (28.4%) and Identity and Democracy group (29.7%), while in Italy the largest number of seats received Identity and Democracy group (38.4%) thanks to the Lega Salvini Premier party. The fact that as many as 41.1% of the seats held by the United Kingdom have not been allocated to any of the recognized political groups is certainly affiliated with Brexit. While a large number of countries have redistributed their seats to almost all political groups, Poland has given all its seats to only three political groups, with - European Conservatives and Reformists Group receiving 51%, Group of the European People's Party 33.3% and Group of the Progressive Alliance of Socialists and Democrats in the European Parliament 15.7% of seats. This allocation of seats is influenced by the fact that two political parties stood out in the polls in Poland – Prawo and Sprawiedliwość, and the Coalition Europeans, which together won more than 80% of the vote.

To answer the research question on the relationship between the voting results among the parties (if a voting results for a specific political group affect the results for some other), we calculated Spearman's rho correlation over the standardized data. Statistically significant correlations are shown in the Table 3. Based on the results, it can be noted that there is a significant statistical relationship between S&D - Group of the Progressive Alliance of Socialists and Democrats in the European Parliament and Greens/EFA - Group of the Greens/European Free Alliance, with a confidence level of 0.01. With the correlation coefficient rho=-0.587, we can conclude that there is a strong negative correlation. In other words, when an EU country prefers S&D political group, the Greens/EFA group will achieve low score. Also, based on the negative

correlation coefficient rho=-0.518 ($p<0.01$) between Group of the European People's Party and Identity and Democracy group. We can conclude that the Identity and Democracy group will achieve lower number of votes in those countries that prefer the Group of the European People's Party. On the other hand, there is a positive correlation between Greens/EFA - Group of the Greens/European Free Alliance and GUE/NGL - Confederal Group of the European United Left - Nordic Green Left (rho=0.381, $p<0.05$), which indicates both parties will achieve similar results (low or high) within a certain country. Correlation results between other parties are not statistically significant.

Table 3: Spearman`s rho correlation

			EPP	ID	S&D	Greens/EFA	GUE/NGL
Spearman's rho	EPP	Correlation Coefficient	1.000	**-.518****	.188	-.340	-.270
		Sig. (2-tailed)	.	.005	.339	.077	.165
	ID	Correlation Coefficient	**-.518****	1.000	-.193	.269	.076
		Sig. (2-tailed)	.005	.	.325	.167	.701
	S&D	Correlation Coefficient	.188	-.193	1.000	**-.587****	-.290
		Sig. (2-tailed)	.339	.325	.	.001	.135
	Greens/EFA	Correlation Coefficient	-.340	.269	**-.587****	1.000	**.381***
		Sig. (2-tailed)	.077	.167	.001	.	.046
	GUE NGL	Correlation Coefficient	-.270	.076	-.290	**.381***	1.000
		Sig. (2-tailed)	.165	.701	.135	.046	.

In the second part of the research, we wanted to examine if it is possible to make clusters of countries based on the voting results. For this purpose, a hierarchical classification using Ward's linkage was used to group countries according to the percentage distribution of seats by political groups. The distance between countries was calculated using the Squared Euclidian distance. Based on the obtained results, solution with 7 clusters were most convenient for the interpretation of the results. According to the Ward's linkage, the countries were grouped as following:

- [Group 1] - Austria, Croatia, Germany, Lithuania, Latvia, Luxembourg, Holland, Slovakia, Spain and Sweden
- [Group 2] - Bulgaria, Hungary, Romania and Slovenia
- [Group 3] - Belgium, Czech Republic, Denmark, Estonia, Finland and France
- [Group 4] - Cyprus, Malta and Portugal
- [Group 5] - Greece and Ireland
- [Group 6] - Italy and United Kingdom
- [Group 7] - Poland

The first group contains as many as 10 countries, making it the largest group. It mainly consists of Western European countries. Based on the dendogram shown in Figure 1, we can see that also Slovakia and Croatia are merged as the most eastern countries in the group, but also one of the youngest EU members. This group mainly consists of countries with strong economy and development. The second group consists of the countries located in Balkans, Bulgaria, Hungary, Romania and Slovenia. The third cluster includes France, Belgium and Czech Republic in addition to the Scandinavian countries, Denmark, Finland and Estonia. The fourth group belonged to Portugal, Malta and Cyprus, so this cluster can be named the Mediterranean Cluster. In the fifth group there are Greece and Ireland, countries that have faced major financial crisis in recent history (Lacina & Vavřina, 2014). The sixth group includes Italy and United Kingdom. The United Kingdom is a step away from leaving the European Union, while Italy is a country that has a lot of debt to the EU, and some authors claim that there are some indications that Italy could possibly leave the Euro area (Franchino & Segatti, 2019; Bordignon & Baglioni, 2019). In the last group is only one country, Poland. What set this country apart is the fact that in the elections in Poland were very uncertain where only two political parties stood out as competitors. The result was that Poland's seats in the EU were reassigned to only three European political parties. These 7 clusters show that the most countries voting results depend on the level of their economic development and perception of their status in the EU.

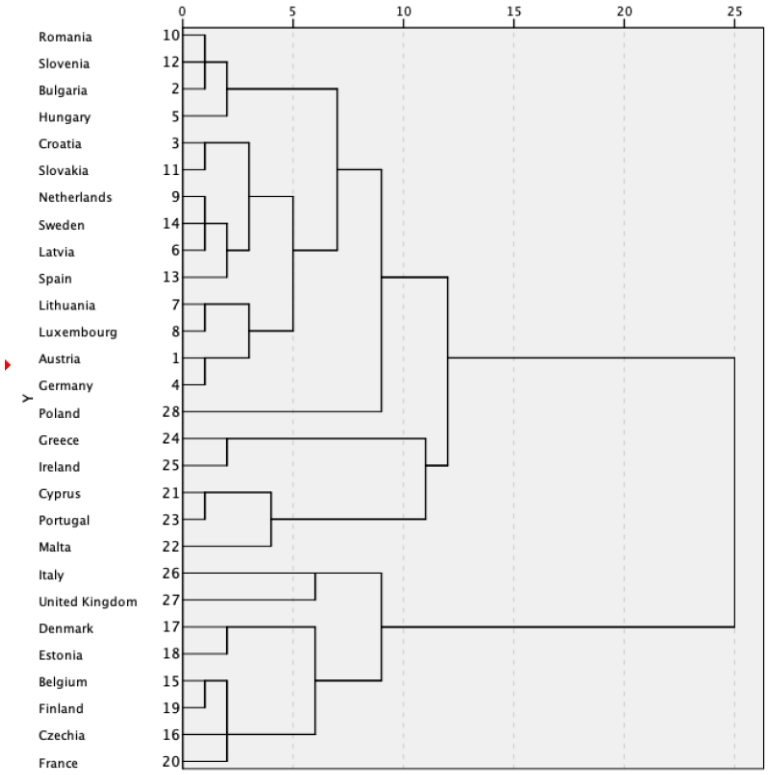

Figure 1: Cluster analysis results - dendogram

5. CONCLUSION

In this paper we examined the dynamics of the European Parliament 2019 voting results. The research was focused on two main research questions: whether it is possible to determine the relationship between the voting results that parties achieve in a certain country, and whether it is possible to cluster countries according to their voting results.

The provided results indicate that some parties are significantly correlated with the results of the others. S&D - Group of the Progressive Alliance of Socialists and Democrats and the European Parliament and Greens/EFA - Group of the Greens/European Free Alliance has strong negative correlation, and when an EU country prefer S&D political group, the Greens/EFA group will achieve low score. Similarly, the Identity and Democracy group reaches lower number of votes in those countries that prefer the Group of the European People's Party. On the other hand, positive correlation between Greens/EFA - Group of the Greens/European Free Alliance and GUE/NGL - Confederal Group of the European United Left - Nordic Green Left, indicates that both parties tend to achieve similar results within a country.
Hierarchical cluster analysis performed by Ward's linkage gave 7 clusters, out of which the main one consists of 10 countries, mostly western ones with high level of economic development. Other clusters were made according to the national similarity and perception of their status within EU. These results supported by detailed analysis of previous and future voting results could be used by the political parties in their campaigns for the next elections and suggest the where to put more effort when promoting their political programmes. However, for more in-depth analysis there should be examined cultural differences and political consciousness of the voters. It would be interesting to examine if the way in which the elections are organized affect the results, since some countries organize the polls on Sundays while others have midweek voting. Nevertheless, this research is a good starting point that shows how the European citizens vote and how they perceive political parties in European parliament.

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APPLICATION OF DATA RESEARCH METHODS IN SUPPLY FORECASTING

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Abstract: *The aim of this paper is to present the data research methods in forecasting the necessary levels of supplies and relevant model of the system for acquiring necessary information and, based on that, to propose improvements in the supply system by utilizing contemporary program tools for decision support. Aim of the research is to find adequate and relevant data research methods in forecasting the needed levels of supplies. Practical aim of the research is application of adequate data research methods to historical data on trends in supply of certain goods, using software tools Excel and WEKA in order to maintain adequate supply levels as close to the optimal levels as possible, which prevents the occurrence of deficit and surplus.*

Keywords*: supplies, data, machine learning, automation.*

1. INTRODUCTION

Supplies represent one of the most important elements when it comes to securing continuous manufacture and sales. Every business enterprise owns certain amounts of some supplies that they wish to reduce, that is, to invest as little money as possible in those supplies. The problem lies in identifying and applying the adequate way to determine the optimal amount of supplies.

Hypotheses relating to the analysis of the application of data research models are:

H1. It is possible to reliably forecast the necessary level of supplies of certain goods by utilizing the methods of historical data demand analysis.

H2. Standard data research methods by methods of machine learning are suitable to be used in forecasting the needed amount of resources necessary for maintaining the required supply levels.

2. ANALYSIS OF THE EXISTING SUPPLY MANAGEMENT METHODS

The first supply management systems had mostly been created in developed business sectors that had causal management models at their basis.

Suresh, Houmin, and Hanqin (2005, p. 375) discussed that corporations are facing problems that make it difficult to identify the optimal supply management model, and those problems reflect in the inability to predict the demand, in implementing heuristics in delivery, unreliable acquisition processes, delivery of great amount of goods, and short time period of demand for certain product.

2.1. Supply forecasting by methods of data research

Demand data are the basis for good system management and based on product demand data from the past it is possible to create the model for forecasting the future needs.

2.1.1. Statistical data research methods

Janičić and Nikolić (2016, p.210-211) discuss that statistics is a mathematical analysis that collects, analyses, interprets, explains and presents data. Statistical methods can be descriptive and inferential. Descriptive statistics engages in measures of central tendency (mean, median and mode) and measures of variability (variance, standard deviation, minimum and maximum variables, and kurtosis and skewness).

Leskovec, Rajaraman and Ulman (2014, p.322) discuss that time series analysis is one of the statistical disciplines that on the rise in recent years. Time series can be classified by various criteria and basic division includes continuous and discrete time series. Continuous time series are those that can be observed and registered at any time, while discrete time series can be registered only at particular time periods.

Objectives of time series analysis can be:
- Description – graphic and summary statistical statements are used
- Explanation – applied in case of dealing with number of time series where it is necessary to use variations of one in order to explain the variations of other series.
- Forecasting – this is primarily the research based on previous observations where time series models that are used in predicting the future values are identified and evaluated
- Control – interval transmission function model is generated and forecast is made based on this model.

2.1.2. Regression learning method

Berry and Linoff (2015, p.315) discuss that regression method is a subfield of data research in which, based on the values of the variables, the value whose domain is set of real numbers is forecasted. Regression enables continuous attributes forecast, and some of the models of regression are linear regression model and neural network model. Linear regression is a model that is linear in regard to variables, while neural network is nonlinear in regard to variables of a model.

Regression analysis represents:
- Matching equations with data
- Calculating expressions that forecast numerical quantities
- Statistical tool that examines relationships between variables
- Technique of forecast modeling, where the examined variables are continuous

Linear regression can be used for classification in the domain of numerical attributes, that is, regression techniques can be used for different types of classification. Regression of least squares assumes that attributes are not only statistically independent, but are also normally distributed with same standard deviation.

3. METHODS, MODELS AND CONTEMPORARY DATA RESEARCH TOOLS

By analyzing currently accepted methods and solutions in data research, it is noticed what their positive and negative effects are, as well as their results. It is seen that there are possibilities to create suggestions for data research and its application in deciding on the adequate quantity of supplies that need to be ordered and have in stock.

3.1. Data research process

Data research process is carried out in several steps and can be done by more than one person. Those steps can be observed in three different ways:
- Look at the problem important at the very beginning and the end of the process of data research
- Data transmission and preparation
- Data analysis, methods of selection, implementation, presentation and interpretation of the results.

3.2. Data research methods

Data research is the process of automatic or semiautomatic analysis of a large amount of data and discovering different patterns. By implementing and applying the methods of machine learning in data research explicit knowledge structures are attained. These are represented by structural descriptions and can largely be applied to new types of data and they have forecasting feature. For each product it is necessary to create and implement adequate data research model.

Berry and Linof (2000, p.177-180) point out "that tasks that need to be completed in the process of data research and finding adequate descriptive attributes for the subject are:
- Reduction means cutting down or leaving out the data not significant for the research.
- Estimation is the assessment of the value determined by the existing variables in a system.
- Classification is a process in which elements are placed into predetermined groups or classes.
- Clustering is a collection of elements which are similar to one another and which differ from the elements from other clusters.
- Association in data research has the role of identifying the rules in data base. "

3.3. Decision trees for machine learning

In order to predict the outcomes, decision trees use series of questions and rules to categorize data. A decision tree is created by branching and each branch is the result of a fulfilled condition from classification questions. The questions represent the way to distribute data to subsets.

Xindong and Vipin (2009, p.310-311) discuss about machine learning methods and optimization of a decision tree are heuristic methods. There are several mechanisms that are used in creating a decision tree from top to bottom, such as: ID3, C4.5, CART. Some of them have two conceptual phases: growth phase and pruning phase (C4.5 and CART). Mechanisms for building a decision tree use only growth phase. These types of algorithms build decision trees from top to bottom using recursive methods.

Moon (2013, p.155) discuss about problems that appear while building a decision tree are:

- How to divide training sets. Each recursive step of a tree building must select test attribute to divide examples set into smaller subsets.
- When to stop with recursive division. Stopping condition is necessary to stop the process of decision tree building. Although these conditions are enough to stop the algorithm, there are other criteria that can be set to enable earlier stop.

Decision tree continues to branch and grow until all the conditions of stopping criteria are met. According to Moon (2013, p.122) these are the conditions that represent the usual stopping rules

- All instances of the data set for building a decision tree belong to one type of the goal attribute;
- Maximum depth of the tree is achieved;
- Number of cases in the final nod is smaller than minimal number of cases that a parent nod can have;
- If the nod is divided, number of cases in one or more children nods, will be smaller than the minimal number of cases for child nod;
- The best division criterion is below certain threshold.

3.4. Regression trees learning methods

Regression trees also consist of attribute hierarchy from example description, but in the leaves of the tree discrete value of the qualitative attribute is not selected. Instead, the value of numerical goal attribute is selected. In practice very often happens that it is necessary to predict behavior of the class that has continuous numerical values.

Learning method of regression tree from system WEKA called M5' or M5P is applied. It was created by combining methods M5 and CART (Classification and Regression Trees). M5 is a system for developing machine learning models that predict numerical values. Like method CART, method M5 builds models based on trees. However, while regression trees have non-numerical values in their leaves, the tree constructed using M5 algorithm contains multiple linear models.

According to Evans and Towill (1995, p.227), these linear models are analog to hybrid functions, which consist of many linear sub-functions. M5P method can efficiently perform high-volume tasks.

Witten I.H. and Hall M.A. (2016, p.310) point out that "M5P method was created by combining M5 and CART. It differs from basic methods of regression trees which are used when the predicted algorithm output can be observed as a real number. In regression tree all the lines that do the partitioning are parallel to axes because every single nod check if some of the variables are bigger or smaller that the set value".

Model trees are very similar to regression trees, but each nod uses the function of linear regression in decision-making. To build the tree, Standard Deviation Reduction (SDR) is used:

$$SDR = sd(T) - \sum_i \frac{|Ti|}{T} * sd(Ti) \tag{10}$$

Where T and Ti represent sets of divided data that are in the nod. Described method is the method for model induction based on numerical data that include continuous classes. Certain alghoritm implementation is under certain conditions carried out faster or slower than some other implementation. Method M5 operates in a way that model is built based on training data set.

4. PROPOSAL OF THE SUPPLY FORECASTING METHOD

Classical methods imply statistical models for data research such as time series analysis, and contemporary data research methods are those like linear regression and regression trees.

Data used in this paper are excerpt from the data found on the website Kaggle, where there is a set of data of historical demand gathered from various companies and under the name of Historical Product Demand. Data excerpt contains data on daily demand for five selected products during 2015. Figure 1 represents structured appearance of analyzed data. In data analysis in this paper only the data from the column Date,

Order_Demand and Product_Code are used and they refer to total demand of specific products for the whole organization.

Date	Order_Demand	Product_Code	Warehouse	Product_Category
2015-01-01	2500	Product_0002	Whse_S	Category_005
2015-01-01	100	Product_0003	Whse_S	Category_005
2015-01-05	600	Product_0004	Whse_J	Category_005
2015-01-06	100	Product_0001	Whse_J	Category_005
2015-01-08	1000	Product_0002	Whse_C	Category_005
2015-01-08	1000	Product_0003	Whse_J	Category_005
2015-01-08	100	Product_0003	Whse_S	Category_005
2015-01-08	100	Product_0004	Whse_J	Category_005
2015-01-09	15000	Product_0002	Whse_S	Category_005
2015-01-09	2000	Product_0003	Whse_J	Category_005
2015-01-12	50000	Product_0002	Whse_S	Category_005
2015-01-13	100	Product_0004	Whse_J	Category_005
2015-01-14	503000	Product_0002	Whse_S	Category_005
2015-01-14	900	Product_0004	Whse_J	Category_005

Figure 1: Display of the part of the product order data table

The data in the other two columns, Warehouse and Product_Category, were not analyzed and are not used in this research because the method of predicting the need for data subsets on product demand for certain warehouses or product categories is the same and it comes down to formation of time sequences of demand by singling out the products based on those added criteria.

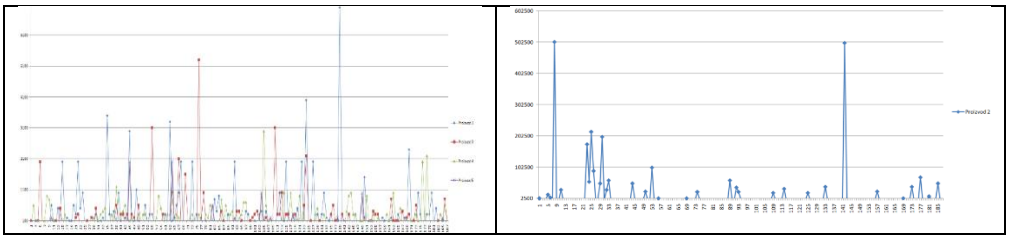

Figure 2: Distribution and order for 5 products (1,3,4,5) and (2) in 2015

4.1. Analysis and demand forecasting using moving averages method

Linear regression is a universally applicable statistical method in data research and creation of forecasting models, based on historical, chronological statistical data, grouped by consecutive time periods or intervals. The other analysis and forecasting method that is reviewed is moving averages method. In the following segment of the paper graphic views of the results of application of moving averages method, performed on taken data by implementing the method in Microsoft Office Excel, are displayed.

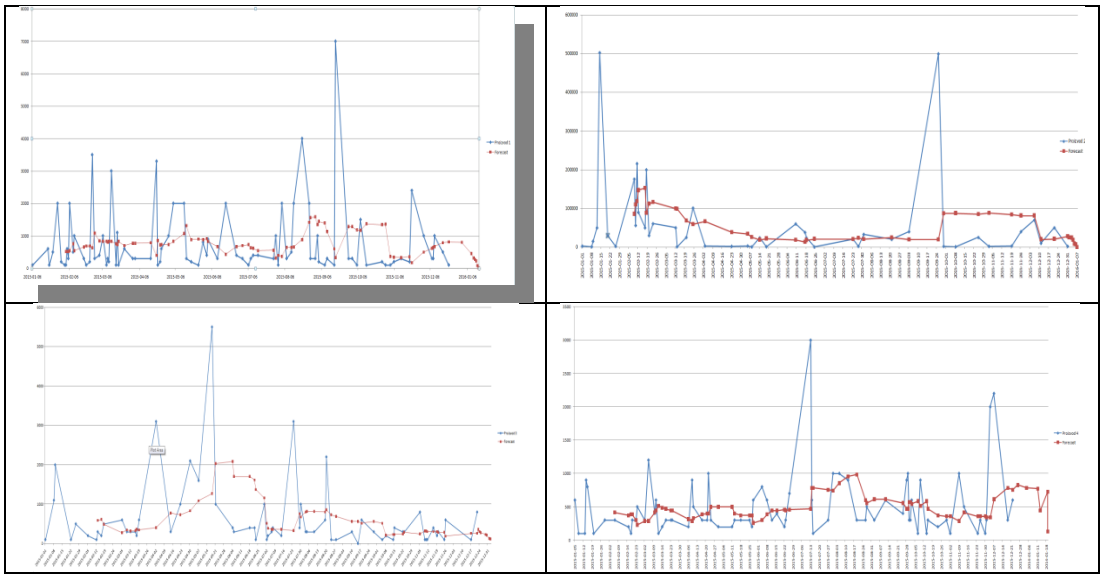

Figure 3: Order distribution for 4 products separately (1,2,3,4) in 2015

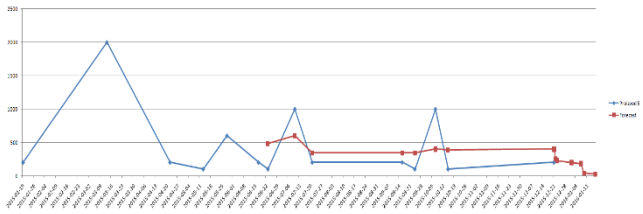

Figure 4: Order distribution for 5 products separately in 2015

4.2. Analysis and demand forecasting using data research methods (Forecast)

Contemporary data research methods are more complex data analysis methods. Using WEKA, the software tool for data research, and the subsystem for time series data research Forecast, data research, based on available history of orders during one year, is performed. Models are learned and the needed resources for selected time interval in the future are predicted. Results of the forecast are displayed by the products since the demand for each product is differently distributed in the observed period.

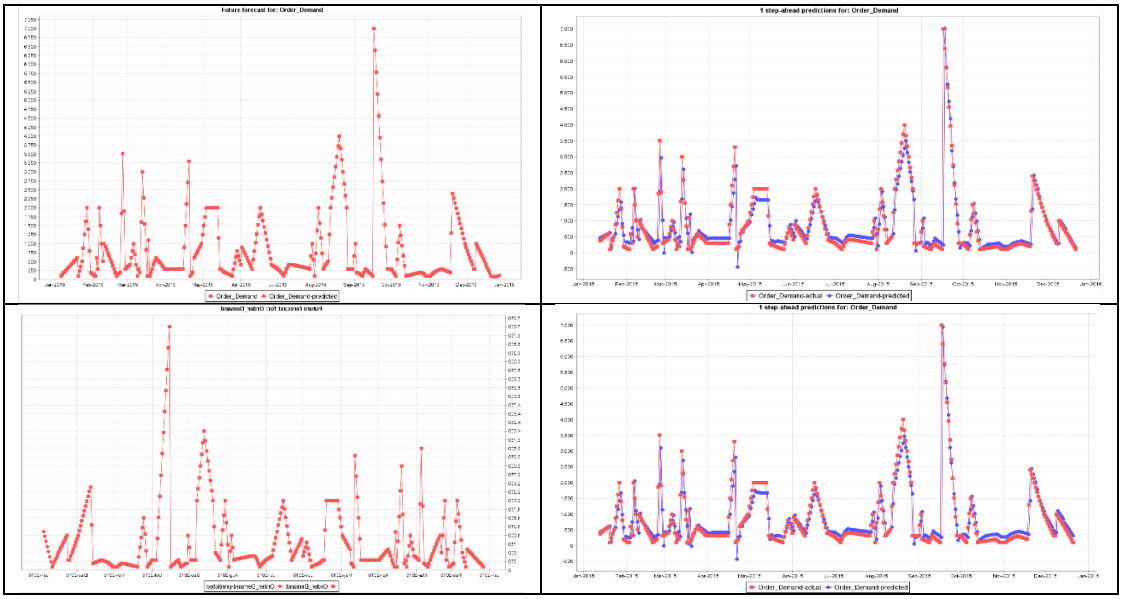

Figure 5: Display of the part of the data table on product order for product Nº 1

Figure 5. shows prediction for 7 days by linear regression methods, regression tree and evaluation of the given models on the training set of data for product Nº 1 obtained using software tool WEKA.

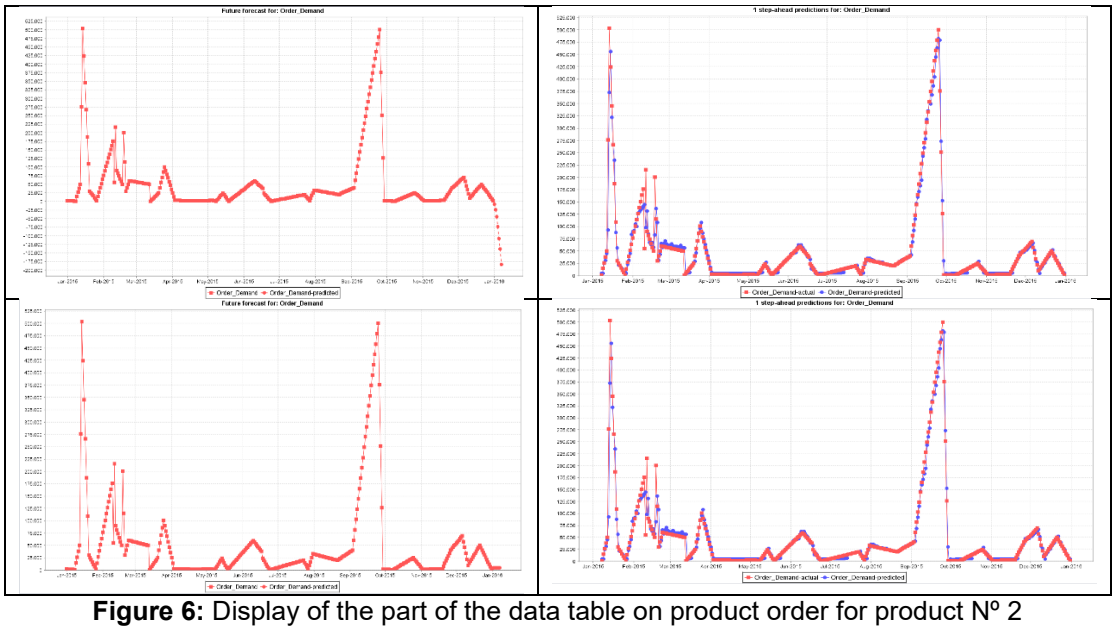

Figure 6: Display of the part of the data table on product order for product Nº 2

Figure 6. shows prediction for 7 days by linear regression methods and regression tree and evaluation of the models on the training set of product data for product Nº 2 obtained using software tool WEKA.

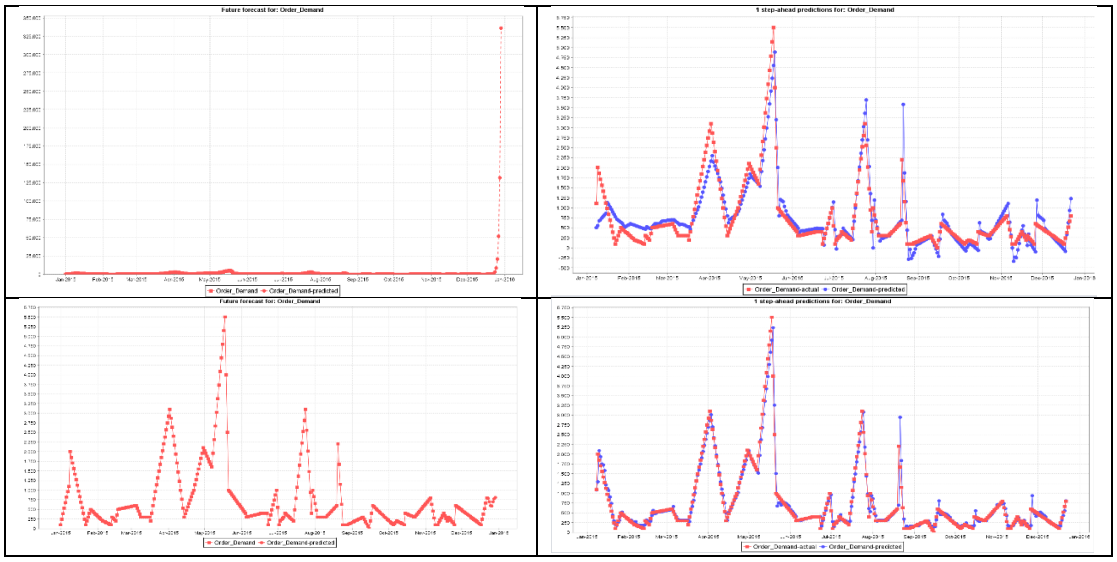

Figure 7: Display of the part of the data table on product order for product Nº 3

Figure 8. shows prediction for 7 days by linear regression methods, regression tree and evaluation of the given models on the training set of data for product Nº 3 obtained using software tool WEKA.

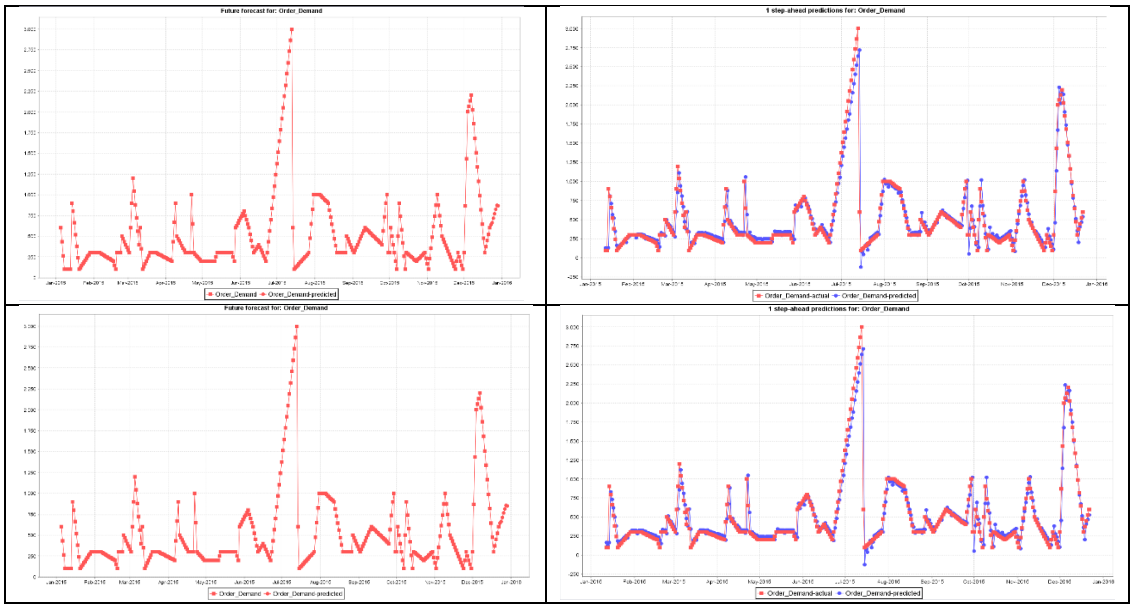

Figure 8. Display of the part of the data table on product order for product Nº 4

Figure 8. shows prediction for 7 days by linear regression methods, regression tree and evaluation of the given models on the training set of data for product Nº 4 obtained using software tool WEKA.

Figure 9. shows prediction for 7 days by linear regression methods, regression tree and evaluation of the given models on the training set of data for product Nº 5 obtained using software tool WEKA.

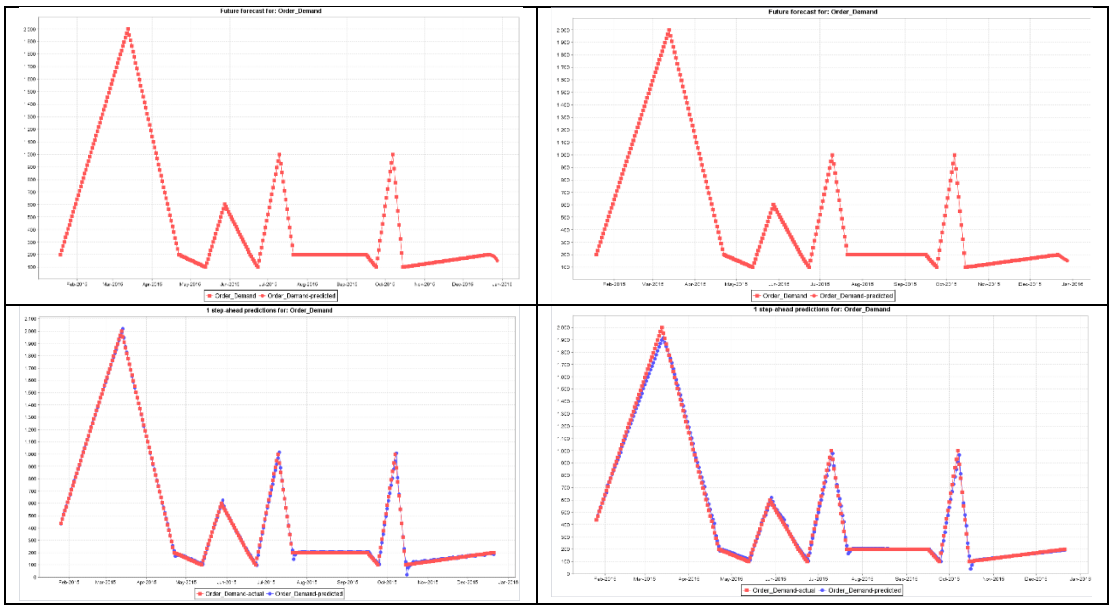

Figure 9. Display of the part of the data table on product order for product Nº 5

4.3. Analysis of the results

Using statistical methods and data research methods, analysis of the time series on demand for five selected products over the period of one year, from the data set taken from website Kaggle, was performed.

Predictive models of regression were used and basic metrics of forecasting the numerical value of product demand are: Mean Absolute Error (MAE), Mean Square Error (MSE) and Root Mean Square Error (RMSE).

Table 1 displays average values of error of product demand forecasting (mean absolute, mean square and root mean square) on training set for five selected products and three demand forecasting methods (statistical method of moving averages, linear regression learning method and regression trees learning method).

Table 1: Comparison of the results of forecasting for examined methods

Product	Moving Averages (Excel)			Linear regression (Weka)			Regression tree (Weka)		
	MAE	MSE	RMSE	MAE	MSE	RMSE	MAE	MSE	RMSE
Product 1	759	1.377.666	1.174	247	266.189	516	254	269.042	519
Product 2	51.910	7.851.807.823	88.610	9.908	6.130.667.796	24.760	7.229	364.238.086	19.085
Product 3	521	1.125.524	1.061	235	123.843	352	349	36.771	192
Product 4	339	270.644	520	84	29.279	171	84	29.366	171
Product 5	239	7.751	278	10	274	17	21	943	31

It is clear that both data research methods, linear regression method and regression trees method, always produce significantly smaller error on training set when compared to moving averages method.

Regression trees learning method from WEKA system is more successful than linear regression method in one case (Product 2), while in two cases the error of both methods is practically the same (Product 1 and Product 4). Regression trees learning method predicts needed quantities of products with smallest error for Product 2, the one which is most needed, as seen in the figures 9 and 10. Linear regression method produces the smallest error in two cases (Product 3 and Product 5), for which the forecasting model is closer to linear model compared to forecasting models of other two products.

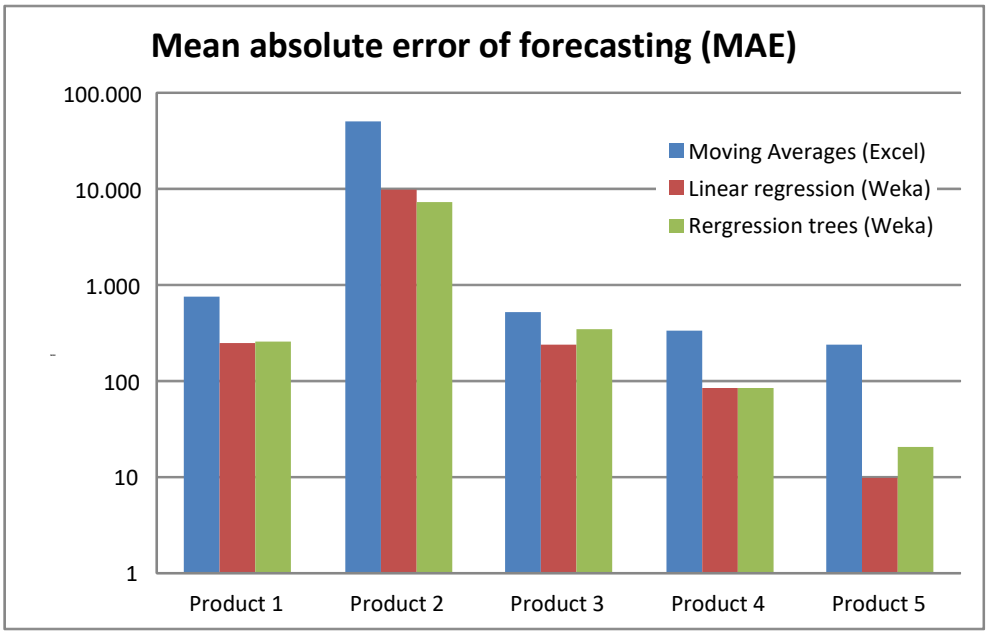

Figure 10: Mean absolute error of forecasting of the examined methods on training set

5. CONCLUSION

Based on the results of the conducted research, both hypotheses of the research are confirmed, and it can be concluded that:

- It is possible to reliably predict the necessary level of supplies of certain products by using the methods of historical demand data analysis.
- Standard machine learning data research methods are suitable to be used in forecasting the needed quantities of products to maintain the necessary supply levels. The research applied two data research methods from WEKA data research system: linear regression learning method and regression trees learning method. Both methods displayed better performances in forecasting the necessary supply levels than the statistical method.

Data research methods are used through specific function for time series analysis (Forecast) from WEKA system, which simplifies the use of standard machine learning methods that are not intended for time series analysis, as they are used for learning based on unregulated training sets.

Methods of time series analysis enable automation of the process of ordering necessary quantities based on known needs for individual product from previous time period.

Standard data research methods, such as various regression learning models, display smaller forecast error than standard statistical methods. Hence their application provides cost reduction in supply management through savings in acquiring only the necessary products and lowering the possibility of supply shortage.

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AGENT-BASED SIMULATION MODEL FOR EWOM INFLUENCE ANALYSIS IN RETAIL

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Abstract: *Electronic commerce has evolved rapidly in the past decade. It involves a large number of market participants with complex connections, behavior and decision-making. This paper presents an agent-based simulation model for analyzing the online retail market. The market and its key participants have been modelled keeping in mind price, electronic word of mouth, and retailers' rating, as factors influencing shoppers' decision, using agents' abilities to represent individuals, their attributes, and behavior. The model is used to conduct simulation experiments and analyze different factors' influence on market behavior. It is shown that the model provides retailers with the possibility to analyze different scenarios in their business.*

Keywords*: agent-based, model, simulation, eWOM, shopping*

1. INTRODUCTION

In the last twenty years, e-commerce has expanded rapidly and is now present in almost all sectors and a majority of developed countries' markets. As a distributed environment, e-commerce involves a large number of market participants: customers, retailers, intermediaries and other service providers who communicate, trade and collaborate among themselves using ICT-based applications. At the beginning of the development of the e-commerce business, many companies aspired to move a part or all of their business to the Internet. At that time, just starting an internet business guaranteed success. Now that may not be the case. Many companies are able to develop their e-commerce infrastructure very quickly and offer their services and products online. That is why it is crucial to establish the right business strategies and provide additional services to customers (Rosaci & Sarné, 2012).

Consumer behavior and their relationships when shopping online has been the subject of numerous research studies (Ahn, 2010; Lee, 2002). A large number of papers uses an agent-based simulation as a basis for evaluating B2C business models in order to improve existing e-commerce strategies and acquire data that can be used in business decision analysis and predictive analytics. Creating agent-based e-commerce models provides new tools for better understanding of consumer behavior and their shopping habits in e-commerce systems.

One of the first such models is the Janssen and Jager model, which formed the process leading to "lock-in" in the consumer market (Janssen & Jager, 2003). North and colleagues have developed one of the most well-known models that have come to fruition for the needs of Procter & Gamble (North et al., 2010). Tao and David Zhang used the agent-based simulation model to present the effect of introducing a new product on the market to serve as a decoy (Zhang & Zhang, 2007). Okada and Yamamoto used the agent-based simulation model to investigate the impact of the electronic word of mouth (eWOM) effect on the habits of customers purchasing on B2C websites (Okada & Yamamoto, 2009). Particular attention is given to the exchange of knowledge and product information between all participants. Furthermore, the literature describes a large number of agent-based simulation models used in customer behavior studies. Liu, Tang et al. used the agent-based simulation model to investigate the nowadays common continual price reductions in online markets (Liu, Tang, Yu, & Lu, 2013).

Although the Internet has dramatically been changed, the phases of consumer habits in the consumer buying process are similar to those present in traditional shopping (Engel, Blackwell, & Miniard, 1994): problem awareness, information search, evaluation of alternatives, a decision on purchase and post-purchase evaluation. However, the Internet and the capabilities it provides, and above all the advanced communication

capabilities, have entirely changed the way these phases are carried out. Consumer behavior can be described as a set of activities that potential customers undertake in searching, selecting, evaluating, buying and using products or services in order to satisfy their needs. They also include the decision-making processes that precede and follow the buying activities (Belch & Belch, 1998; Čavoški & Marković, 2016; Schiffman & Kanuk, 2009; Solomon, Bamossy, Askegaard, & Hogg, 2010).

2. RESEARCH FRAMEWORK

An analysis of the previously mentioned research showed that all the papers dealt with a single phenomenon in online shopping. The aim of this research is to investigate how different consumer practices and their interconnections influence the complexity of their online shopping habits. The proposed simulation model analyzes the impact of different variables on the assessment of consumer behavior and different policies in e-commerce management. The model presented in this paper as the main influencing factors in consumer buying behavior considers product price, eWOM effects, and seller reputation.

The first feature of the product that the buyer looks after when choosing a product is undoubtedly the price. A price has a significant impact on customer behavior and consequently, on sale (Han, Gupta, & Lehmann, 2001). Today, the technical features of the Internet make it easy to compare the prices of similar or the same products and services from different suppliers. This fact forces sellers to continually change their pricing policy and offer additional services. On the other hand, the sensitivity of a particular customer or a specific group of customers to the price of a product varies significantly depending on the type of product. The first variable of the simulation model tends to model this phenomenon.

The electronic word of mouth significantly reduces the risk and uncertainty in the purchase and consumption of products and services (Bone & Fitzgerald, 1995). Consumers are increasingly relying on word-of-mouth during their decision-making process, especially when buying high-involvement products (Dellarocas, 2003). It is an informal buyer to buyer communication about the features of the products and capabilities and quality of the retailer selling the product. Customers often try to find different information about the products and online sellers through various online sources, social networks, internet forums and similar online communities. Customers with previous experience in online shopping demonstrate a tendency to share both positive and negative experiences about the purchase they made (eWOM effect) (Godes & Mayzlin, 2004; Said, Drogoul, & Bouron, 2001).

The goal of the study presented in this article is to build an agent-based simulation model that will show the relationships between customers, the way they evaluate products, and online retailers from whom they purchased products and the post-purchase collaboration.

There are numerous studies in the literature that address the issue of trust between buyers and sellers. Trust is essential in all forms of online sales (B2C, C2C) (Bellman, Lohse, & Johnson, 1999; Hoffman, Novak, & Peralta, 1999; Jarvenpaa, Tractinsky, & Vitale, 2000; Strader & Ramaswami, 2002). During the product or service research phase, customers may interact with sellers who do not have a good reputation. There may also be misunderstandings with sellers who have a good reputation. Of course, these cases are not so common. When buyers cooperate with honest and professional sellers with a good reputation, they are able to reduce research time, and therefore the costs associated with research (Beladona & Tsatsoulis, 2007). The model demonstrates how a seller's reputation can influence a buyer's decision to buy a product and repeat purchases from the same seller.

The proposed variables are modelled in the form of a utility function that frames a customer's behavior when selecting a product. Utility function takes into account all the input variables of the simulation model. The design of the simulation model ensures that the influence of all input variables can be observed simultaneously, or separately depending on the simulation experiment. Different business policies can be studied in this way.
At the very beginning of the simulation experiment, a large number of agents (buyers and sellers) are generated, forming a virtual market. Special attention is given to the mutual interactions of shopper agents and the influence of a number of connections between them on their behavior. The key business indicators of B2C sales that are observed are market share, number of reviewers and level of rating. They represent the output variables of this simulation model.

3. SIMULATION MODEL DEVELOPMENT AND RULES OF BEHAVIOR

In the previous chapter, we identified the key input and output variables of the simulation model and how they influence the consumer's decision to buy the product from an online retailer. The simulation model considers a decentralized electronic marketplace in which agents, representing retailers (retailer), offer products, and agents representing customers buy products (shopper). The simulation model is constructed in such a way that the researcher can observe the behavior of each individual shopper or a group of shoppers. In this way,

it would be possible to experiment with different shopper groups (shoppers with different characteristics) or study shopper's behavior in different market conditions.

Initially, the simulation model generates agents, shoppers and retailers, based on the defined input parameters. Upon the initial generation of agents, the model is creating a network of connections between agents. The initial network is generated on a random basis and kept until the end of the simulation. Agents affiliated in this way form a "special" group of friends.

Three groups of shoppers are defined, and each of them has different preferences regarding major deciding factors. Group one is the one where the price is most important, group three is not price-sensitive, but takes care about the retailer's rating. As expected, the second group is in the middle and the most numerous.

Upon generating agents and forming a virtual market, shoppers start moving and searching for a product they need. When they find potential retailers (based on location proximity), firstly they reject any retailer they had a bad experience with, and afterwards, retailer's rating and the price is analyzed. In addition to that, shoppers share information with their connections about potential retailers and experience with previous purchases from them and whether it is positive or negative. Based on all the collected information, shopper calculates a utility function (U_f) for each potential retailer and chooses the one with the highest value. Additionally, the model allows setting a utility function threshold so that the retailers who do not reach this threshold are rejected. After the purchase, a shopper is leaving a review for the retailer, and a new retailer's rating is calculated.

3.1. Components of Utility Functions

The consumer's utility function is created on the basis of information the shopper collects on a retailer and in interactions with other shoppers. The virtual market is made of shoppers, their interconnections, and retailers representing products. Each time the shopper has the intention to buy a product, the utility function is calculated for every potential retailer:

$$U_f = -\frac{w_p \cdot P}{P_e} + D + \frac{R}{R_e} \quad (1)$$

where: U_f – utility function; P – price of the product; w_p – consumer sensitivity to the price of the product; P_e – expected product price; this parameter is difficult to define so it will be replaced by a mean value of all the products P_m; D – the effects regarding positive and negative recommendations received from connections may be calculated in the following manner (Aggarwal, Gopal, Gupta, & Singh, 2012):

$$D_i = \frac{E_p^2 - E_p E_n}{(E_p + E_n)^2} \quad (2)$$

where: E_p – number of positive ratings of retailers; E_n – number of negative ratings of retailers.
The final member of the utility function (rating) comprises parameters related to consumers' attitudes, beliefs, risk perception and trust in the retailer.

4. SIMULATION EXPERIMENTS AND RESULTS

The simulation model is implemented in the NetLogo software. It was used for a number of simulation experiments, and data was collected for an analysis of the behavior of online shoppers. Most important indicators that were observed are related to shoppers' communication and its influence on retailers' performance.

The simulation experiments were conducted using the following parameters: number of shoppers was 1000 (initially 30% of them bought the product); number of retailers was 20 (except where stated differently); price had Normal distribution N(100,20); utility function threshold was 0.6; number of connections was two (except where stated differently).

Results of the simulation experiments provided us with some interesting conclusions. The first key finding is the influence of the number of connections between shoppers on a number of successful purchases. Namely, shoppers are more prone to completing purchases online if they get an opinion from their acquaintances (2), but only up to a certain level. If they get information from too many acquaintances, the effect is slowing down and eventually starting do decrease (Table 1).

The second important conclusion drawn from simulation experiments is regarding retailers with a low rating. Those retailers are rarely being selected especially when there is one with similar price and better rating nearby. In our experiments, the only way for them to increase sales is by decreasing the price. Even then only

shoppers from the first group (where the price is the most important in utility function) will decide to purchase their product.

Table 1: Influence of the number of connections on online shopping

Maximal number of connections	Number of purchases
2	6350
4	8239
6	8390
8	8473
10	8283

The final conclusion presented in this paper is related to the number of retailers on the market. The model confirms the expected, the number of retailers cannot grow limitlessly. Figures 1 and 2 are supporting this claim. As we can see from the figures, with 20 retailers (x axis), the one with highest market share (y axis) has 16%. When there are more retailers (70) present in the market, most of them are getting a small market share (less than 2%). A question arises how long they would survive the competition.

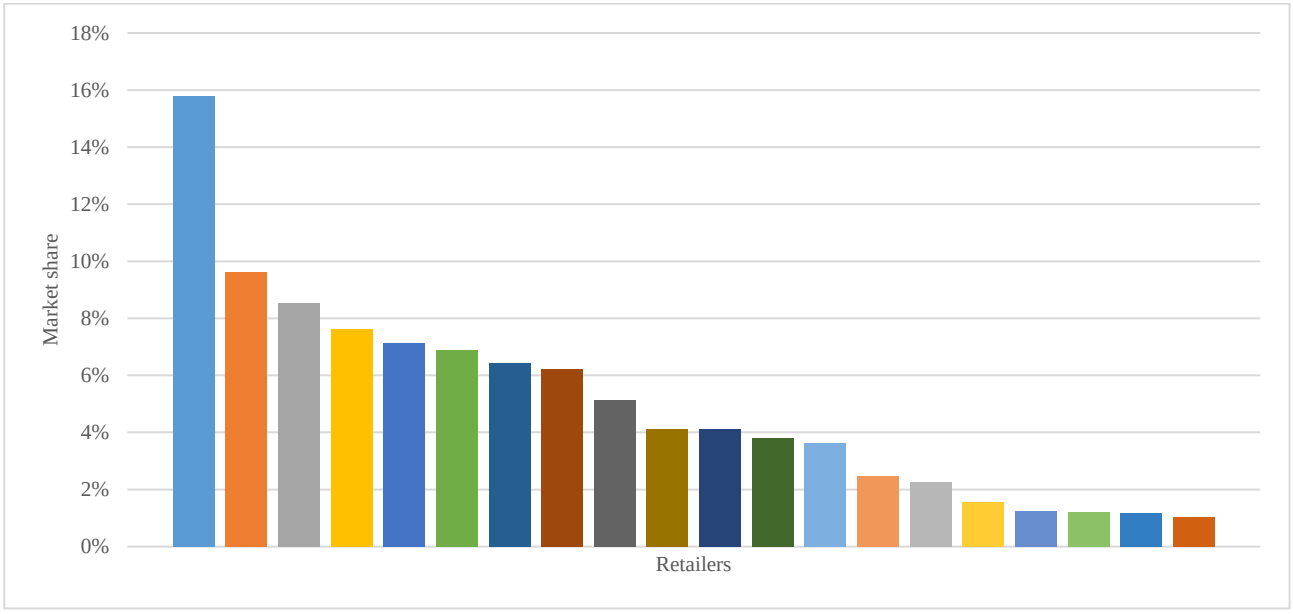

Figure 1: Retailers' market share (20 retailers in the market)

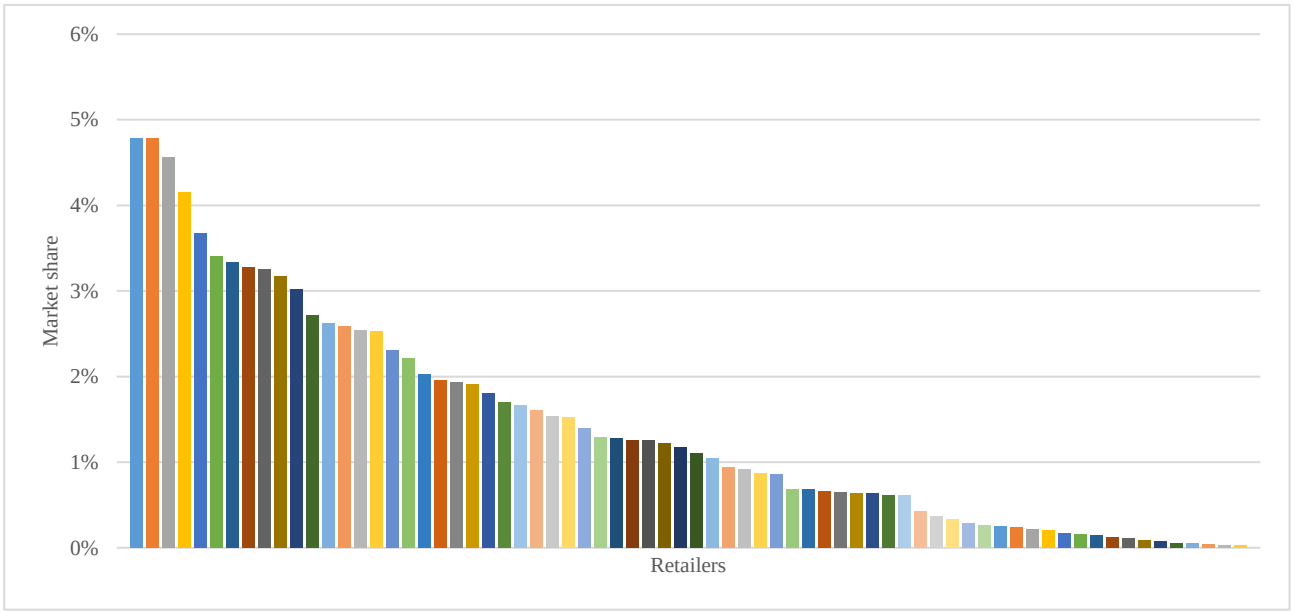

Figure 2: Retailers' market share (70 retailers in the market)

5. CONCLUSION

This paper is presenting the usage of agent-based modelling and simulation for analyzing the online retail market. The market and its key participants have been modelled keeping in mind price, electronic word of mouth, and retailers' rating, as factors influencing shoppers' decision.

Although the model is still in development, it provides retailers with the possibility to analyze different scenarios in their business. Retailers should be aware of the power eWOM has nowadays. Rating of their product is publicly available for each and every potential shopper. In addition to that, shoppers are tightly connected with their friends and acquaintances via social media and messaging platforms. Shoppers' connections will most probably have a stronger influence on purchase decision than thousands of ratings available on the product page. The proposed model is suitable for products and/or services that are not bought daily, and with greater value. Those are the products/services that shoppers are rating and talking about.

The designed model for analyzing the online retail market is providing a better insight into the importance of different factors influencing shoppers' decision-making. Future research will be devoted to model even more complete system with a broader basket of important factors.

5.1. Limitations and Future Directions of the Study

The presented model is in the ongoing development and currently takes into consideration only three groups of variables. In future research, the model will be expanded with additional variables (like demographics). Shoppers' segmentation is currently conducted based on experts' assessment, and it should be done using specific market research and data analysis (e.g. cluster analysis).

Other direction of future research includes social media marketing analysis and targeting influencers with personalized campaigns.

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EFFICIENCY ASSESSMENT OF HEALTH CLINICS IN BELGRADE USING WINDOW DEA METHOD

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Abstract: *Health care, as one of the most important activities for the society survival, has always been the topic of business and success analysis. The research subject in this paper is precisely the business efficiency of 23 Belgrade clinics, observing the relationship between available resources and the results achieved over ten years. After the introductory part of the paper, which will define the subject and goal of the research, the concepts of health and health care institutions, follows a description of the basic characteristics, as well as the procedure of Window DEA method. Before the efficiency analysis itself conducted using the mentioned method, a short review of the literature, ie scientific papers in this field is given. DEA-Solver LV8 was used to obtain the research results based on data taken from the publications of the City Institute for Public Health - Belgrade.*

Keywords*: Window DEA analysis, relative efficiency, output oriented model, health clinic.*

1. INTRODUCTION

Recently, it can be noticed that great emphasis is placed on monitoring and analysis of increasingly complex indicators of business success in all organizations, regardless of their activity. Such tendencies are also present in health care organizations, where the management emphasizes the analysis of business efficiency through constant monitoring of increasingly complex indicators of business success. The need for efficiency analyzes arises primarily due to the evidently high level of funds necessary for the maintenance and quality functioning of the health system. In order to provide patients with efficient and high quality service, it is very important that hospital management understands the importance of evaluating and using information and technology and therefore have a better chance for success (Rabar, 2010).

DEA method is widely used for evaluation of the efficiency of health care institutions as one of the most suitable for obtaining relevant results. In most of papers in this area, the number of beds and the number of doctors were taken as inputs (Rabar, 2010; Afonso & Aubyn, 2011; Varabyova & Schreyögg, 2013), while various data related to rates were chosen as outputs - mortality or capacity utilization indicators - number of beds (Varabyova & Schreyögg, 2013; Mitrović et al., 2015). Table 1 provides an overview of the input and output variables in the papers dealing with efficiency analysis using Window DEA.

Table 1: An overview of Window DEA papers in health care institutions with input and output variables presented

Reference	Input variables	Output variables
Mirmozaffari and Alinezhad (2017)	Number of doctors Number of beds Number of other medical and administrative staff	Number of patients in ambulance Number of hospitalized patients
Flokou et al. (2017)	Number of beds Number of doctors Number of other employees	Number of outpatient visits Number of operations Number of hospitalized patients
Kazley & Ozcan (2008)	Number of non-doctors (full-time) Number of beds Capital assets Labor costs not including wage costs	Number of hospitalized patients Number of ambulance patient visits

The analysis performed in this paper aims to assess the state of the health institutions in the Belgrade clinics, and indicate possible directions for improvement that need to be implemented to the health system.

This analysis was conducted by observing a ten-year time period and the Window DEA method was used to show the efficiency trend.

2. WINDOW DEA METHOD

The window - DEA method was developed as a result of the need to monitor and analyze the perforations of certain entities over many periods and at the same time monitor the dynamics of changes in these performances. It acts on the principle of moving averages and is used to determine the performance trends of the observed entities, observing their inputs and outputs (Asmild et al., 2004). Each possible decision-making unit (DMU) in different periods is considered as a separate DMU. Therefore, the performance of one DMU is compared not only with the performance of other DMUs covered by the observed time window, but also with the performance of that DMU in other periods.

DEA window analysis has been used to observe *N* (*j* = 1, …, *N*) DMUs during P (*t* = 1, …, *P*) periods of time. Each of the *n* DMUs uses *s* different inputs to produces *m* different outputs. Thus, it can be concluded that the observed set consists of *n* x *P* entities, and one *j*-th entity in the period *t*, DMU_j^t has a *s* - dimensional input vector and *m* - dimensional output vector (x_j^t i y_j^t) (Savić, 2012).

If the window starts in time *l*, $1 \le l \le P$ and the width of the window is *w*, $1 \le w \le P - l$, (denoted by l_w) the number of observations is $n \times w$, where it's necessary to determinate of window size $w = (P + 1) / 2$, and window length $p = P\text{-}w+1$, then input matrix (X_{l_w}) and output matrix (Y_{l_w}) of each window will look like as follows (Savić, 2012):

$$X_{l_w} = \left(x_1^l, x_2^l, ..., x_n^l, x_1^{l+1}, x_2^{l+1}, ..., x_n^{l+1}, ..., x_1^{l+w}, x_2^{l+w}, ..., x_n^{l+w} \right) \quad (1)$$

$$Y_{l_w} = \left(y_1^l, y_2^l, ..., y_n^l, y_1^{l+1}, y_2^{l+1}, ..., y_n^{l+1}, ..., y_1^{l+w}, y_2^{l+w}, ..., y_n^{l+w} \right) \quad (2)$$

Based on the previous assumptions, an output-oriented Window DEA model can be defined (Savić, 2012):

$$\begin{aligned} &(Max)\, Z_{kl_w}^t \\ &st \\ &X_{l_w} \lambda \le x_{tl_w} \\ &Z_{kl_w}^t \times y_{kl_w}^t - Y_{l_w} \lambda \le 0, (s \times w) \\ &\lambda_s \ge 0, s = 1, 2, ..., n \times w \end{aligned} \quad (3)$$

3. EVALUATION OF THE EFFICIENCY OF BELGRADE CLINICS

In order to define the model that will be used to evaluate the efficiency of clinical centers, first of all, the units whose efficiency will be evaluated must be determined. The entire health system of a country can be taken as a decision-making unit and compare to other countries with similar economic and social development, but also health systems within a country at the regional level, hospitals, departments within a health institution and even doctors themselves can be taken for DMU. In this paper, one health clinic is considered as one DMU, and database used for analysis includes 23 clinics on the territory of Belgrade.

Selection of input and output indicators is one of the most difficult steps, given that health care institutions have a huge amount of data that can be taken into account when analyzing their business. Using the results of the variables used in previously published papers and taking into consideration the specific characteristics of the healthcare system in Serbia and Belgrade, the following input variables are chosen:

- number of beds,
- number of hospitalized patients per year,
- number of employed doctors and
- number of other employees.

The following output variables are chosen:

- total number of patient treatment days and
- number of cured patients per year.

Publications of the City Institute for Public Health Belgrade from the period from 2008 to 2017 (Tošović 2010; Tošović 2011; Tošović 2012; Tošović 2013; Tošović 2014; Matijević 2015; Matijević 2016; Matijević 2017; Matijević 2018) are used to collect data.

Two different examples – scenarios are analyzed and solved in this paper. The same input and output variables are used for both scenarios, and the difference is reflected in the way the employees are divided into categories. In the first scenario, employees are divided into two categories - doctors and other employees, and the second scenario it was analyzed whether the efficiency of the observed clinics will change if the employees are divided into medical and non-medical staff. The idea is to observe and conclude to what extent the structure of the employees affects the efficiency of the clinics.

3.1. Window DEA method - Scenario 1

The aim of this paper is to maximize outputs using existing inputs, due to the limited resources available in the Serbian health system. Therefore, the output-oriented Window DEA model is applied and implemented using the software tool DEA solver LV8.0.

Previously defined input variables are used in the efficiency analysis for scenario 1. Results of descriptive statistics for the period from 2008 to 2017 are given in Table 2.

Table 2: Descriptive statistics for the period 2008-2017 (Scenario 1)

	No. of beds	No. of hospitalized patients	No. of doctors	No. of other employees	No. of hospital days	No of cured patients
Max	494.1	13639.7	98	401	96482.6	13614.5
Min	11	662	8.5	19.4	2392.3	661.2
Average	128.55	3065.66	38.26	145.66	32211.48	3010.46
SD	99.34	2670.25	22.07	84.89	21368.99	2655.53

In order to make sure that the results obtained using the DEA solver are correct, as well as that the input data used in the analysis are appropriate, it is necessary to check the correlation between inputs and outputs. Table 3 shows the correlation between inputs and outputs, taking into account the data from 2008. It can be noticed that the correlation between all inputs and outputs is high. Here we can single out the correlation between the number of beds and the number of hospitalized patients (93.35%), which can be easily explained by the fact that the number of beds in clinics is projected in accordance with the average number of patients.

Table 3: Correlation for input and output variables for year 2008. (Scenario 1)

	No. of beds	No. of hospitalized patients	No. of doctors	No. of other employees	No. of hospital days	No of cured patients
No. of beds	1	0.933477	0.854899	0.908531	0.933325	0.930266
No. of hospitalized patients	0.933477	1	0.800220	0.839863	0.858474	0.999182
No. of doctors	0.854899	0.800220	1	0.885909	0.844408	0.797065
No. of other employees	0.908531	0.839863	0.885909	1	0.914240	0.831586
No. of hospital days	0.933325	0.858474	0.844408	0.914240	1	0.845021
No of cured patients	0.930266	0.999182	0.797065	0.831586	0.845021	1

Since the correlation coefficient between inputs and outputs differs depending on the input data, and the observation period is quite long, Tables 4 and 5 show the results for period 2015-2017. These data are presented in order to provide a clear picture of the correlation assessment at different points in the observed period, 2017 was taken as the last year in the period, and 2015 because it stood out as specific.

It can be noticed that the correlation between inputs and outputs in 2015 is slightly lower than in other years (see Table 5). For example, the correlation coefficient between the number of hospitalized patients and the number of employed doctors is 39.70%. This low correlation is conditioned by the smaller number of patients that year, so the underutilization of employee capacity was higher than usual.

Table 4: Correlation for input and output variables for year 2015. (Scenario 1)

	No. of beds	No. of hospitalized patients	No. of doctors	No. of other employees	No. of hospital days	No of cured patients
No. of beds	1	0.673063	0.632368	0.787989	0.756306	0.666706
No. of hospitalized patients	0.673063	1	0.397048	0.406636	0.825630	0.998392
No. of doctors	0.632368	0.397048	1	0.809541	0.436668	0.406022
No. of other employees	0.787989	0.406636	0.809541	1	0.462985	0.402596
No. of hospital days	0.756306	0.825630	0.436668	0.462985	1	0.824637
No of cured patients	0.666706	0.998392	0.406022	0.402596	0.824637	1

For the last year in the observed period, a high correlation coefficient between inputs and outputs is shown in Table 5. This is a typical picture for all years from the period from 2008 to 2017, except for the previously presented 2015. Due to the above, it can be concluded that the input data, as well as the results obtained by this analysis are good.

Table 5: Correlation for input and output variables for year 2017. (Scenario 1)

	No. of beds	No. of hospitalized patients	No. of doctors	No. of other employees	No. of hospital days	No of cured patients
No. of beds	1	0.909864	0.827791	0.927551	0.955294	0.907426
No. of hospitalized patients	0.909864	1	0.789864	0.835385	0.894618	0.999479
No. of doctors	0.827791	0.789864	1	0.893143	0.855821	0.785280
No. of other employees	0.927551	0.835385	0.893143	1	0.884675	0.832345
No. of hospital days	0.955294	0.894618	0.855821	0.884675	1	0.887692
No of cured patients	0.907426	0.999479	0.785280	0.832345	0.887692	1

Window DEA analysis enables to determine the length of the window, which depends on the length of the period. It is necessary to select the length of the window that allows credible results. In accordance with the requirement to choose the window lenght so the possibility of greater tehnological changes is negligible, we came to the conclusion that the number of periods that one window will cover, ie the length of the window, is equal to 5.

Taking into account the fact that a certain decision-making unit, in this case a clinic, can be considered efficient if it was efficient in a given year regardless of the window, Table 6 provides an overview of average efficiency ratings by year. The average of the efficiency assessments of a certain DMU in a certain year is presented, taking into account the efficiency assessments from all windows that covered that particular year in their time interval.

Based on the results shown in Table 6, 15 out of 23 clinics in a given year are efficient regardless of the window in which a particular year was analyzed. The question that can be posed here is whether the years that are at the beginning or at the end of the entire ten-year period are relevant. The fact is that they were included fewer times in the analysis, so we have 2008 and 2017 included in the analysis in just one window. It is possible that in these years the clinics would have had different average efficiency ratings if another time period had been taken into account in which these two years would not have been at the end of the period. Although eight clinics are inefficient, from the results it can be concluded that the inefficient ones also have a very high efficiency rating. Thus, the most inefficient clinic, regardless of the year, has a score of 90.33%, which tells us that even those inefficient clinics with very small changes can become efficient.

3.2. Window DEA method - Scenario 2

As previously said, employees are divided into different categories for the second scenario in order to determine whether this change will provide different results. Results of scenario 2 descriptive statistics for period from 2008 to 2017 are given in Table 6.

Table 6: Descriptive statistics for the period 2008-2017 (Scenario 2)

	No. of beds	No. of hospitalized patients	No. of medical staff	No. of non-medical staff	No. of hospital days	No of cured patients
Max	494.1	13639.7	408.5	95.6	96482.6	13614.5
Min	11	662	25.7	2.5	2392.3	661.2
Average	128.55	3065.66	155.14	30.43	32211.48	3010.46
SD	99.34	2670.25	88.55	20.07	21368.99	2655.53

In tables 7, 8 and 9 are given correlations between inputs and outputs for the second scenario including years 2008., 2015. and 2017. in order to point out some differences compared to first scenario.

Table 7: Correlation for input and output variables for year 2008. (Scenario 2)

	No. of beds	No. of hospitalized patients	No. of medical staff	No. of non-medical staff	No. of hospital days	No of cured patients
No. of beds	1	0.933477	0.876754	0.825900	0.933325	0.930266
No. of hospitalized patients	0.933477	1	0.812687	0.764500	0.858474	0.999182
No. of doctors	0.876754	0.812687	1	0.682244	0.891940	0.804986
No. of other employees	0.825900	0.764500	0.682244	1	0.777608	0.760358
No. of hospital days	0.933325	0.858474	0.891940	0.777608	1	0.845021
No of cured patients	0.930266	0.999182	0.804986	0.760358	0.845021	1

Table 8: Correlation for input and output variables for year 2015. (Scenario 2)

	No. of beds	No. of hospitalized patients	No. of medical staff	No. of non-medical staff	No. of hospital days	No of cured patients
No. of beds	1	0.673063	0.762935	0.737748	0.756306	0.666706
No. of hospitalized patients	0.673063	1	0.436242	0.263153	0.825630	0.998392
No. of doctors	0.762935	0.436242	1	0.809401	0.495276	0.436279
No. of other employees	0.737748	0.263153	0.809401	1	0.286650	0.255775
No. of hospital days	0.756306	0.825630	0.495276	0.286650	1	0.824637
No of cured patients	0.666706	0.998392	0.436279	0.255775	0.824637	1

Table 9: Correlation for input and output variables for year 2017. (Scenario 2)

	No. of beds	No. of hospitalized patients	No. of medical staff	No. of non-medical staff	No. of hospital days	No of cured patients
No. of beds	1	0.909864	0.932479	0.910967	0.955294	0.907426
No. of hospitalized patients	0.909864	1	0.860889	0.845322	0.894618	0.999479
No. of doctors	0.932479	0.860889	1	0.874636	0.921621	0.858336
No. of other employees	0.910967	0.845322	0.874636	1	0.817005	0.842498
No. of hospital days	0.955294	0.894618	0.921621	0.817005	1	0.887692
No of cured patients	0.907426	0.999479	0.858336	0.842498	0.887692	1

What can be noticed as a difference is that when employees are divided into medical and non-medical staff, the correlation coefficients between the number of medical staff and other employees and other inputs is higher than the coefficient when only the number of doctors is taken into account.

In this scenario as well, 2015 is specific in terms of lower correlation coefficients compared to other years from the observed period.

Table 10: Average efficiency of clinics - Scenario 1 and Scenario 2

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Clinic for Burns, Plastic and Reconstructive Surgery	Scenario 1	0.9901	0.9922	0.9886	0.9856	0.9885	0.9927	0.9845	0.9909	1	0.9889
	Scenario 2	0.9902	0.9922	0.9886	0.9856	0.9888	0.9927	0.9845	0.9909	1	0.9889
Clinic for Allergology and Immunology	Scenario 1	0.9996	0.9982	0.9965	0.9999	0.9986	1	0.9971	1	0.9959	1
	Scenario 2	0.9996	0.9982	0.9964	0.9999	0.9986	1	0.9971	1	0.9959	1
Clinic for Digestive System Diseases	Scenario 1	0.9753	0.9730	0.9801	0.9780	0.9804	0.9834	0.9877	0.9860	0.9923	0.9908
	Scenario 2	0.9753	0.9732	0.9798	0.9779	0.9803	0.9830	0.9876	0.9840	0.9921	0.9908
Clinic for Dermatovenerology	Scenario 1	1	1	0.9998	1	1	0.9979	1	1	1	1
	Scenario 2	1	1	1	1	1	0.9984	1	1	1	1
Clinic for Endocrinology, Diabetes and Metabolic Disease	Scenario 1	0.9966	0.9984	0.9994	0.9980	0.9993	1	0.9986	0.9993	1	0.9988
	Scenario 2	0.9965	0.9983	0.9993	0.9979	0.9993	1	1	0.9993	1	0.9985
Clinic of Gastroenterology and Hepatology	Scenario 1	0.9806	0.9815	0.9766	0.9898	0.9855	0.9851	0.9887	0.9945	0.9961	0.9906
	Scenario 2	0.9812	0.9819	0.9768	0.9910	0.9896	0.9855	0.9889	0.9947	0.9961	0.9906
Clinic for Gynecology and Obstetrics	Scenario 1	0.9992	0.9994	1	1	0.9996	0.9995	0.9998	0.9988	1	1
	Scenario 2	0.9986	0.9992	0.9995	1	0.9997	0.9992	0.9998	0.9988	1	1
Clinic for Thoracic Surgery	Scenario 1	0.9852	0.9898	0.9937	1	0.9857	0.9967	0.9951	0.9970	0.9971	1
	Scenario 2	1	0.9857	0.9793	0.9816	0.9787	0.9842	0.9818	0.9865	0.9942	0.9843
Clinic for Hematology	Scenario 1	0.9404	0.9470	0.9538	0.9612	0.9575	0.9617	0.9688	0.9700	0.9743	0.9730
	Scenario 2	0.9404	0.9470	0.9538	0.9612	0.9575	0.9616	0.9688	0.9700	0.9742	0.9730
Clinic of Infectious and Tropical Diseases	Scenario 1	0.9689	0.9699	0.9621	0.9539	0.9588	0.9508	0.9466	0.9594	0.9474	0.9521
	Scenario 2	0.9689	0.9698	0.9621	0.9537	0.9589	0.9476	0.9429	0.9504	0.9462	0.9523
Clinic for Cardiac Surgery	Scenario 1	1	1	0.9783	0.9415	0.9858	0.9681	0.9712	0.9739	0.9582	0.9813
	Scenario 2	1	1	0.9822	0.9415	0.9911	0.9628	0.9712	0.9746	0.9582	0.9684
Clinic for Vascular Surgery	Scenario 1	1	0.9744	0.9677	0.9760	0.9787	0.9788	0.9810	0.9805	0.9812	0.9752
	Scenario 2	1	0.9739	0.9662	0.9705	0.9738	0.9787	0.9782	0.9792	0.9809	0.9745
Clinic for Cardiology	Scenario 1	0.9659	0.9905	0.9900	0.9924	0.9887	0.9935	0.9953	0.9991	0.9985	1
	Scenario 2	0.9657	1	0.9996	0.9931	0.9891	0.9954	0.9960	1	0.9996	1
Clinic for Nephrology	Scenario 1	0.9719	0.9621	0.9738	0.9744	0.9609	0.9744	0.9810	0.9857	0.9714	0.9804
	Scenario 2	0.9719	0.9620	0.9738	0.9744	0.9609	0.9744	0.9810	0.9857	0.9714	0.9804

Table 11: Average efficiency of clinics - Scenario 1 and Scenario 2 - continued

Clinic for Urology	Scenario 1	0.9881	1	1	0.9973	0.9973	0.9917	0.9949	0.9965	0.9979	1
	Scenario 2	0.9835	1	0.9963	0.9887	0.9883	0.9912	0.9945	0.9966	0.9979	0.9982
Clinic for Neurosurgery	Scenario 1	0.9571	0.9610	0.9598	0.9637	0.9674	0.9866	0.9824	0.9844	0.9791	0.9877
	Scenario 2	0.9505	0.9538	0.9528	0.9578	0.9562	0.9697	0.9762	0.9754	0.9790	0.9881
Clinic of Neurology	Scenario 1	0.9665	0.9932	0.9971	0.9925	0.9944	0.9958	0.9948	0.9974	0.9986	0.9996
	Scenario 2	0.9663	0.9931	0.9969	0.9926	0.9944	0.9958	0.9948	0.9974	0.9985	0.9994
Clinic for Eye Diseases	Scenario 1	1	0.9997	1	1	1	0.9999	0.9999	1	1	1
	Scenario 2	1	0.9997	1	1	0.9999	0.9999	0.9999	1	1	1
Clinic for Orthopedic Surgery and Traumatology	Scenario 1	0.9791	0.9786	0.9782	0.9709	0.9767	0.9855	0.9861	0.9860	0.9914	0.9884
	Scenario 2	0.9791	0.9768	0.9782	0.9706	0.9765	0.9856	0.9862	0.9861	0.9915	0.9886
Clinic for Otorhinolaryngology and Maxillofacial Surgery	Scenario 1	0.9968	0.9976	0.9967	0.9962	0.9939	0.9978	0.9973	1	0.9983	0.9994
	Scenario 2	0.9968	0.9972	0.9966	0.9960	0.9939	0.9978	0.9974	1	0.9983	0.9992
Clinic of Lung Diseases and Tuberculosis	Scenario 1	1	0.9961	1	0.9576	0.9442	0.9998	0.9465	0.9033	0.9698	1
	Scenario 2	0.9691	0.9636	1	0.9428	0.9265	1	0.9372	0.9033	0.9768	0.9338
Clinic of Psychiatry,	Scenario 1	1	0.9993	0.9995	1	1	1	1	1	1	1
	Scenario 2	1	0.9995	0.9995	1	1	1	1	1	1	1
Pacemaker center "Prof. Dr. Milan-Bane Đorđević"	Scenario 1	0.9988	0.9989	0.9979	1	1	1	1	1	1	1
	Scenario 2	0.9988	0.9989	0.9979	1	1	1	1	1	1	1

The average efficiency ratings by years for clinics obtained based on the analysis for both Scenario 1 and Scenario 2 can be seen in Table 6. It is noticed that all those inefficient clinics are very close to the efficiency limit, which leads to the conclusion that with small changes they can become effective. We see that the most inefficient is the Clinic for Pulmonology in 2015 (characterized as specific), with an efficiency rate of 90.33%.

4. CONCLUSION

The application of the Window DEA method for evaluating the efficiency of 23 clinics in Belgrade during a ten-year period (2008. – 2017.) is presented in this paper. Two different examples were solved, where the different input variables were used: number of beds, number of hospitalized patients, number of doctors and number of other employees (in the first scenario), and number of medical and number of non-medical staff (in the second scenario). The output variables were the same for both scenarios: number of days of treatment of patients and number of cured patients per year.

Based on all the presented results, it can be concluded that by changing the input variables the number of efficient units remains the same, 15 effective DMUs out of the observed 23, with a difference in efficiency ratings for certain years among the scenarios. Therefore, we conclude that staff inputs do not have a large impact on the actual efficiency of the analyzed units in these ten years, but possibly some minor impact on efficiency ratings for certain years in a particular window. All observed decision-making units are very similar in terms of organization and capacities, so no large difference in their efficiency can be noticed. Clinics in Belgrade have a very similar work organization, which is to be expected because they are part of the same health system. It is also concluded that the applied methods gave satisfactory results in the analysis of this problem. It can be noted that this similarity in results would not be expected if clinics included in analysis would be from other countries, either regions, and perhaps even only clinics from other cities in Serbia.

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EXPLORING THE EFFECTS OF ECONOMIC AND DEMOGRAPHIC FACTORS ON IMMIGRATION: PANEL DATA APPROACH

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Abstract: *This paper aims to explore the effects of economic and demographic factors on the number of long-term immigrants arriving in a particular country. The variables include GDP per capita, Life expectancy, Acquisition of citizenship, and Infant mortality rate. To provide answers to the raised questions, we observed 27 European countries in the period 2008-2018. The chosen data analysis was panel data approach. The obtained results indicate that both groups of factors can be used to model the level of immigration, whereas the factor Acquisition of citizenship stands out. We believe that this research could provide additional insights into the factors which impact the levels of immigration in the European countries and could initiate further research on the topic.*

Keywords*: Immigration, European countries, Fixed effects model, Random effects model, Pooled OLS*

1. INTRODUCTION

When it comes to population projections, the most difficult component is the projection of international migration (Coleman, 2008). Cappelen et al. (2015) believe that the unprecise estimation of migration could have large consequences on the population projections, thus leading to the possible creation of policies with an unwanted effect. Migrations definitely cannot be stopped, but migrations need to be managed in a humane way, with understanding and compassion (Anan, 2015). Therefore, it is of crucial need to explore and determine which factors have an effect on migration so that those factors could be used in a projection model.

According to the results of the analysis of the World Trade Organization, development-oriented research is the main driving force that determines the volume and flow of international trade, capital movements and foreign direct investment, as well as the development of integration processes (Dejanović et al., 2018). Creating immigration policies of developed countries, which at the same time with stricter regimes for asylum seekers and uneducated population are moving in the direction of attracting highly educated and skilled migrants, mostly from underdeveloped and developing countries, are becoming the leading strategies of the world's most developed countries, in literature known as “Struggle for talents”. The result of this struggle is the acquisition of human capital which, if directed in the right way, can become the strength of the nation (Dejanović et al., 2018).

According to Cappelen and Peters (2018), by ensuring the freedom of movement of Europeans, underpinning a fundamental principle of the EU, and requiring that intra-EU labour immigrants have the same rights to (most types of) health and social security benefits as nationals, the EU has caused friction between the national and EU-immigrant population. While nationals may want restrictions on the access to welfare rights of incoming EU citizens, their national governments cannot respond to such concerns by legislating welfare chauvinistic policies. Neither can the governments respond by restricting the free movement of intra-EU labour, because this is a cornerstone of the EU. Non-EU immigration, on the other hand, can be restricted. This, combined with the sudden escalation of intra-EU immigration, leads us to expect that it is specifically intra-EU immigration that is detrimental to welfare state support. They therefore hypothesize that:
In countries with higher levels of intra-EU migration, citizens are less likely to support their welfare state than citizens in countries with lower levels of intraEU migration.

In testing the presented hypothesis, Cappelen and Peters (2018) largely follow Brooks and Manza’s (2008) approach, which holds that there can be multiple sources that together and in interaction determine

preferences. On the one hand, they emphasize the embedded preference approach, according to which welfare preferences are rooted in: (a) the social structure in which people find themselves (e.g., age, gender, race, greater/less access to resources); (b) involvement in discursive communities (e.g., churches, schools); and (c) the collective memory of welfare state development, where people's attitudes are shaped by their common experience of a country's welfare system (e.g., universalistic regimes). This embedded preferences approach specifically emphasizes multicausality, and, because the causes are unlikely to change drastically within a short period of time, the approach underlines stability of preferences. On the other hand, Brooks and Manza also emphasize the economic model, according to which welfare preferences are mostly shaped by individuals' economic calculations. Here, preferences are expected to change more rapidly and dramatically, in tandem with economic developments.

„The causes that led to the explosion of the migrant crisis in 2015 are diametrically different and overall: fleeing war suffering, searching for a better life, leaving dysfunctional states and fleeing from various forms of extremism and terrorism etc. It is estimated that in 2000 there were about 150 million migrants in the world, ten years later 214 million with the assumption of growth to 405 million by 2050. The main flows of migration are directed towards highly developed countries and areas where the European Union has been the most desirable but also the most easily accessible destination for several years." (Tadić et al., 2016)

Driving forces of migration can be divided into two groups: economic and demographic factors. According to Kim & Cohen (2010), economic factors are, for example, income and employment rates, while the demographic factors are life expectancy, child mortality, years of healthy living. However, in the migration studies, Fertig & Schmidt (2001) state, the research on the driving forces places more attention on economic factors, thus neglecting the impact of demographic factors which can also be significant.

On the other hand, Ramos & Suriñach (2017) offer another approach to dividing forces of migration: on push and pull factors. Factors which are classified as push factors are the factors having effect in the home country which drive the person to consider immigration. On the other hand, the pull factors are the factors coming from host countries, which attracts immigrants. For example, an economic factor with push effect is poverty, while prospects of higher wage is also an economic factor, but with a pulling effect. Another pull factors can be labor market (Nannestad, 2004; Almeida, Fernando & Sheridan, 2012) or family and friends already the resident in host countries (Derwing & Krahn, 2008).

The issue of modelling migration has been a topic of extensive research. For example, Mitchell and Pain (2003) proposed an econometric model to model migration flows to the United Kingdom. Howe and Jackson (2004) created a conceptual framework for the long-term projection of migration using demographic, economic, and developmental drivers. Alvarez-Plata, Brucker, and Siliverstovs (2003) also created an econometric model for migrations, on the level of EU-15 after the eastern enlargement.

There is a growing need to unveil what are the determinants of immigration in European countries. Therefore, the key question in this paper is to discover which determinants have an impact on the number of long-term immigrants arriving in European countries. To do so, we collected data on 27 European countries for the period 2008-2018 on immigration and four factors whose impact we strive to observe.

The paper is divided into five sections: Section 1 saw the introduction to the research; Section 2 will present insights on the collected data on which the analysis will be performed. The following section sees a brief description of the employed methodology, while the Section 4 presents the obtained results. Finally, in Section 5, we provide a discussion and conclusion.

2. COLLECTED PANEL DATA

In order to observe which indicators and how impact the level of emigration in EU countries, we used the data available from Eurostat. The indicator which we strive to model is *Immigration* using economic factors (*GDP per capita* and *Acquisition of citizenship*) and demographic factors (*Life expectancy* and *Infant mortality rate per 1000 live births*). Some of these variables were used in previous research to model immigration. For example, Koegh (2013) modelled levels of migration using GDP. The list of the indicators used in the research and their definition is given in Table 1.

The data was collected for 27 European countries. Several countries had to be removed from the analysis due to missing data. The panel data period was from 2008 to 2018 which was the latest available period. The source from which we collected the data is (Eurostat, 2020). The countries which we observed in our sample are Austria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Table 1: Indicators included in the analysis

Indicator	Definition
Immigration	Total number of long-term immigrants arriving into the reporting country during the reference year
GDP per capita	Ratio of real GDP to the average population of a specific year
Life expectancy	Life expectancy at birth is defined as the mean number of years that a new-born child can expect to live if subjected throughout his life to the current mortality conditions (age specific probabilities of dying)
Acquisition of citizenship	Number of grants of citizenship of the reporting country to persons usually resident in the reporting country who have previously been citizens of another country or who have been stateless
Infant mortality rate per 1000 live births	The ratio of the number of deaths of children under one year of age during the year to the number of live births in that year. The value is expressed per 1 000 live births.

Source: Eurostat (2020)

3. METHODOLOGY

To observe the relation between the chosen variables and inspect their effect on the level of immigration we opted for panel data that describe entity behaviour in two dimensions: across entities (cross-section) and over time (time-series). The most commonly used models for panel data regression estimation are Pooled OLS, Fixed effects regression model, and Random effects regression model (Adeleye & Eboagu, 2019; Ahmed & Bhatti, 2019; Kumar & Ranjani, 2019; Marianno & Strunk, 2018; Onakoya, Johnson, & Ogundajo, 2019; Onali, Ginesti, & Vasilakis, 2017).

The pooled OLS suspects homogeneity of all panel data sections, treating them the same as if they were the single section of data. It does not suspect the particular attributes of entities nor uncommon effects over time. The fixed effects model suspects heterogeneity among different entities, so that each cross-section has a different intercept. In this case, an intercept might be different for entities but not affected over time. The random effects regression model also suspects heterogeneity among entities, but not over time, but the individual-specific effects are uncorrelated with the predictors.

The panel data regression has been previously used in the field of migration analysis and research. For example, Gross & Schmitt (2003) used panel data to explore are migration flows influenced by the presence of residents from the same origin in the receiving country. Besides confirming the hypothesis, they also showed that the larger the host country is compared to the origin country, it attracts larger flows of immigrants. Ukrayinchuk & Jayet (2011) used panel data to observe migrations within Helvetic regions. They pointed out that the factors which influence the attractiveness of a province are the level of urbanisation, rental-housing supply and tourist attractiveness. Belot & Ederveen (2012) tested the effects of cultural barriers on migration within OECD countries. Some of their results are that the unemployment rate at the receiving country decreases immigration flows and that that the distance between capital cities has a negative effect on migration flows. Kim & Cohen (2010) used panel data to determine the factors which impacted international migratory inflows and outflows Western, industrialised countries. Lead by these examples, we also used panel data analysis.

4. RESULTS

Before presenting the results of panel data analysis, we give the summary descriptive statistics for all observed countries in the period 2008-2018 in Table 2.

Looking at the number of long-term immigrants arriving, most immigrants has arrived in Germany in 2015, 1571047, while the least arrived in Estonia in 2012, 2639. This indicator has a high standard deviation and IQR, indicating that the values of this indicator vary quite a lot between the observed countries in the observed period. The highest GDP per capita was measured in Luxembourg in 2018, 83470$. On the other hand, the lowest GDP per capita was in Romania in 2010, 6190$. Again, according to the standard deviation and IQR, this indicator also varies a lot. Observing more closely the *Acquisition of citizenship,* we can see that it ranges from 130 (Lithuania, 2018) to 225793 (Spain, 2013). The variables related to life expectancy and infant mortality rate have a small variance indicating that there have not been significant variations in the observed period.

Table 2: Descriptive statistics of the observed variables for the period 2008-2018

Variable	Mean	SD	Min	Max	Median	IQR
Immigration	136265.92	204396.23	2639	1571047	52236.00	138201.50
GDP per capita	25852.52	15860.11	6190	83470	22210.00	22765.00
Life expectancy	79.64	2.84	71.70	83.50	80.80	4.30
Acquisition of citizenship	29840.37	49211.16	130	225793	4980.00	26746.00
Infant mortality rate per 1000 live births	3.714	1.52	0.700	11.00	3.50	1.50

Next, we proceed to the panel data analysis. The results of the fixed effects, random effects, and pooled OLS and the comparative analysis of the three models are given in Table 3. As mentioned before, there was no missing data, so no countries were removed from the analysis.

Table 3: Panel data regression models

Variable	Fixed effects	Random effects	Pooled OLS
Intercept	-424330.3	-829657.8	197770.5
GDP per capita	6.138**	1.623	0.787**
Life expectancy	5384.852	11179.78	-2668.517
Acquisition of citizenship	-0.932***	0.461*	3.259***
Infant mortality rate per 1000 live births	228.388	5336.868	8997.399**
F	69.153***	3.471**	442.032***
Adjusted R2	0.873	0.032	0.598
Cross-section random Rho	/	0.592	/
Hausman Chi-square test	104.005***		
Wald F	0.357		
Time period (year)	11	11	11
Number of countries	27	27	27
Number of observations	297	297	297
Cross sections included	27	27	4
Total pool (balanced) observations	/	/	1188

*p<0.05, **p<0.01, ***p<0.001

In the fixed effects model, *GDP per capita* and *Acquisition of citizenship* showed to be statistically significant, while the remaining two factors not. This result proved that economic factors are more important for modelling immigration level. The adjusted R square of the model is 0.873, meaning that 87.3% of the variability of the immigration level can be explained by the four chosen variables. Within the model, the regression coefficient of *GDP per capita* is positive, indicating that the higher GDP per capita attracts migration. On the other hand, the coefficient of *Acquisition of citizenship* is negative which is unexpected, indicating that the more citizenship is given, the less migrations towards that country will be.

In the next model, the random effects model, only *Acquisition of citizenship* showed to be statistically significant. The obtained coefficient is 0.461, indicating that the more citizenship is given, the more migrations towards that country will be, which is in contrast with the results in the fixed effects model. The random effects model is of lower quality than the fixed effects model with the adjusted R square of just 0.032.

Next, we assess the third model, the pooled OLS. In this model, both economic and demographic variables were significant. Namely, *GDP per capita, Acquisition of citizenship,* and *Infant mortality* proved to be statistically significant. As in the fixed effects model, the higher GDP per capita attracts migration. As in the random effects model, the more citizenship is given, the more migrations towards that country will be. The coefficient of the *Infant mortality rate* is positive, indicating that the higher infant mortality rate attracts migration, which is not expected. The adjusted R square of the model is 0.598, meaning that 59.8% of the variability of the immigration level can be explained by the four chosen variables.

To determine the better between the models, we used the Housman test and Wald F test. Housman test compares fixed effects model and random effects model. The null hypothesis of the test is that the random effects model is appropriate, against the alternative hypothesis which is that the fixed effects model is appropriate. Hausman Chi-square statistics 104.005 and is significant at the level of 0.001. Therefore, we conclude that the fixed effects model is appropriate in this case.

Finally, we compare the fixed effects model and the pooled OLS model. To do so, we used the Wald test, which tests the significance of the fixed effects model dummy variable coefficients. For this purpose, we created four dummy variables, one for each explanatory variable. The null hypothesis of the test is that the dummy variable coefficients all equal zero, indicating that the pooled OLS model is appropriate. Contrarily, the alternative hypothesis which is that the dummy variable coefficients are different from zero, indicating that the fixed effects model is appropriate. In our case, the Wald F statistics is 0.357, indicating that the pooled OLS model is appropriate if comparing the two models.

4. CONCLUSION

The presented research aimed to explore the effect of different push and pull economic and societal variables on the level of immigration in Europe. The exploratory variables included *GDP per capita, Life expectancy, Acquisition of citizenship,* and *Infant mortality rate*. The employed statistical method was panel data regression.

For the purpose of exploring the effect of the chosen four variables, we created a short, balanced panel data. We created a fixed effects model, random effects model, and pooled OLS model and compared them. The pooled OLS proved to be the most appropriate according to the Housman test and Wald F test. This result was not expected as the pooled OLS did not explain the largest percent of the variability (59.8%) compared to the fixed effects model (87.3%). On the other hand, the pooled OLS model is the model in which three out of four explanatory variables are statistically significant. The variable that attracts attention is *Acquisition of citizenship*, as it was statistically significant in all three models. This is expected because the panel included EU countries were the many immigrants came from war-torn areas looking for security and stability. The result builds on research of Barrett and coauthors (2013), where they concluded that the immigration in EU countries do not correlate with welfare generosity.

During our research, we could identify several future directions of the study. One possible direction of the study could be the joint probabilistic projections (Azose & Raftery, 2015). Namely, for policymakers on the European level, it could be of interest to try to project migrations. Also, time series modelling could be employed as well to predict the migration levels (Cappelen et al., 2015).

One of the future directions of research should be the examination of those countries that were colonial powers (such as Great Britain, France, Spain, Portugal or Belgium) and the examination of whether there is a certain rule in the migration from former colonies to them (Kymlicka, 2003). Another direction of research is to include more variables into consideration. Foad (2012) noted that there is positive correlation between immigration and foreign direct investment. Variable which could also be taken in to consideration is assimilation policy (Bloemraad, Korteweg & Yurdakul, 2008).

The presented has several limitations which should be pointed out. First, we observed just 27 countries over a period of 11 years. Therefore, the panel could be extended in future research. Also, the number of explanatory variables should be discussed. Namely, we used two economic and two demographic variables. Namely, societal variables such as human rights abuse and discrimination levels could be included. The same accounts for political variables such as corruption, political freedom, and governance (Ramos & Suriñach, 2017).

Nevertheless, we believe that this paper contributes to the literature in the field of European migrations showing that both economic and societal factors should be taken into account when analysing and modelling migrations.

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SOLUTION VALUE ENVELOPE TO FULL FUZZY TRANSPORTATION PROBLEMS

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Abstract: *In this paper we provide empirical solutions to the special class of full fuzzy transportation problems. We use trapezoidal fuzzy numbers to describe the both parameters and decision variables of the problem. Our approach is based on a quadratic optimization model derived from the original transportation model considering the cost coefficients, demands and supplies as decision variables. By our approach we aim to introduce a new methodology able to test the effectiveness of any approach that provides solutions to the same class of problems. In our study we analyze and compare the existing solution methods from the recent literature, and illustrate our theoretical results solving relevant instances.*

Keywords*: transportation problem, full fuzzy programming problem, trapezoidal fuzzy numbers*

1. INTRODUCTION

Fuzzy linear programming problems are widely studied and many researches in this field can be found in the recent literature. Ghanbari et al. (2019) presented a well documented survey on the existing models and obtained solutions to fuzzy linear programming problems in general, but also to full fuzzy transportation problems in particular.

Baykasoğlu and Subulan (2017) introduced a method based on the constrained fuzzy arithmetic and solved full fuzzy transportation problems in which all of the parameters and decision variables were fuzzy numbers. They proposed their methodology as an alternative to those based on extension principle (Bellman and Zadeh, 1970) motivating that the latter ones may produce questionable results for real-life applications.

Ebrahimnejad (2016) solved fuzzy transportation problems with LR flat fuzzy numbers. He converted the initial problem into four crisp bounded transportation problems assuring that the obtained fuzzy optimal solution is a non-negative LR flat fuzzy number. Later on, Ebrahimnejad and Verdegay (2018) approached the fully intuitionistic fuzzy transportation problems converting them into single objective crisp linear problems whose solutions provide intuitionistic fuzzy solutions to the original problems. Their solution approach was based on ordering of trapezoidal intuitionistic fuzzy numbers using an accuracy function.

Giri et al. (2015) proposed a solution approach to fixed charge multi-item solid transportation problems with parameters (direct costs, fixed charges, supplies, demands, conveyance capacities) and decision variables (transported quantities) expressed by triangular fuzzy numbers. They involved chance constrained programming, expectation, modified graded mean integrated value and minimization of fuzziness methods to obtain three different crisp models.

Kocken and Sivri (2016) provided a parametric method to derive all optimal solutions to fuzzy solid transportation problems. They used the feasibility range based on fuzzy supply-demand-conveyance quantities; found the breaking points of fuzzy costs; and finally constructed the optimal solutions.

Liu and Kao (2004) proposed a dual based model to describe the set of feasible objective values that are optimal values to crisp problems derived from the full fuzzy transportation problem. They solved the fuzzy transportation problem under the particular assumption that the total supply is less than the total demand. Even thought that in this way their methodology lost its generality, their idea can be further extended to solve a more general class of problems.

More studies on transportation problems in fuzzy environment can be found in Baykasoğlu and Subulan (2019), Díaz-Madroñero et al. (2014), Ghasemy Yaghin and Darvishi (2019), Kaur and Kumar (2011), Kaur and Kumar (2013), Kumar et al. (2020), Mahmoodirad et al. (2019), Mishra and Kumar (2020), Molla-Alizadeh-Zavardehi (2013), Verdegay (2015) and Yang et al. (2017).

The methodology we propose in this paper is able to disclose the shapes of the fuzzy set solutions in the relevant region of the feasible objective values to full fuzzy transportation problems. We use trapezoidal fuzzy numbers for both parameters and decision variables of the transportation problem and an extension principle based concept of optimal solution and derive quadratic models. We conduct experiments on instances recalled from the recent literature, report our numerical results, and compare them to the results obtained using well-known approaches.

The rest of the paper is organized as follows: Section 2 is devoted to notation and terminology; Section 3 presents the extension principle based concept of optimal solution to a full fuzzy transportation problem and our novel models used to derive the membership functions of optimal value and solution; Section 4 reports our numerical results and their comparison to existing results; and Section 5 includes our final conclusions and direction for future researches.

2. NOTATION AND TERMINOLOGY

2.1. Fuzzy sets

Zadeh (1965) introduced the concept of fuzzy set that was further widely used in many scientific areas including mathematical optimization. We will use the trapezoidal fuzzy numbers and extension principle (Bellman and Zadeh, 1970) from his theory of fuzzy sets through our paper.

A fuzzy set $\tilde{A}$ over the universe X is defined as a collection of pairs $\left(x, \mu_{\tilde{A}}(x)\right)$ such that $x \in X$ and $\mu_{\tilde{A}}(x) \in [0,1]$. In other words, the first component of each pair is an element of the universe, while the second element is its corresponding membership degree. Function $\mu_{\tilde{A}}$ is the membership function of the fuzzy set $\tilde{A}$. A trapezoidal fuzzy number is an especial case of fuzzy set over the universe $\mathbb{R}$ whose membership function has a trapezoidal graphic representation. Each trapezoidal fuzzy number $\tilde{A}$ can be seen as a quadruple (a^1, a^2, a^3, a^4) that graphically assumes a linear increase from $(a^1, 0)$ to $(a^2, 1)$ and a linear decay from $(a^3, 1)$ to $(a^4, 0)$. The membership function $\mu_{\tilde{A}}$ of the trapezoidal fuzzy number $\tilde{A}$ is defined such that $\mu_{\tilde{A}}(x) = (x - a^1)/(a^2 - a^1)$ on the interval $[a^1, a^2]$; $\mu_{\tilde{A}}(x) = 1$ on the interval $[a^2, a^3]$; $\mu_{\tilde{A}}(x) = (a^4 - x)/(a^4 - a^3)$ on the interval $[a^3, a^4]$; and $\mu_{\tilde{A}}(x) = 0$ on $\mathbb{R} \setminus [a^1, a^4]$.

Applying the extension principle (Bellman and Zadeh, 1970), the fuzzy subset $\tilde{B}$ of the universe Y, intended to be equal to $f\left(\tilde{A}_1, \ldots, \tilde{A}_p\right)$, where $Y = X_1 \times \ldots \times X_p$ and each $\tilde{A}_i$ is a fuzzy set of its corresponding universe X_i, $i = \overline{1,p}$, has the membership function defined by:

$$\mu_{\tilde{B}}(y) = \max_{f(x_1,\ldots,x_p)=y} \left(\min \left\{ \mu_{\tilde{A}_1}(x_1), \ldots, \mu_{\tilde{A}_p}(x_p) \right\} \right).$$

2.2. Problem formulation

This study addresses the full fuzzy transportation problem (FF-TP). The mathematical formulations of both the crisp balanced transportation problem (TP) and its analogical full fuzzy problem are presented in Table 1.

Conditions $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$ and $\sum_{i=1}^{m} \tilde{a}_i = \sum_{j=1}^{n} \tilde{b}_j$ for the crisp and full fuzzy model respectively must be fulfilled to assure the non-emptiness of the feasible sets, and they show that the problems are balanced.

The crisp problem described in Table 1 has *m* nodes representing the sources and *n* nodes representing the destinations. We denoted by a_i, $i = \overline{1,m}$, and b_j, $j = \overline{1,n}$ the quantities that are supplied by the source node *i*, and the quantities that are required by the destination node *j*, respectively. Let c_{ij}, $j = \overline{1,n}$ be the coefficients of the cost function, and let x_{ij}, $i = \overline{1,m}$, $j = \overline{1,n}$ be the number of units transferred along the link (i, j). Solving this problem we determine a feasible way to transport the available amount of commodities from sources to destinations, such that it minimizes the total transportation cost. By analogy, the parameters involved in the full fuzzy model have the same interpretation under the assumption that they additionally describe the uncertainty of the input data in a fuzzy manner.

Table 1: Crisp model (1) and full fuzzy model (2) for balanced transportation problems

Model (1)	**Model (2)**
$\min \quad f(x) = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}\,,$	$\min \quad \tilde{f}(\tilde{x}) = \sum_{i=1}^{m}\sum_{j=1}^{n} \tilde{c}_{ij}\tilde{x}_{ij}\,,$
$s.t.$	$s.t.$
$\sum_{j=1}^{n} x_{ij} = a_i, i = \overline{1,m},$	$\sum_{j=1}^{n} \tilde{x}_{ij} = \tilde{a}_i, i = \overline{1,m},$
$\sum_{i=1}^{m} x_{ij} = b_j, j = \overline{1,n},$	$\sum_{i=1}^{m} \tilde{x}_{ij} = \tilde{b}_j, j = \overline{1,n},$
$x_{ij} \geq 0, i = \overline{1,m}, j = \overline{1,n}$	$\tilde{x}_{ij} \geq 0, i = \overline{1,m}, j = \overline{1,n}$

There are two more models (presented in Table 2) for crisp transportation problems, each of them with its specific feasibility condition. These models are involved and must be taken into consideration in the analysis of a full fuzzy transportation problem that uses fuzzy numbers for both coefficients and decision variables. The feasibility condition for Model (3) is $\sum_{i=1}^{m} a_i \geq \sum_{j=1}^{n} b_j$, while for Model (4) it is $\sum_{i=1}^{m} a_i \leq \sum_{j=1}^{n} b_j$.

Table 2: Unbalanced transportation models

Model (3)	**Model (4)**
$\min \quad f(x) = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}\,,$	$\min \quad f(x) = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}\,,$
$s.t.$	$s.t.$
$\sum_{j=1}^{n} x_{ij} \leq a_i, i = \overline{1,m},$	$\sum_{j=1}^{n} x_{ij} = a_i, i = \overline{1,m},$
$\sum_{i=1}^{m} x_{ij} = b_j, j = \overline{1,n},$	$\sum_{i=1}^{m} x_{ij} \leq b_j, j = \overline{1,n},$
$x_{ij} \geq 0, i = \overline{1,m}, j = \overline{1,n}$	$x_{ij} \geq 0, i = \overline{1,m}, j = \overline{1,n}$

3. SOLUTION CONCEPT AND SOLVING MODELS TO AN FF-TP

Based on the extension principle, a solution to an FF-TP is described by its membership function constructed with the help of the membership degrees $\mu_{\tilde{f}}(z)$ of the optimal objective values z obtained by optimizing TPs with certain parameters.

We first construct the fuzzy set that describes the feasible values of the objective function by computing their membership degrees. From the such obtained fuzzy set we retain the increasing piece of its membership function that also represent the increasing piece of the membership function of the fuzzy set of the minimal feasible values of the objective function. To construct the decreasing piece of the membership function of the fuzzy set of the minimal feasible values of the objective function we follow the methodology of Liu and Kao (2004). They considered the dual of the transportation problem (3) and formulated the quadratic model (9) which optimizes the objective function with respect to $\tilde{a}_i$, $\tilde{b}_j$ and $\tilde{x}_{ij}$, $i = \overline{1,m}$, $j = \overline{1,n}$. The numerical illustration given in Section 4 shows that we improve the result of Liu and Kao (2004) in regard to the left side of the membership function of z.

For fixed values of z we compute their membership degrees by solving the following quadratic programming Model (7) that considers all parameters as variables and imposes the original objective function to be equal to z. For details about the quadratic programming and effects of approximations in numerical optimization we refer the reader to Brieden et al. (2000).

$$
\begin{gathered}
\max \quad \alpha \\
\text{s.t.} \\
\mu_{\tilde{c}_{ij}}(c_{ij}) \geq \alpha \quad i=\overline{1,m}, j=\overline{1,n}, \\
\mu_{\tilde{b}_j}(b_j) \geq \alpha, \quad j=\overline{1,n}, \\
\mu_{\tilde{a}_i}(a_i) \geq \alpha, \quad i=\overline{1,m} \\
\sum_{i=1}^{m}\sum_{i=1}^{m} c_{ij}\, x_{ij} = z, \quad i=\overline{1,m}, j=\overline{1,n}, \\
x \in X_{a,b}
\end{gathered}
\tag{7}
$$

Model (7) yields values whose graphical representation approximate the shape of the fuzzy set that represents the feasible values of the objective function. The left (increasing) side of this shape also describes the fuzzy set that represents the minimal values of the objective function.

The constraint $x \in X(a,b)$ included in Model (7) summarizes a disjunctive system of constraints that allows both cases of total demands less or equal to total supply and total demands grater or equal to total supply whatever the original model imposes. This flexibility is due to the fact that even imposing one type of inequality between the total fuzzy demand and total fuzzy supply, a switched inequality may arise between possible crisp demands and supplies. It means that, independent on the model chosen for the full fuzzy transportation problem, any of Models (1), (3), (4) may arise when crisp possible parameters are chosen.

To describe the constraint $x \in X(a,b)$ mathematically we have to consider the following disjunctive system of constraints

$$
\begin{array}{lcl}
\sum_{j=1}^{n} x_{\mathrm{ij}} \leq a_i, i=\overline{1,m}, & & \sum_{j=1}^{n} x_{\mathrm{ij}} \geq a_i, i=\overline{1,m}, \\
\sum_{i=1}^{m} x_{\mathrm{ij}} \geq b_j, j=\overline{1,n}, & \vee & \sum_{i=1}^{m} x_{\mathrm{ij}} \leq b_j, j=\overline{1,n}, \\
x_{ij} \geq 0 \quad i=\overline{1,m}, j=\overline{1,n}, & & x_{ij} \geq 0 \quad i=\overline{1,m}, j=\overline{1,n}.
\end{array}
$$

To handle the disjunctive system of constraints we transform it in a conjunctive form using the following pair of double inequalities and a binary variable y:

$$
\begin{gathered}
a_i y \leq \sum_{j=1}^{n} x_{\mathrm{ij}} \leq a_i, i=\overline{1,m}, \\
b_i(1-y) \leq \sum_{i=1}^{m} x_{\mathrm{ij}} \leq b_j, j=\overline{1,n}, \\
y \in \{0,1\}, \\
x_{ij} \geq 0 \quad i=\overline{1,m}, j=\overline{1,n}.
\end{gathered}
$$

Using the analytical form of the membership functions of the trapezoidal fuzzy numbers $\tilde{a}_i$, $\tilde{b}_j$ and $\tilde{c}_{ij}$, $i=\overline{1,m}, j=\overline{1,n}$ we obtain lower and upper bounds for the decision variables a_i, b_j and c_{ij} as follows.

The inequality $\mu_{\tilde{a}_i}(a_i) \geq \alpha$ provides that a_i belongs to the α-cut of the fuzzy number $\tilde{a}_i$, thus it is transformed to the double inequality $\alpha a_i^2 + (1-\alpha)a_i^1 \leq a_i \leq \alpha a_i^3 + (1-\alpha)a_i^4$ by inverting the functions used to defined the trapezoidal fuzzy number $\tilde{a}_i$. Similar double inequalities are obtained from the α-cuts of the trapezoidal fuzzy numbers $\tilde{b}_j$ and $\tilde{c}_{ij}$, $i=\overline{1,m}, j=\overline{1,n}$.

Applying all above mentioned changes on the original constraints $x \in X(a,b)$ and on $\mu_{\tilde{b}_j}(b_j) \geq \alpha$, $\mu_{\tilde{a}_i}(a_i) \geq \alpha$, and $\mu_{\tilde{c}_{ij}}(c_{ij}) \geq \alpha, i=\overline{1,m}, j=\overline{1,n}$, we obtain Model (8).

$$
\begin{gathered}
\max \quad \alpha \\
\text{s.t.} \\
\alpha b_j^2 + (1-\alpha) b_j^1 \le b_j \le \alpha b_j^3 + (1-\alpha) b_j^4, \quad j = \overline{1,n}, \\
\alpha a_i^2 + (1-\alpha) a_i^1 \le a_i \le \alpha a_i^3 + (1-\alpha) a_i^4, \quad i = \overline{1,m} \\
\alpha c_{ij}^2 + (1-\alpha) c_{ij}^1 \le c_{ij} \le \alpha c_{ij}^3 + (1-\alpha) c_{ij}^4, \quad i = \overline{1,m}, j = \overline{1,n} \\
\sum_{i=1}^m \sum_{i=1}^m c_{ij}\, x_{ij} = z, \\
a_i y \le \sum_{j=1}^n x_{\text{ij}} \le a_i, \quad i = \overline{1,m}, \\
b_i (1-y) \le \sum_{i=1}^m x_{\text{ij}} \le b_j, \quad j = \overline{1,n}, \\
y \in \{0,1\}, \\
x_{ij} \ge 0 \quad i = \overline{1,m}, j = \overline{1,n},
\end{gathered}
\tag{8}
$$

The decision variables of Model (8) are $\alpha, x_{ij}, a_i, b_j, c_{ij},\ i = \overline{1,m}, j = \overline{1,n}$, and the constraint system of the model is mixed integer quadratic.

The mathematical model used by Liu and Kao (2004) to derive the right side of the membership function is

$$
\begin{gathered}
\max \quad \sum_{i=1}^m a_i\, u_i + \sum_{i=1}^m b_j\, v_j \\
\text{s.t.} \\
u_i + v_j \le \alpha c_{ij}^3 + (1-\alpha) c_{ij}^4, \quad i = \overline{1,m}, j = \overline{1,n} \\
\alpha b_j^2 + (1-\alpha) b_j^1 \le b_j \le \alpha b_j^3 + (1-\alpha) b_j^4, \quad j = \overline{1,n}, \\
\alpha a_i^2 + (1-\alpha) a_i^1 \le a_i \le \alpha a_i^3 + (1-\alpha) a_i^4, \quad i = \overline{1,m}, \\
\sum_{i=1}^m a_i = \sum_{j=1}^n b_j.
\end{gathered}
\tag{9}
$$

An empirical fuzzy set solution to a FF-TP problem can be obtained by employing a Monte Carlo simulation based algorithm that in each iteration generates random values for all coefficients $a_i, b_j, c_{ij},\ i = \overline{1,m}, j = \overline{1,n}$ and uses them to solve a classic TP. The obtained minimal value and all components of the optimal solution are reported as belonging to the corresponding fuzzy set solution with the membership degree equal to the minimum of the membership degrees of all coefficients. In other words, if $\overline{x}$ is the optimal solution and $\overline{z}$ is the optimal value of the TP with coefficients $a_i, b_j, c_{ij},\ i = \overline{1,m}, j = \overline{1,n}$, then their membership degrees in the fuzzy set solution is always greater than

$$
\min_{i,j} \left\{ \mu_{\tilde{c}_{ij}}(c_{ij}), \mu_{\tilde{a}_i}(a_i), \mu_{\tilde{b}_j}(b_j) \right\}. \tag{10}
$$

4. NUMERICAL RESULTS

For our numerical illustration we recall a transportation problem solved in (Liu and Kao, 2004). Their transportation problem was modeled using an analogical fuzzy form of Model (3), and its fuzzy coefficients are reported in Table 3.

The coefficients of the objective function, supplies and demands are described by trapezoidal fuzzy numbers as quadruples properly indexed with respect to $m = 2$ sources and $n = 3$ destinations. Liu and Kao (2004) used two level models to derive the left and right sides of the membership function of the objective *z*.

Table 3: Trapezoidal fuzzy numbers $\tilde{c}_{ij}, \tilde{a}_i, \tilde{b}_j, i = \overline{1,2}, j = \overline{1,3}$ for the numerical example

	***j* = 1**	***j* = 2**	***j* = 3**	**Supplies**
i = 1	(10, 10, 10, 10)	(50, 50, 50, 50)	(80, 80, 80, 80)	(70, 90, 90, 100)
i = 2	(60, 70, 80, 90)	(60, 60, 60, 60)	(20, 20, 20, 20)	(40, 60, 70, 80)
Demands	(30, 40, 50, 70)	(20, 30, 40, 50)	(40, 50, 50, 80)	

The graphic representation of the membership function of the fuzzy set of the feasible values of the objective function (*z* with respect to α) is given in Figure 1.

The numerical values were determined by solving Model (8) for values of *z* varying from 1400 to 14500 with step 100. Minimal values of z together with a minorant of their membership degree (in accordance to Formula (10)) in the fuzzy minimal set, obtained via Monte Carlo simulation, are also shown in Figure 1.

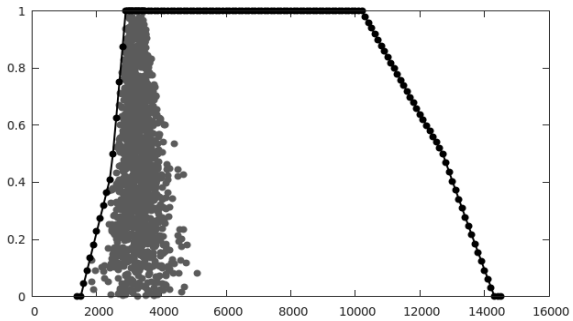

Figure 1: The envelope of the feasible values (yielded by solving Model (8)), and some minimal values (generated using the Monte Carlo simulation algorithm) of the objective function of the FF-TP described in Table 3. On the abscise are shown the values of *z*, while on the ordinate their membership degrees.

Figure 2 (on the left) shows the results obtained by Liu and Kao (2004), and our results obtained by Monte Carlo simulation. Note that the Monte Carlo simulation found solutions that are out of the solution shape provided by the methodology proposed in (Liu and Kao, 2004). In other words, there are smaller values of the objective function with strictly positive membership degrees that can be reached using the given fuzzy parameters. Liu and Kao (2004) used the crisp Model (3) to derive the shape of the fuzzy set solution values imposed on all feasible group of crisp parameters, ignoring the possibility that individual pairs of crisp parameters may fulfill other type of inequalities than those specific to Model (3).

Figure 2 (on the right) shows Liu and Kao's results; the solutions obtained by the same Monte Carlo simulation; and the results obtained by solving Problem (8) for several distinct values of $z \in [1500,3800]$. Comparing to Liu and Kao's results it is clear that we obtained a better numerical approximation of the exact shape of the left side of the fuzzy set solution to the fuzzy transportation problem.

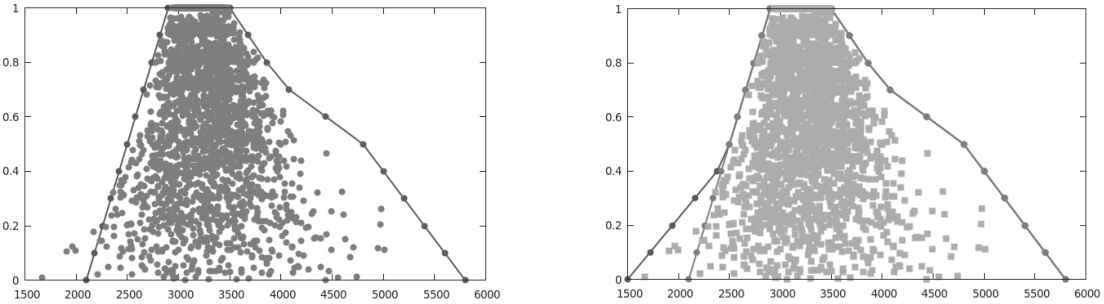

Figure 2: Left: Monte Carlo simulation and the results obtained by Liu and Kao (2004). Right: Monte Carlo simulation, the results of Liu and Kao (2004), and our left side improved shape of the fuzzy set solution

The numerical values obtained for the decision variables during the Monte Carlo simulation are shown in Figure 3. These shapes cannot be interpreted as fuzzy sets solution to the original problem since they do not fulfill the original constraints. Despite this, they provide relevant information about those feasible values of each decision variable separately that are part of an optimal solution to at least one transportation problem with feasible values of the parameters.

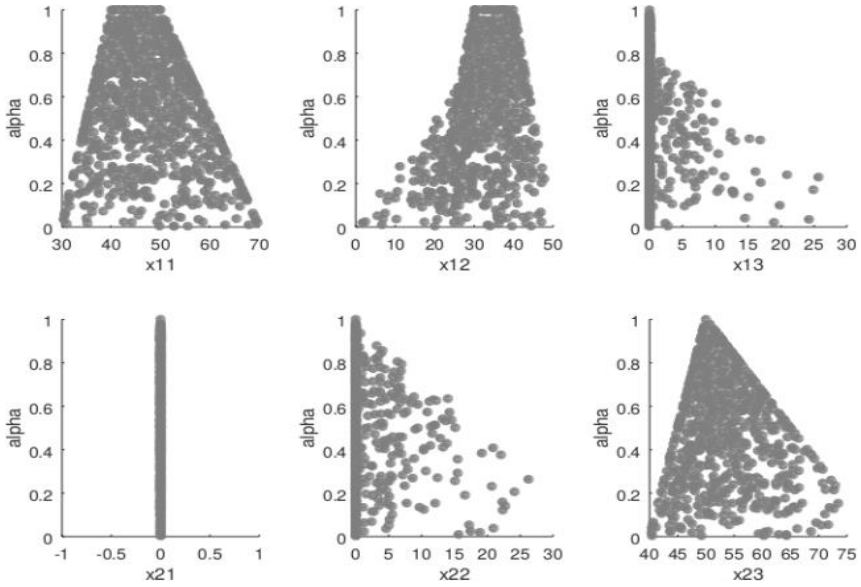

Figure 3: The graphic representation of the optimal solutions obtained in a Monte Carlo simulation process applied to the input data shown in Table 3 and used in Model (3).

5. CONCLUSION

In this paper we provided two kinds of solutions to the special class of full fuzzy transportation problems: empirical and numerical. The methodology we proposed disclosed the approximate shapes of the fuzzy set solutions in the relevant region of the feasible objective values. We used trapezoidal fuzzy numbers for both parameters and decision variables of the transportation problem and an extension principle based concept of optimal solution. We derived quadratic solution models and conducted experiments on instances obtained from the literature. We reported our numerical results, and compared them to the results obtained using an existing approache.

After the literature review and presentation of notation and terminology we presented the extension principle based concept of optimal solution, and our quadratic optimization models derived from the original transportation model that considered the cost coefficients, demands and supplies as decision variables. The novel methodology is able to test the effectiveness of any approach that provides solutions to the same class of problems.

Fuzzy linear programming problems in general and full fuzzy transportation problems in particular are widely studied in the recent literature an there are many open directions for further researches. In future we will focus on applying a validity test, based on a Monte Carlo simulation algorithm, to the existing solution approaches to a wider class of fuzzy optimization problems aiming to formulate improved approaches whenever it is needed.

ACKNOWLEDGEMENT

This work was supported by the Serbian Ministry of Education, Science and Technological Development through Mathematical Institute of the Serbian Academy of Sciences and Arts and Faculty of Organizational Sciences of the University of Belgrade.

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A NOVEL APPROACH FOR LEARNING TEMPORAL POINT PROCESS

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Abstract: *In this paper, we presented a novel methodology for learning temporal point process based on the implementation of one-dimensional numerical integration techniques. The implementation of numerical methodology is used for linearizing negative maximum likelihood (neML) function to enable backpropagation of neML derivative. The presented approach is tested on highway toll dataset. Moreover, four different well-known point process baseline models were compared: first-order and second-order polynomial Poisson inhomogeneous process and Hawkes with exponential and Gaussian kernel. The results showed that different numerical integration techniques influence the quality of the obtained models.*

Keywords*: traffic prediction, temporal point process, Hawkes process, Poisson process, numerical integration*

1. INTRODUCTION

Nowadays, one of the most popular research areas is focused on modelling event sequence. Event sequence has become extremely popular in a variety applications such as traffic (Ryu & Steven, 1998), epidemiology (Zahrieh, 2017), network activities (Liu, 2018), bioinformatics (Farajtabar et al., 2017), e-commerce etc. The event data carry important information about timestamps when an event occurred. Additionally, event data can also provide information concerning event attribute such as class of event, type, participator, etc. This type of point process is known as a marked point process. Compared to the time-series event occurrences are treated as random variables generated in an asynchronous manner, which makes them fundamentally different from time series where equal and fixed time intervals are considered. This property makes them useful in a wide variety of applications where discretizing events to fixed interval results in bad prediction performances and high computational cost.

Generally, there are two types of point process models: temporal (univariate) point process and spatial-temporal (multivariate) point process. In the case of the univariate point process, the objective is to model temporally correlated event occurrence, whereas in spatial-temporal point process the event occurrences are correlated in space and time. Multivariate point process is generally mostly used in the analysis of protein patterns (Jacobsen et al., 2007) and financial market predictions (Bowsher, 2007). The general formulation of the point process makes them available to model event occurrences continuous or discontinuous (with jumps). Additionally, the point process can be further generalized by stochastic differential equations to stochastic point process.

The main idea behind different types of point process models is hidden in modelling conditional intensity function. Conditional intensity function can be interpreted heuristically as expected number of events that are going to occur in infinitesimally small timestamp (dt). This intensity function can be modelled as constant (homogeneous process) or function of time (inhomogeneous process). Learning intensity function (Mei & Eisner, 2017) from given dataset present one of the most popular subjects of research. A point process is extremely useful in modelling traffic congestion and traffic event occurrences (Jia, Jiang, Liu, Cui, & Shi, 2018) (arrival of vehicles, pedestrian movement, etc.). Simulating highway traffic and predicting highway congestion (Nguyen, Krishnakumari, Calvert, Vu, & Van Lint, 2019) is one of the main problems connected with point process modelling. In the case of highway congestion, the event occurrences can be described as the number of vehicles that pass highway toll.

In this paper, we presented the data-driven approach for learning different types of conditional intensity functions used in temporal point process models. Our approach is based on implementing numerical integration methods to linearize negative maximum likelihood (neML) and backpropagate derivative of neML. Based on the dataset that consists of exact timestamps when vehicle passes the highway toll we implemented

provided methodology and showed that it can be successfully used for any type of conditional intensity function. Furthermore, we compared four different baseline models based on neML scores: first-order and second-order polynomial Poisson inhomogeneous process, Hawkes with exponential and Gaussian kernel.

2. RELATED WORK

We structure the discussion of related work onto the two broad previously mentioned categories: intensity approaches and intensity-free approaches. The intensity approaches present the methods where the point process is modelled by different functional forms of conditional intensity functions (Rasmussen, 2011). In the case of an intensity-free methods point process is modelled with some type of unsupervised machine learning algorithms.

Intensity approaches present the oldest approaches in modelling point process. They rely on functional form that completely depends on the form of conditional intensity function. The poisson process presents the simplest point process where conditional intensity function has constant value (Last & Penrose, 2017). The more complicated variant of this process is observed when conditional intensity function is modelled as a product of kernels (Kirchner, 2017). Recent research proposed different variants of modelling intensity function by deep neural networks (Mei & Eisner, 2017; Xiao, Yan, Yang, Zha, & Chu, 2017). Xiao et al. presented an interesting approach of modelling intensity function by a recurrent neural network. However, in this paper authors assumed that integral in negative maximum likelihood is correlated only with the current timestamp. Even though, this strong assumption cannot be justified by theoretical properties of point process models the obtained results were significantly better compared to well-known baseline models. In the paper neural ordinary differential equations (Chen, Rubanova, Bettencourt, & Duvenaud, 2018; Zhang et al., 2019) authors presented an interesting approach for modelling models dynamic by deep neural networks. Moreover, the authors presented an interesting example where point process is modelled by differential equation and solved using Euler method. Besides, the authors implemented the backpropagation technique for reducing memory complexity during the training phase.

Intensity-free approaches are based on modelling point process by unsupervised learning techniques (Ghahramani, 2003). Compared to intensity approaches this methods can obtain better results, however, they are more prone to overfitting due to small datasets or large expressive powers of the model. Variational autoencoders (VAE) present unsupervised machine learning algorithms that are mostly used for point process modelling. The Action Point Process variational autoencoder (APP-VAE) presents a variational auto-encoder that can capture the distribution over the times and categories of action sequences (Mehrasa et al., 2019). The APP-VAE obtained state-of-the-art results on the MultiTHUMOS and Breakfast datasets. A declustering based hidden variable model that leads to an efficient inference procedure via a variational autoencoder for solving multivariate highly correlated point process is presented in (Yuan et al., 2020). Besides of VAE, generative adversarial networks (GANs) have recently been proposed as a method for describing event occurrences (Xiao et al., 2017). The authors proposed an intensity-free approach for point processes modelling that transforms nuisance processes to a target one by using Wasserstein GANs. Experiments on various synthetic and real-world data substantiate the superiority of the proposed point process model over conventional ones.

The model presented in this paper belongs to the class of intensity approaches. Compared to the standard intensity approaches our model has more expressive power and is less prone to overfitting compared to intensity-free approaches.

3. POINT PROCESS

In the term point process, the word point is used as a representation of the event on the timeline. Furthermore, it is accepted by the authors to think about the temporal point pattern as an ordered array of times when events occurred. Mutual to such events is that there is no information about how many there will be and when they will happen. Usually, there is some more complex mechanism behind them that explains their nature. To explain this nature and predict future events, it's convenient to use a tool for stochastic process modeling point patterns - a temporal point process.

To describe phenomena over time, the evolutionary character is essential. *Evolutionarity* means that what is happening now only depends on what happened in the past, so the future events don't have any impact on the current state. Accepting evolutionarity, the challenge to describe and predict the temporal point pattern comes down to finding a stochastic model for the time of the next event given the times of previous events. This knowledge of the times of previous events up to but not including current time t is given by history H_{t_n}:

$$H_{t_n} = \left(t_0, t_1, t_2, ..., t_{n-1}, t_n\right)$$

One of the possible approaches to define a process is by finding the distribution of time length between subsequent events. This time is also known as *interevent time*. Let $f(t_{n+1} \mid H_{t_n})$ be the *conditional density function* of the time of the next event t_{n+1} given the history of previous events H_{t_n}. Since the density functions $f(t_n \mid H_{t_{n-1}})$ specify the distributions of all interevent times, one by one, and according to the evolutionary character of the process, distribution of all events is given by the joint density (respecting the rule that the joint density for a bivariate random variable can be represented as $p(x, y) = p(x) \cdot p(y \mid x)$):

$$f(t_0, t_1, t_2, ..., t_{n-1}, t_n) = \prod_n f(t_n \mid H_{t_{n-1}})$$

Another popular approach involves a conditional intensity function as a function that defines expectation that an event will occur in the infinitesimal interval around *t* given the history *H* at times before time *t*.

The conditional intensity $\lambda(t)$ is defined to be the expected rate at which events will tend to occur around time *t* given the H_{t_n} :

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{E\left(N(t, t+\Delta t) \mid H_{t_n}\right)}{\Delta t}$$

where N denotes the number of events occurred in interval (t+Δt). Previously mentioned papers mostly agreed that the conditional intensity function is a more convenient and intuitive way of specifying how the present depends on the past in an evolutionary point process.

Considering the conditional density $f(t_{n+1} \mid H_{t_n})$ and its corresponding cumulative distribution function $F(t_{n+1} \mid H_{t_n})$ for any $t > t_n$, the conditional intensity function is defined by Liu (2018):

$$\lambda(t_{n+1}) = \frac{f(t_{n+1} \mid H_{t_n})}{1 - F(t_{n+1} \mid H_{t_n})}$$

In other words, the conditional intensity function specifies the mean number of events in a region conditional on the past. It's assumed that there are no points coincide so that there is either zero or one point in an infinitesimal interval.

Proposition 1. A conditional intensity function $\lambda^*(t)$ [1] uniquely defines a point process if it satisfies the following conditions for any point pattern $(t_0, t_1, t_2, ..., t_{n-1}, t_n)$ and any $t < t_n$:

1. $\lambda^*(t)$ is non-negative and integrable on any interval starting at t_n , and
2. $\int_{t_n}^{t} \lambda(s)\, ds \to \inf \text{ for } t \to \inf$ (Rasmussen, 2011)

Different functional forms have been found helpful in concrete examples of point process modelling. In this paper, we aim to present a novel approach for the incorporation of well-known forms into learning models that describe the temporal point patterns. Four different functional forms are considered: first and second-order polynomial Poisson inhomogeneous processes, Hawkes with exponential and Gaussian kernels.

The form of the homogeneous *Poisson process* describes a completely random process independent of history. Such a conditional intensity function is equal to conditional density function:

$$\lambda(t) = b = const$$

The common way to introduce a dependency to a model is to turn into a polynomial form. First and second-order forms are presented as:

$$\lambda(t) = a + b \cdot t$$

[1] Notation * is used for stating that the function λ depends on the history H_{t_n}

and equivalently

$$\lambda(t) = a + b \cdot t + c \cdot t^2$$

where $a \geq 0,\ b \geq 0 \text{ and } c \geq 0$ are learnable coefficients.

On the other hand, Hawkes suggests the one possible solution for the clustered point process (Hawkes, 1971). A significant number of real phenomena have clustered nature. The process of a car arriving on the highway and the process of a customer arriving at a store, both have such a nature. The clustered nature explains that observation of a few points in the recent past increases the chance that there will be new points soon. In other words, the probability of seeing a new event increases due to previous events.

$$\lambda(t) = \mu + \alpha \cdot \sum_{t<t_i} \exp\left(-\left(t - t_i\right)\right)$$

where $\mu, \alpha \geq 0$.

The Hawkes form emphasizes that each time a new point arrives in this process, the conditional intensity grows by α and then decreases exponentially back towards μ. Hawkes process gives a felicitous form for conditional intensity function that can be used as a foundation for adapting to a specific problem. The standard form is given by:

$$\lambda(t) = \mu + \alpha \cdot \sum_{t_i<t} \varphi\left(t - t_i\right)$$

where φ represents the kernel function that can be replaced to better suit specific problems. The base form of Hawkes uses an exponential kernel. We are considering another form where the kernel is represented as a sum of Gaussian basis functions (Zha & EDU):

$$\lambda(t) = \mu + \alpha \cdot \sum_{t<t_i} \left(2 \cdot \pi \cdot \sigma^2\right)^{-1} \cdot \exp\left(\frac{-t^2}{2 \cdot \sigma^2}\right)$$

3.1. Likelihood function – learning point process

For the observed point pattern $\left(t_0, t_1, t_2, ..., t_{n-1}, t_n\right)$ on $[0, T]$ for some given $T > 0$, a likelihood function is given by:

$$L = \prod_{i=1}^{n} \lambda^*\left(t_i\right) \cdot exp\left(-\Lambda^*\left(T\right)\right)$$

where $\Lambda^*\left(T\right)$ stands for integrated conditional intensity function, given by:

$$\Lambda^*\left(T\right) = \int_0^T \lambda^*\left(s\right) ds$$

The λ^* function should be selected concerning Proposition 1 and the integral is going to be solvable.

In order to fit the parameters of the point process to the observed event data, it is necessary to define a loss function. The loss function can be defined as a negative log-likelihood:

$$\log L = \sum_{i=1}^{N} \log \lambda^*\left(t_i\right) - \int_0^t \lambda^*\left(t\right) dt$$

$$loss = -\log L = -\sum_{i=1}^{N} \log \lambda^*\left(t_i\right) + \int_0^t \lambda^*\left(t\right) dt$$

This provides the right and powerful instrument to be able to optimize the parameters of the defined function λ^* intending to maximize negative loss.

Since the function λ^* can take any functional form, it's expected that many of them will not have an analytic solution of the integral. Although integration would be possible, it is often not feasible due to a computational limitation. For the Hawkes form of the conditional intensity function, given the previous equation, loss have the following form:

$$loss = -\log L = -\sum_{i=1}^{N} \log \lambda^*(t_i) + \int_0^t \lambda^*(t)\,dt = -\sum_{i=1}^{N} \log \lambda^*(t_i) - \left(\mu \cdot t + \alpha \cdot \sum_{t_i<t} \int_0^t \exp(t - t_i)\,dt \right)$$

In the example, the $\Lambda^*(t)$ has an analytical solution, but it quickly tends to fall into the trap of overflowing the memory space of float numbers. Given the behavior of the exponential function and the constraints of float numbers in Python, for each $t > 92$, $\Lambda^*(t)$ will tend to infinity.

In this paper, we offer an alternative solution to avoid the problem explained, whether integration is not possible due to a non-integrable function or due to an overflow problem. We introduce the utilization of a numerical approximation of a one-dimensional integration in a previously defined loss function. There are several widely accepted approximations of solutions of a one-dimensional integral.

In this paper, we are going to present the result of using a Trapezoid and Simpson's rule, Euler method, and Gaussian quadrature rules based on interpolating functions. The trapezoidal rule is a technique for approximating the definite one-dimensional integral. It works by approximating the region under the graph of the function as a trapezoid and calculating its area. Applied to conditional intensity function, it takes the following form:

$$\int_{t_1}^{t_2} \lambda(t)\,dt \approx (t_2 - t_1) \cdot \frac{f(t_1) + f(t_2)}{2}$$

Euler's Method is another technique, which uses the idea of local linearity or linear approximation, where the small tangent lines over a short distance are used to approximate the solution to an initial-value problem. Simpson's rule is the approximation for n+1 values bounding n equally spaced subdivisions. Gaussian quadrature rule is an approximation of the definite integral of a function, usually stated as a weighted sum of function values at specified points within the domain of integration, named after a mathematician Carl Friedrich Gauss.

4. EXPERIMENTAL SETUP

The presented approach was successfully tested on highway toll dataset and four different well known point process models were compared. The sequence of cars arriving at the ramp toll on the E 75 highway was taken as a concrete example of interest. Highway European route E 75 is part of the International E-road network, which is a series of main roads in Europe. The E 75 starts at the town of Vardø in Norway, goes through seven countries and ends at town Sitia in Greece, after about 4,380 kilometres. The observed part connects two large Serbian cities, Belgrade and Niš. More precisely, we decided that the goal of the modelling was the process of arrivals in Niš from the direction of Belgrade on the busiest ramp toll, marked number 3. The average time between two passes in one day is about 20 seconds. Figures 1 and 2 show that there is a correlation between the number of cars and hours of the day, but no significant correlation with a minute of hours.

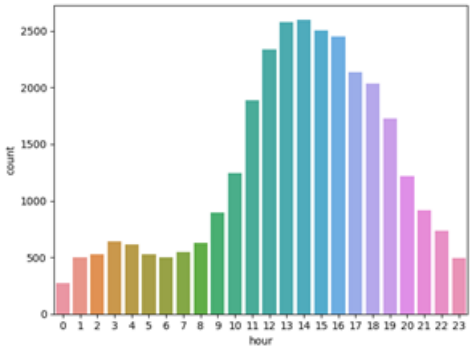

Figure 1: Number of cars that crossed the toll by hour

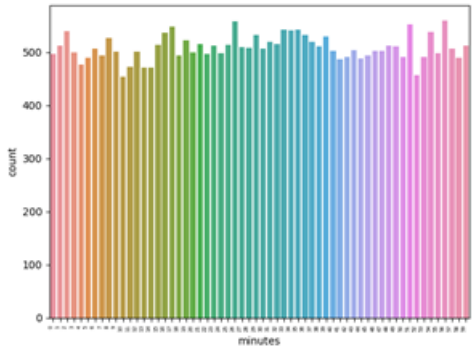

Figure 2: Number of cars that crossed the toll by minute

The implementation of numerical methodology is used for linearizing the neML function to enable backpropagation of neML derivatives. We have trained four different forms of the conditional intensity function

with five different numerical approximations of the integral part and an analytical solution where possible. In total, we present the results of 23 models. All models were trained in 50 epochs and with a constant learning rate of 0.001. As an optimization method, Adam stochastic optimization was used. Adam is an algorithm for first-order gradient-based optimization of stochastic objective functions, based on adaptive estimates of lower-order moments. All defined models are implemented in Pytorch (Paszke et al., 2019), an optimized tensor library for deep learning using GPUs and CPUs implemented in Python.

The obtained results are presented in Table 1. The best results are obtained using the Hawkes baseline with the sum of the Gaussians kernel. We hereby confirm that the process of the car arriving at the ramp toll is most likely a clustered point process, so Hawkes' models proved to be significantly better. Using the sum of Gaussians kernels, the dependence on time is emphasized in a sophisticated way, so this leads to the best results. On the other hand, polynomial forms let down, since they don't hold the information about any clustered pattern. In terms of execution time, polynomial models take less time than Hawkes models due to their derivation complexity and the number of parameters being learned.

However, with all models used, we have shown that the functions can be optimized following the given goal.

Table 1. Results

Model name	Integration scheme	Loss
Poisson Polynomial Second Order	Euler	1.03E+13
Poisson Polynomial Second Order	Implicit Euler	1.03E+13
Poisson Polynomial Second Order	Trapezoid	9.55E+12
Poisson Polynomial Second Order	Simpsons	8.77E+12
Poisson Polynomial Second Order	Gaussian_Q	7.99E+12
Poisson Polynomial Second Order	Analytical	8.77E+12
Poisson Polynomial First Order	Euler	2.18E+08
Poisson Polynomial First Order	Implicit Euler	2.18E+08
Poisson Polynomial First Order	Trapezoid	1.87E+08
Poisson Polynomial First Order	Simpsons	1.55E+08
Poisson Polynomial First Order	Gaussian_Q	1.24E+08
Poisson Polynomial First Order	Analytical	1.55E+08
Hawkes	Euler	57141.27
Hawkes	Implicit Euler	58971.43
Hawkes	Trapezoid	55488.9
Hawkes	Simpsons	52010.85
Hawkes	Gaussian_Q	48537.86
Hawkes	Analytical	50361.51
Hawkes Sum Gaussians	Euler	27313.95
HawkesSumGaussians	Implicit Euler	29099.78
HawkesSumGaussians	Trapezoid	26773.55
HawkesSumGaussians	Simpsons	24525.94
HawkesSumGaussians	Gaussian_Q	22345.78

5. CONCLUSION

In this paper, we presented a novel methodology for learning temporal point process based on the implementation of one-dimensional numerical integration techniques. The likelihood function of intensity point process has integral of conditional intensity function given in the limits of data observation. Bearing in mind that conditional intensity function can take any kind of mathematical form, in many cases this integral is analytically intractable. Due to this, in this paper, we presented a possibility to linearize integral with standard numerical techniques and to backpropagate derivative through it. The presented approach was successfully tested on highway toll dataset and four different well known point process models were compared. In addition, we presented that different numerical techniques for integration can be successfully implemented in automatic differentiation package such as Pytorch. Further studies should address using deep neural networks (feed-forward and recurrent networks) as a conditional intensity function to better capture dependencies between event occurrences.

ACKNOWLEDGEMENT

This work was supported in part by the ONR/ONR Global under Grant N62909-19-1-2008. In addition, this research is partially supported by the Ministry of Science, Education and Technological Development of the Republic of Serbia grants TR35004 and TR41008. The authors would like to express gratitude to company

Saga d.o.o Belgrade, for supporting this research. The authors would also like to thank public enterprises Roads of Serbia for providing data for this research.

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SIMULATION OF SKI LIFT QUEUEING TIMES ON SKI RESORT KOPAONIK USING PETRI NETS

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Abstract: *We provide a simulation on the waiting times induced by different ski lift speeds. We argue that ski lift speed has direct influence on queuing in front of ski lifts. This paper proposes a model of a ski lift queuing system for one ski lift only. We model the Karaman Greben lift from Mt. Kopaonik, Serbia. We argue that synchronous management of ski lift speeds across a ski resort could reduce global queuing times, increase user satisfaction and provide more efficient exploitation of ski lifts. This paper provides an introductory analysis of the work of one ski lift and opens the possibility of further research in order to optimize the work of ski resort by cost benefit optimization criteria.*

Keywords*: Petri nets, ski congestion, point process, reducing queuing time, skiing*

1. INTRODUCTION

Ski resorts constantly tend to conform to skier needs, achieve cost-effectiveness and generate stable revenues (Delibašić, Marković, Delias, & Obradović, 2016). This paper proposes a Petri Net model for a ski lift and shows how changing lift speed influences queuing times. There are currently 25.857 ski lifts worldwide, 2084 ski resorts in 68 countries (Vanat, 2020), Serbia being one of those countries.

Skiing is a multibillion-dollar business, with figures in the industry constantly growing. Although global climate change is happening, the season 2018/2019 was the best ih history (Vanat, 2020). Every year there are more 400 million visits to ski resorts worldwide. Even though climate change will make great impact on duration of ski season and number of available ski resorts (Wobus et al., 2017), the current research is focused on increase satisfaction of skiers (Matzler, Füller, & Faullant, 2007, p. 409) and customers of ski resort loyalty (Alexandris, Kouthouris & Meligdis, 2006).

Nowadays, the well-known problem that frequently occurs on small ski resorts, but is not uncommon on large ones either, during high season, is crowd on ski lifts (skiing congestion) (Jo, Kim, & Shin, 2016). The huge crowds on ski lifts is correlated with many negative effects that can reduce total profit of ski resorts through skiers dissatisfaction (Haugom, Malasevska, & Lien, 2020). Besides, in the case of crowdedness and insufficient ski capacity the number of ski injuries is drastically increasing (Davey, Endres, Johnson, & Shealy, 2019; Serita, 1987). Because of that there are many methods that can be applied to reduce skiing congestion (Haugom, Malasevska, & Lien, 2020) and consequently increase skiers satisfaction.

Particularly, one way to reduce queues on ski lifts is by increasing capacity of ski lifts or optimizing velocity of ski lifts. Increasing velocity of ski lift is going to cause reduction of ski queues and significantly affect queue length. However higher velocity of ski lift is correlated with the increase of energy assumption and consequently the total operational costs. In order to optimize velocity the objective function described by sum of ski lift operational costs and costs of waiting in the queue should be optimized. Most often the velocity of the ski lifts is not optimized and follows some standard pattern that is obtained by ski lift manufacturers or experts opinion. Similarly, can be stated with the change of ski lift capacity, where increasing ski lift capacity influence additional operational and investment cost, and decrease of queue length. Due to that same cost benefit optimization analysis should be considered.

In this paper we simulate the effects of changing velocity on one of the most crowded ski lift, located at the ski resort Kopaonik. In order to evaluate the effects of changing velocity of ski lift the data driven approach for modelling arrival of skiers in combination with Perti net where used. The point process that describes the arrival of skiers on ski lift was modelled with 9 exponential distributions, each used for one hour period. The obtained

results proved that effects of changing velocity of ski lift can have significant impact on ski lift congestion and consequently satisfaction of customers. This paper provides an introductory analysis of the work of one ski lift and opens the possibility of further research in order to optimize the work of ski resort by cost benefit optimization criteria.

2. RELATED WORK

Due to the increased popularity of winter sports, there are many research studies connected with skiing and ski resorts. Moreover, there are many papers that analyze skiing techniques, for example, Martínez et al. (Martínez, et al., 2019) developed a sensor set up and an algorithm to precisely detect turns during alpine ski, which is feasible for daily use. Similar research studies were presented in (Brunauer, Kremser, & Stöggl, 2019).

However, more studies are oriented in order to increase skiers satisfaction. Delibašić et al. (2020) provides an overview of the efforts done in analyzing ski lift transportation data with the goal to advance the decision-making process in ski resorts. Additionally, authors provided congestion analysis in ski resorts. The correlation between skiers travel time and their overall satisfaction in the ski resort is presented in (Li, Yuen, & Kanhere, 2015; Wu, & Solmaz, 2017). It is concluded that skiers are willing to pay higher ski ticket prices for shorter lift queues and less crowded slopes (Fonner, & Berrens, 2014). Ski resort Vail, USA, introduced the service of congestion reports to skiers. This service is provided by estimating the number of WiFi and Bluetooth in front of the ski lift entrance points. However, it is only used for current state information provision, and requires installation of additional infrastructure in the ski resort. Poulhès et al. (2017) proposed an agent-based simulation model, called DynaSki, with the goal to help ski resort planners to better understand the congestion phenomenon, and to test whether a replacement of a ski lift could provide lower waiting times for ski lifts. Similarly, Barras et al. (2014) have proposed a multi-agent model, called Ski-Optim, that analyzes congestion on ski lift entrances. Holleczek et al. (2012) proposed a particle-based model for modeling skier traffic in the ski resorts with the use of GPS data.

Petri nets are widely used in modeling, analysis, and control of discrete event systems arising from manufacturing, transportation, computer and communication networks, and web service systems (Zhou, & Wu, 2018). Verification of congestion probability on Wireless sensor network was modelled by Petri nets and presented in (Hafidi, & Gharbi, 2019). Similarly, Qi et al. (13) proposed a unified approach for modelling a two-level traffic light control strategy for preventing incident-based urban traffic congestion. Furthermore, there are many other studies focused on usage of petri nets in congestion simulation and control (Luo, Huang, & Weng, 2019; Dotoli, & Fanti, 2006).

To the best of our knowledge this is the first paper where data driven approach in combination with Petri nets are used for ski lift simulation to show the effect of ski lift velocity on queueing time.

3. METHODOLOGY

Petri net (PN) is a tool for system modelling and simulation consisting of: graph, that represents the structure of the system; and marking, that describes the state of the system. The graph of a PN is directed, weighted and bipartite, with two types of nodes: transitions and places. Transitions are used to model activities or events in the system while places represent conditions and/or results of activities. The places contain tokens corresponding to some objects in the system and each token distribution in the PN places represents one system state. The flow of tokens around the PN, enabled by the "firing" of transitions, simulates the system dynamic. Tokens can be unstructured or structured. If they have a structure, the so-called colour, the PN is called Coloured Petri Net (CPN) (Jensen, & Kristensen, 2015). CPNs can be upgraded with deterministic or stochastic delays as well as with the high-level programming language in order to define additionally the conditions, duration and results of transitions firing.

In this paper, the model for simulation of ski lift can be presented by three different section: section for arrival of skiers at the ski lift entrance gate, section that present ski queue and section that describe servicing of skiers by ski lift chairs. In the section for arrival of skiers at the ski lift entrance gate, skiers arrivals are generated by the stochastic process. Even though distribution of arrivals of skiers on ski entrance gate can be described by complex point process, where conditional intensity function can be presented by complex kernels (Mei, & Eisner, 2017, p. 6754) or functions (Chen, Rubanova, Bettencourt, & Duvenaud, 2018), in this paper we assumed that arrival of clients are distributed by exponential distribution. The previous assumption is completely justified bearing in mind that the paper goal is aimed at the creating model to simulate ski lift by Petri nets (further research papers will take in account more complicated point process distributions). In section that present servicing of skiers, arrival of ski chairs are deterministically determined by velocity of ski lifts. However, this process is also stochastic, due to stochasticity of seats occupied by skiers on each ski chairs. Eventually, because of stochastic nature of arrivals and servicing of skiers, the number of skiers in queue is also stochastic.

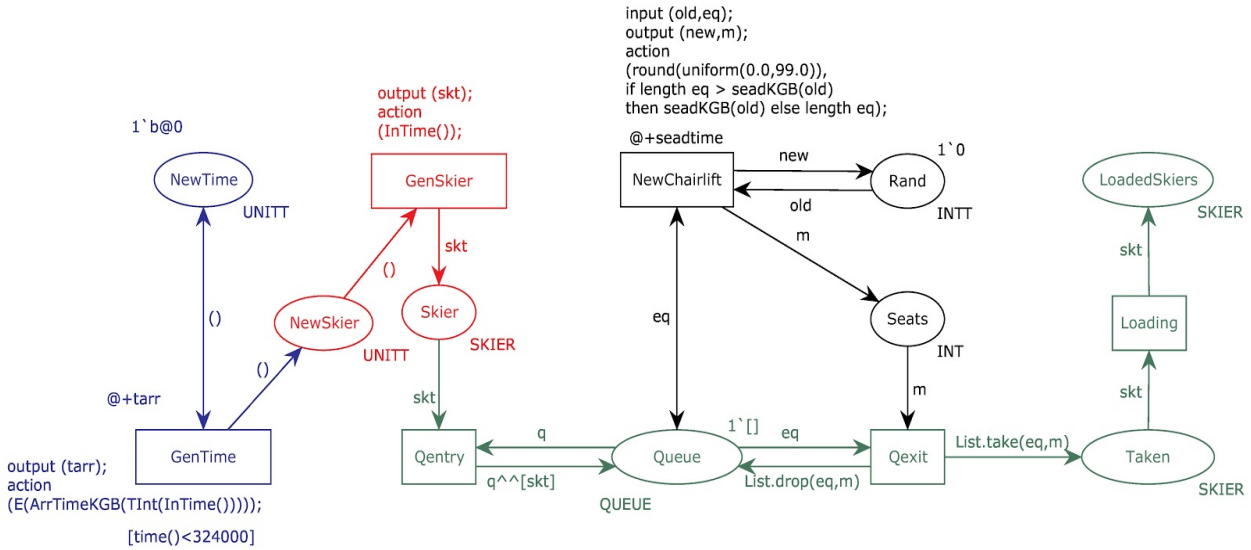

Figure 1: CPN (Mei, & Eisner, 2017, p. 6754) of KGB ski lift

The PN in Figure 1 is Generalized Stochastic Coloured Petri Net (GSCPN) since it includes exponentially distributed timed transitions and immediate transitions. In the blue part of the CPN, the exponentially distributed arrivals of skiers are modelled. Different arrival rates at one-hour time intervals are defined using functions TInt (x) and ArrTimeKGB(x). Arrival time is assigned to each skier in the red part of the CPN. This arrival time was later used to calculate the waiting time of each skier. The green part of the CPN models skiers entering the queue, waiting, getting out of the queue and boarding the ski lift. The number of skiers boarding the oncoming chairlift is defined by the variable m whose value is determined in the black part of the net using function seadKGB(x). In this part of the net, the constant circulation of the ski lift and the arrival of new chairlift at a given time interval are modeled. In addition to the Figure 1 in Appendix A we provided code for modelling ski lift by Petri Net in CPN software.

4. EXPERIMENTAL RESULTS

The ski resort Kopaonik is located in central Serbia. For skiing and snowboarding, there are more than 55 km of slopes available, with 25 ski lifts. The ski resort is situated between the elevations of 1,057 and 2,017 m. Mt. Kopaonik stretches up to the peak of Pancic at 2,017 m. Multiple 6 and 4-person chairlifts make the ski resort one of the most modern winter sports resorts in south-eastern Europe. One of the biggest challenges of ski resort Kopaonik is related to occurrence of crowding on ski lifts. In this paper we simulated the most crowded ski lift Karaman Greben. Karaman Greben ski lift is 6 person chairlift situated in the center of Kopaonik. The ski lift has a total of 73 baskets. The ride length is 1250 m, while the altitude difference is 165 m. In nominal operating mode, the ride takes 5 minutes.

Data used in this research for evaluation of parameters of point process, includes information on ski lift gate entrance for the 22. February 2009. This date was chosen because it was the most crowded day in the period between seasons 2006 to 2011.

The information about ski lift entrance was used for fitting 9 different exponential distribution, each one used hourly in the period from 8 AM to 4 PM. The conditional intensity values (λ [s^{-1}]) of skiers arriving time on ski lift are presented in Table 1.

Table 1: Conditional intensity values (λ [s^{-1}]) hourly

Hour	λ [s^{-1}]
8	0.1462
9	0.0484
10	0.0484
11	0.0488
12	0.0484
13	0.0484
14	0.0488
15	0.0484
16	0.0523

It can be observed that the conditional intensity values are similar in the mid time part of the day, whereas early in the morning conditional intensity values are the largest. Most of the skiers accommodation capacity are located nearby Karaman Greben, in order to reach the other parts of ski resort early morning the Karaman Greben is most crowded.

Based on the experts opinion probability distribution of number of ski seats occupied in ski chair can be described by empirical distribution presented in Figure 2. It can be observed that the 4 seat is the most probable number of occupied seats in ski chair. Moreover, the events where the ski chair is fully occupied or totally empty are rarely events.

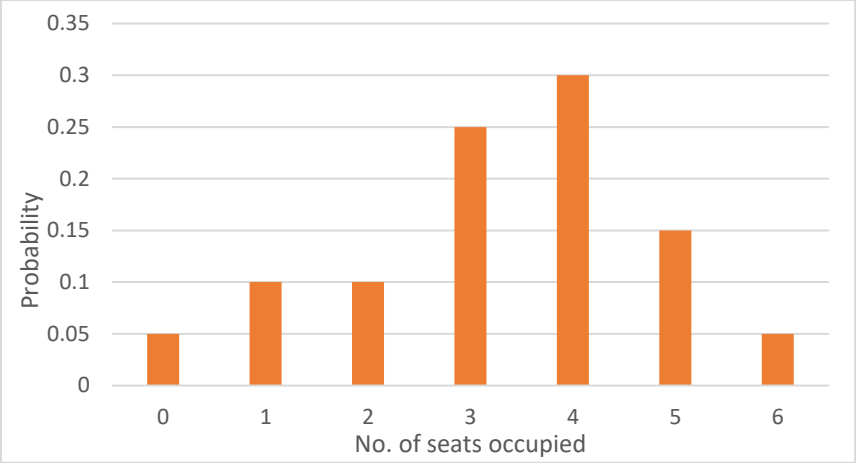

Figure 2: Probability distribution of no. of seats occupied in ski chair

The simulation of the ski lift as a queuing system was performed using the software package CPN Tools (CPNTools 2020). Each simulation was replicated 1000 times. During the simulations, the value of "seadtime" parameter, which represents the time interval between successive chairlift arrivals, was varied. The performances measured as the output of the simulations were: the length of the queue (Lq) and the skiers waiting time (Wq). The results obtained by incrementally increasing the value of the parameter "seadtime" are shown in the Table 2.

Table 2: Lq and Wq for different seadtime

		seadtime [sec]				
		11.4	9.8	8.6	7.6	6.9
Lq [skier]	**average**	0.794	0.506	0.386	0.314	0.271
	std	0.22	0.069	0.033	0.02	0.015
	max	58	32	24	21	15
Wq [sec]	**average**	15.908	9.978	7.527	6.029	5.14
	std	4.383	1.336	0.608	0.351	0.255
	max	348	197	118	99	74

Results obtained by Table 2 are showing that higher velocities of ski lift Karaman Greben have negative correlation with the length of the queue and skiers waiting time. Even though this result might indicate that the ski lift velocities should always be nominal, there might be some other factors that are preventing this, such as: high wind speed, snow showers, large number of child skiers and etc.

5. CONCLUSION

In this paper we provided comprehensive methodology of applying data driven approach in combination with Petri nets in order to show how changing velocity of ski lift Karaman Greben have impact on length of the queue and skiers waiting time. Moreover, we showed that nominal operating regime (lowest value of seadtime) reduce skiers waiting time and increase overall satisfaction of customer. Even though, this nominal operating regime is desirable, there are many situations where it is prohibited to operate in this regime. Further topics of research are going to be focused on finding optimal velocities of ski lift in correlation with the predicted conditional intensity functions of skiers arrival time and weather forecast, based on cost benefit objective functions.

ACKNOWLEDGEMENT

This work was supported in part by the ONR/ONR Global under Grant N62909-19-1-2008. In addition, this research is partially supported by the Ministry of Science, Education and Technological Development of the Republic of Serbia grants TR35004 and TR41008. The authors would like to express gratitude to company Saga d.o.o Belgrade, for supporting this research.

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APPENDIX A

```
(* COLSETS *)
    colset SKIER= INT timed;
    colset QUEUE=list SKIER;
    colset INTT= int timed;
    colset UNITT=unit with b timed;
(* PARAMETERS *)
    (* TIME PARAMETERS *)
        val arr=324000;
        (* KGB arrival parameters *)
            val atKGB1=0.01463;
            val atKGB2=0.00484;
            val atKGB3=0.00484;
            val atKGB4=0.00488;
            val atKGB5=0.00484;
            val atKGB6=0.00484;
            val atKGB7=0.00488;
            val atKGB8=0.00484;
            val atKGB9=0.00523;
        (* Ski lift transportation parameters *)
            val seadtime=69;
(* FUNCTIONS *)
    fun seadKGB(x)=if x<=30 then 1
    else if x>30 andalso x<=60 then 2
    else if x>60 andalso x<=80 then 3
    else if x>80 andalso x<=85 then 4
    else if x>85 andalso x<=87 then 5
    else if x>87 andalso x<=89 then 6
    else 0;
    fun ArrTimeKGB(x) = case x of 1 => atKGB1 |2 => atKGB2|3 => atKGB3 |4  => atKGB4 |5 => atKGB5|6
=> atKGB6 |7 => atKGB7|8 => atKGB8|9 => atKGB9;
    fun tcheck(x,y)=round(normal(x,y));
    fun TInt (r) = if r<=36000 then 1
    else if r>36000 andalso r<=72000 then 2
    else if r>72000 andalso r<=108000 then 3
    else if r>108000 andalso r<=144000 then 4
    else if r>144000 andalso r<=180000 then 5
    else if r>180000 andalso r<=216000 then 6
    else if r>216000 andalso r<=252000 then 7
    else if r>252000 andalso r<=288000 then 8
    else 9;
    fun E(x) = round (exponential(x));
    fun U(x,y)=round(uniform(x,y));
    fun InTime() = IntInf.toInt (time());
```

NETWORK DATA ENVELOPMENT ANALYSIS: THE EFFECTS OF APPLICATION

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Abstract: *The purpose of this paper is to demonstrate the effects of network data envelopment analysis (NDEA) method in measuring the efficiency of a system, whereby the internal structure of a system is considered. The detailed decomposition allows the inefficiency to be identified. Consequently, in recent years, a few types of network data envelopment analysis method for measuring the relative efficiency of decision making units (DMUs) have been found. Main benefits are more realistic performance assessment and analyzing efficiency. This provides a clearer perception into main facts which reducing the performance and ways the performance improvement. Based on this, decision makers are getting information which can be of great importance for improving efficiency of the system.*

Keywords*: network data envelopment analysis, overall efficiency, decision making unit, two stage structure, performance improvement*

1. INTRODUCTION

Data envelopment analysis (DEA) is a non-parametric optimization method for measuring the relative efficiency of decision making units (DMUs) with multiple inputs and multiple outputs (Charnes, Cooper, & Rhodes, 1978) based on Farrell's pioneering work (Farrell, 1957). The implementation of the DEA method can be divided into four basic phases: (1) the selection of decision making units; (2) input and output selection; (3) solving DEA models and (4) analyzing and interpreting solutions (Martic, 1999). In the educational literature various theoretical achievements and practical applications were described (see, for example, Zhou et al., 2008; Liu et al., 2013; Sueyoshi et al., 2017).

Therefore, various DEA models and DEA-based techniques were employed to real world problems such as CCR models or BCC models (Ebrahimi & Salehi, 2015), non-radial DEA (Wang & Zhao, 2017), bootstrap DEA (Duan et al.,2016), DEA window analysis (Wang et al., 2012), DEA frontier (Lins et al., 2012), slacks-based DEA (Hu & Liu, 2017), DEA-bargaining game (Rezaee et al., 2012), DEA–MBP model (Welch & Barnum, 2009), DEA-Malmquist (Wang & Feng, 2015), stochastic DEA (Vaninsky, 2018), double-bootstrap DEA (Guerrini et al., 2017), dynamic environmental DEA (Cui et al.,2016), radial stochastic DEA (Zha et al., 2016), DEA discriminant analysis (DEA-DA) (Chen et al., 2016), interval DEA-CCR (Gong, & Chen, 2017), super-efficient DEA (SE-DEA) (Liu et al., 2013) and others (Mardani et al., 2018). Also, in some previous studies DEA methods are integrated, for resolving challenges and measuring the relative efficiency, with various techniques such as AHP, ANP, ANN, TOPSIS in different application areas.

Convencional DEA suggested by Charnes et al., (1978) is used to measure efficiency, ignoring links between sub-DMUs, and takes into account only the inputs employed and outputs produced. That makes it complicated to determine ways for DMUs in order to achieve better performance. Hence, traditional DEA models by Charnes et al., (1978), use only to the single-stage efficiency of a system (Qin & Sun,2019). The network DEA model which was developed by Färe and Grosskopf (1996), takes into account multi-stage processes. The process contains inputs, outputs, and intermediate measures that connected the DMUs internal structures. Network structures (multi-stage) have been an important field for researchers in DEA, since when Färe and Grosskopf (1996) evolved and introduced a network DEA model.

2. NETWORK DATA ENVELOPMENT ANALYSIS

In traditional DEA approaches, researchers treated DMUs as a "black box" (Färe & Grosskopf, 2000). In measuring efficiency, only the inputs and the outputs are taken into account, not considering the intermediate products formed and employed within the system and the operations of the internal divisions (Kao, 2018).

There are two main deficiency: first is that, the inefficiencies arising from activities within this internal structure cannot be addressed, which limits the information that can be gained to improve efficiency of the system (Chen, 2016), and second is that this may produce confusing results, for example, the component divisions aren't efficient, while the system is efficient.

Fare and Grosskopf (1996) and Wang et al., (2000) are first authors in which papers mentioned the components stages of DMU. Färe and Grosskopf (2000) primarily suggested network DEA model. That model takes into account multi-stage processes, which contains inputs, outputs, and intermediate measures and thus connects the DMUs internal components (Guo et al., 2017). A few models have been suggested for determination the divisional and overall efficiency of a network. Each case study on network DEA is related with a structure, based on which a model is established, and an application in different industries and sectors is performed (Kao, 2014). The network structures imply general two-stage structure, basic two-stage structure, parallel structure, series structure, mixed structure, and dynamic structure.

In recent years, researchers try to analyze the internal structure of DMUs. Process within a DMU need to be take into account when apply network DEA models. Process within a DMU can involve a few stages or sub-processes. Every stage has different inputs and outputs connected to intermediate flows (Färe & Grosskopf, 2000). There can be two stage structure: in first, outputs are generated based on inputs, and that outputs are inputs for next stage (e.g. Cook et al., 2010, Premachandra et al., 2012, Sahoo et al., 2014, Jianfeng et al., 2015).

The basic DEA models are CCR (Charnes, Cooper and Rhodes) (Charnes et al., 1978) for assessing efficiency measures under the assumption of constant returns to scale (CRS) and BCC models (Banker, Charnes and Cooper) (Banker, et al., 1984) for assessing under the assumption of variable returns to scale (VRS). DEA is a nonparametric method which builds on the concept of multiple inputs and outputs. The technical efficiency of a DMU is determined as maximising the ratio of a weighted sum of outputs to a weighted sum of inputs. This ratio is always number between 0 and 1. Hence, related to weights (Charnes et al., 1994) is that the results aren't take into account inputs and/or outputs when their weights are 0 or ε, and the DEA model can't distinguish DMUs and perceives many efficient DMUs. In the common-weights DEA models, the internal structure of production process is ignored. The production process contains interrelated processes where each one has its own inputs and outputs along with intermediate measures within the system. Network DEA models are alternative models that take into account interdependencies among DMUs.

The paper by (Kao & Hwang, 2008) gives the basic idea for the formation of a two-stage DEA model. The two-stage production process for DMU_k being evaluated is composed of two sub-processes. Different from the conventional one-stage production process, this production process is composed of two sub-processes with q intermediate products Z_{pk}, $p = 1, ..., q$. This intermediate products Z_{pk} are the outputs of stage 1 as well as the inputs of stage 2.

For DMU_k can be measured the overall efficiency E_k, which represents the combination of the values of efficiency E_k^1 in stage 1 and efficiency E_k^2 from stage 2. For efficiency E_k^1 x_{ij} ($i = 1, ..., m$) represent inputs, and z_{pj} ($p = 1, ..., q$) outputs DMU_j, $j = 1, ..., n$. Each input for DMU_k that is evaluated is assigned weight coefficinets v_i ($i = 1, ..., m$), while the outputs are assigned weight coefficients w_p ($p = 1, ..., q$). In the second stage, the products z_{pj} ($p = 1, ..., q$) are treated as inputs, and y_{rk} ($r = 1, ..., s$) as outputs which are assigned weight coefficients u_r ($r = 1, ... , s$) for each DMU_j ($j = 1, ..., n$).

The overall efficiency E_k for DMU_k can be calculated as the product of the efficiency from the first and second stage $E_k = E_k^1$ x E_k^2. A modified linear model to calculate the overall efficiency E_k proposed in (Kao & Hwang, 2008), Model (1) is following:

$$(max)E_k = \sum_{r=1}^{s} u_r y_{rk}$$

$$\sum_{i=1}^{m} v_i x_{ik} = 1$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, j = 1, \dots, n \qquad (1)$$

$$\sum_{p=1}^{q} w_p z_{pj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, j = 1, \dots, n$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{p=1}^{q} w_p z_{pj} \leq 0, j = 1, \dots, n$$

$$w_p, u_r, v_i \geq \varepsilon, p = 1, \dots, q, r = 1, \dots, s, i = 1, \dots, m$$

This model can be written as dual model. The modified dual model for the proposed relational two-stage model, Model (2), is as follows:

$$(min)\theta_k - \varepsilon(\sum_{i=1}^{m} s_i^v + \sum_{p=1}^{q} s_p^w + \sum_{r=1}^{s} s_r^u)$$

$$\sum_{j=1}^{n} (\lambda_j + \delta_j) x_{ij} - s_i^v = \theta_k x_{ik}, i = 1, \dots, m$$

$$\sum_{j=1}^{n} \delta_j z_{pj} - s_p^w = 0, p = 1, \dots, q \quad (2)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^u = y_{rk}, r = 1, \dots, s$$

$$\lambda_j, \delta_j, s_i^v, s_p^w, s_r^u \geq 0, j = 1, \dots, n, p = 1, \dots, q, r = 1, \dots, s, i = 1, \dots, m$$

In the model, both λ_j and δ_j represent the importance assigned to the final outputs, respectively, intermediate outputs DMU_j (*j=1, ..., n*) when forming a virtual composite unit that is on the efficiency limit. The values $s_i^v, s_p^w, s_r^u \geq 0, (p = 1, \dots, q, r = 1, \dots, s, i = 1, \dots, m)$ show how much it is necessary to reduce the values of inputs or increase the values of intermediate and final outputs to make the observed DMU effective.

Two-stage relational DEA models commonly use concepts of cooperative or non-cooperative games. This approach combines the DEA method and game theory in order to overcome the problem of conflicting goals of different systems. In game theory, there are two basic approaches: cooperative and non-cooperative. A non-cooperative approach is a situation in which one of the players represents the leader, while the other player represents the companion. In the literature, this approach is better known as the Stackelberg game. Cooperative play is an essentially different concept whose basic idea is the cooperation of players in order to maximize the efficiency of both players. It is known, in the literature, as a centralized model.

There are many real examples, DMUs may take the structure of multiple stage with intermediate measures. Many existing DEA approaches or the conventional DEA models, don't appropriately address such multi-stage structures. The study by Liang et al., (2008) provides ways to address the conflict between the two stages caused by intermediate measures, and provide efficiency scores for both individual stages and the overall process. Also, it shows that the overall efficiency of the two-stage process is the product of the efficiencies of the two stages.

The network DEA models have been employed to estimate the efficiency of a different applications, such as insurance industry (Rahmani, 2014), electricity power production and distribution plants (Khalili-Damghani & Shahmir, 2015), airlines (Mallikarjun,2015), production systems (Matin,2015), energy saving and emission reduction (Wu et al.,2015), sustainability of supply chain management systems (Fallahpour et al., 2016), universities (Lee & Worthington, 2016), banking (Lozano, 2016), investment trust corporations (Lu et al., 2016) and bus transit systems (Yu et al., 2016).

2.1. Two stage network DEA approach

As a type of DEA, two-stage DEA models is becoming more and more interesting for researchers. Many papers about DEA models claimed that is their property a two-stage structure in a way that the first stage uses inputs to get outputs, and that outputs later become the inputs which used for the second stage (e.g., Chen et al.,

2009a; Chen et al., 2009a, Sahoo et al., 2014). Seiford and Zhu (1999) presented the new approach which identifies areas for improved the performance and examined the performance of the top 55 U.S. commercial banks using the two-stage production process, that separates profitability and marketability. A multi-factor financial performance model, which inherently recognizes tradeoffs among various financial measures, based on a two-stage DEA model, proposed by Zhu (2000), offers an alternative perspective and characterization on the performance of top-ranked 500 companies. A model that identifies the efficient frontier of a two-stage production process connected by intermediate measures developed by Chen and Zhu (2004). Authors, for the first stage, used assets and labor as inputs and as outputs got profit and revenue. Outputs from the first stage becomes inputs in the second stage market value, returns and earnings per share were outputs in the second stage. Yang (2006) proposed a two-stage DEA model for assessing the double impacts of business strategies and operating strategies for the industry of insurance, in field of life and health, in Canada. On that way, managers will have a clear perception when making decisions. It enables integration of the investment and production performance for the insurance companies which provides management performance assessment and also how to get efficiency for the insurers who use the company's services. Relations and equivalence among two existing DEA approaches that address measuring the performance of two-stage processes examined by Chen et al., (2009a). The approach of Chen et al., (2010) determines the frontier points for inefficient DMUs within the framework of two-stage DEA.

The general two-stage network DEA is extensively used. For example, Wu et al., (2015) used a two-stage network DEA framework to estimate energy saving and emission decrease efficiency in the 30 municipalities, provinces, and autonomous of China's regional., Yan et al., (2017) proposed the network DEA model which accounting negative externalities and apply it for decomposition of profit inefficiency in the biomass-agriculture circular system. Chen et al., (2017) applied a stochastic network DEA, with undesirable outputs such as flight delays and CO2 emissions, where two stage are considered: flight and network efficiency. Moon and Min (2017) employed a DEA model to measure energy efficiency of energy intensive manufacturing firms in Korea, with a two-stage model that includes two efficiency measures: pure energy efficiency and economy efficiency. Olfat et al., (2016) proposed a novel combination, fuzzy extension of SBM dynamic network approach, which makes it possible to have a comprehensive evaluation of airports' performance. Bostian et al., (2016) employed a network DEA approach that provide to estimate energy efficiency and environmental performance separately. Shermeh et al., (2016) proposed a slacks-based measure (SBM) model, and presented, using the suggested model, a case study on the regional power companies in Iran. Simon et al., (2011) combined Data envelopment analysis and a Malmquist index with a bootstrap method to calculate productivity growth of 34 Spanish university libraries, where a three-stage service model has been developed. Yang et al., (2008) developed a DEA-based model that includes undesirable outputs, for a problem of farrow-to-finish swine production.

While the basic two-stage structure does exist, the most common case is that both stage are allowed to employ exogenous inputs and exogenous outputs to be product. It's general network structure which represents open system. Based on the work of Liang et al., (2008), authors Li et al., (2012) proposed the methodology where the inputs to the second stage include additional inputs and the outputs from the first stage, as well. Based on work of Chen et al., (2009a), the methodology extended by Cook et al., (2010) to examine general multi-stage network structures. It's applicable under the supposition of variable returns to scale and constant returns to scale, but it isn't objective, when setting the weight, towards the second division. Despotis et al., (2016) suggested a new method to get the overall efficiency, ensuring the unbiasedness of weight set and the uniqueness of the efficiency value. Ang et al., (2016), previously mentioned method, extended to the general two-stage network structure and multi-stage structure. Kao (2009) developed a relational model to decompose efficiency of the system, under the supposition of constant returns to scale, into a weighted average of the process efficiencies, for a parallel system of few processes. Kao (2016) developed a relational model from the viewpoint of efficiency decomposition, and also suggested two approaches for discussing the relationships between the overall efficiency of system and divisional efficiency.

A few substitute models for a two stage process were suggested by Wang and Chin (2010). Additionally, in the paper they demonstrated that efficiency of two stage process can also be modeled as the weighted harmonic mean of the two independently efficiencies in the different stages. Also, they prolonged two stage model by Kao and Hwang (2008) to VRS supposition. Finally, according to authors, the importance weights of the separately stages have to be taken into consideration, and on that way they generalized models which proposed Chen et al., (2009). Authors Kao and Hwang (2011) mixed two models, an input-oriented model and an output-oriented DEA model. An input-oriented DEA model established to unconnecte the efficiency of process into the input technical and scale efficiencies. The same, an output-oriented model into the output technical and scale efficiencies. According to this, integrating this two models obtained the systems efficiency, which is result of the technical and scale efficiencies. A two-stage model which take into account, at the same time, intermediate measures in efficiency assessment and decomposition and the structure of inputs suggested by Jianfeng (2015).

3. ADVANTAGES OF APPLYING THE NETWORK DEA

The use of the network DEA method provides many advantages and can solve many real world problems, in a wide variety of industries. It enables evaluation, determines efficient and inefficient units, measures performance and indicates to decision makers the possibilities for their improvement. Many researchers (e.g., Seiford and Zhu, 1999; Castelli et al., 2004; Cook and Zhu, 2014) have been involved in the research of this area, and a various of methodologies have been suggested for the performance assessment of a DMU internal structure.

Measuring efficiencies and evaluations are used by two concepts (Kao, 2016). The external evaluation is measure from outside, based on exogenous inputs and outputs. Performance is analyzed by the efficiency of system. On the other hand, the internal evaluation is measure from inside. The system efficiency is determined by the overall performance of the internal and external evaluations. This should point out inefficient parts in order to make improvements. The main characteristic which is differently among these evaluations is that the intermediate products are considered only in internal evaluation. In such a way, in the external evaluation can happen that some divisions aren't efficient, but the whole system is efficient. On the other hand, if all divisions are efficient, then the whole system is efficient in the internal evaluation.

Some studies have measured divisional and overall efficiency, and obtained mathematical connections among these two types of efficiencies, based on a basic two-stage structure. The model which can decompose the overall efficiency into the product of the two divisional efficiencies under the supposition of constant returns to scale with an application to non-life insurance companies in Taiwan evolved by authors Kao and Hwang (2008). Constructed on the basis of the previous model, multiplicative efficiency decomposition applying the game theory concept evolved by Liang et al., (2008). Based on additive efficiency decomposition, the overall efficiency into a weighted average of the two divisional efficiencies where the constant returns to scale isn't needed decomposed by Chen et al., (2009). However, additive efficiency decomposition has its own mathematical problems as indicated by authors Guo et al., (2017). For example, additive efficiency decomposition is able to be solved employing second order cone programming, which was demonstrated in paper by Chen et al., (2017).

On the other side, based on multiplicative efficiency decomposition, the overall efficiency as the result of divisional efficiency determined by authors Zha and Liang (2010) and Du et al., (2011). There are many examples of two-stage network DEA models applications in real world problems. For example, Luo (2003) considered the banking operations of the 245 large banks in the US with assets greater than one billion US dollars, on way that the operations are separated into two stage to measure marketability and profitability. Based on the previously mentioned network DEA approach authors Lo and Lu (2009) evaluated financial holding companies in Taiwan. Yang et al., (2012) integrated a two-stage series performance model and fuzzy multiobjective model in order to measure managerial efficiency in Taiwan bank branches. Also, Tsolas (2013) discussed profitability and stock market performance of 19 construction firms in Greece. According to the relational model proposed in the paper by Kao and Hwang (2008) the performance of internet entrepreneurships measured by Cao and Yang (2011). Chen et al., (2012) propose a novel use of the two-stage network to evaluate the design performance of 534 carlines from more than 20 producers.

4. CONCLUSION

Network structures (multi-stage) have been an important field for researchers in DEA, since when Färe and Grosskopf (1996) evolve a network data envelopment analysis model. Traditional DEA model is not taken into account the internal structure of decision making units, while the network DEA model takes into account multi-stage processes. That process contains inputs, outputs, and intermediate measures that linked the internal structures of the DMUs.

The goal of such an observation is to explore the DMUs structure through the decomposition of efficiency into stages. Sub-stages are connected by variables. Therefore, this approach offers a novel way of perceiving the efficiencies of the stages, as well as the efficiency of the process, at all. This direction provides noticeable advantages, primarly a better way for finding facts that affects the performance of decision making unit and improve it.

Based on the before mentioned studies and the extensive work of many researchers, we can conclude that analyzing efficiency of non-network structures is less realistic than analyzing efficiency with network structures of complex systems. Different from the classical DEA model, which takes into account only the initial inputs and final outputs of a DMU, network DEA can considered intermediate inputs and outputs in all stages. Traditional DEA model optimizes the efficiency result of a DMU, by calculating the ratio among weighted initial inputs and weighted final outputs. Different from traditional DEA models, in the network DEA models the efficiency of every stage is calculated by considering ratios of weighted inputs and weighted outputs in every

stage, in addition to obtaining the result of the whole network. The network DEA models take into account the interrelationship of the processes within the system to measure the efficiency of the system and those of the processes at the same time.

This effects and advantages of network DEA models are numerous. It's described in the paper, theoretically and practically through examples. The main effect is the ability to identify weak areas, ie the source that causes the inefficiency of the whole system by measuring the efficiency of the system and two sub-processes using the network DEA model, which can improve performance.

Finally, for future researchers, the following scopes can be interesting: to propose some more frameworks for implementation of network data envelopment analysis, a more case studies of specific applications in the industry should be presented as well, suggested DEA approaches can be used for performance evaluation of network structure and performance improvement in many areas of different practical implementation, etc.

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QUALITY 4.0 AND

INTERNATIONAL STANDARDS

CONTENT

QUALITY ASSURANCE IN AGILE SOFTWARE DEVELOPMENT

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Abstract: *Agile software development methods are said to be superior to traditional ones stressing interaction, customer collaboration, short development cycles and technical excellence. However, there are claims that agile methods might lack aspects that are regarded to be crucial to quality assurance (QA). This paper investigates the degree to which QA is covered in agile software development. Through the Cycles of Control Framework (2004) QA practices are identified on its respective time horizons. This paper suggests (1) the addition of testing practices that are not initially covered in the agile methods themselves, (2) an independent tester role for the iteration time horizon, and (3) exploratory testing based on a session for the heartbeat time horizon.*

Keywords*: quality assurance, software development, agile principles*, *testing, standard.*

1. INTRODUCTION

In 2001, a group of methodologists came together to discuss different software development approaches resulting in the formation of the so-called Agile Alliance and the signing of the Manifesto for Agile Software Development. The manifest covers 12 principles of agile software development (ASWD) that highlights interaction and individuals, collaboration with customers, short cycles of development, frequent deliveries of working software as well as technical excellence (Itkonen et al., 2005). Agile methods accompany the short and time-boxed process of frequent and incremental development. During the development, iterations come up with quick feedback and enable control points appearance in which the development plans can be reviewed. As such, agile methods are based on adaptive software development approaches while traditional software development lifecycle (SDLC) models are based on predictive methods. In traditional SDLC models, teams operate with detailed plans and have complete lists of tasks and requirements that have to be done in a given amount of time. Predictive approaches are completely depended on the requirement analysis as well as on cautious planning at the very beginning of the cycle (Stoica, Mircea & Ghilic-Micu, 2013). Although agile methodologies are superior to traditional ones, there are many problems and difficulties such as a noteworthy decrease in documentation (Vijayasarathy & Turk, 2008). Itkonen et al. (2005) even state that agile principles are challenging in terms of testing and QA and add, that agile methods lack aspects that traditionally are seen to be significant and basic to successful QA. This leads to the question of whether QA is enough covered and included in these agile methods. The aim of this paper is to increase the level of understanding of QA in ASWD by recognizing challenges and cons in agile methods regarding the software quality assurance (SQA) principles based on Itkonen et al. (2005).

The first and second parts are related to the principles of SQA and SQA from an agile perspective. In the third part, the methodology is presented. In this part, the Cycles of Control (CoC) framework, developed by Rautianen (2004), is introduced as the suggested research framework in this paper. The following chapter is related to the analysis of QA practices in agile methods based on the CoC framework. Finally, conclusions and potentials for future works are covered.

2. SOFTWARE QUALITY ASSURANCE

The ISO 9126 provides a model for software quality definitions that are organized into a strict hierarchy of quality characteristics and sub-characteristics as shown in *Figure 1*. This standard has been revised by the ISO 25000 guiding the development of software products “through the specifications of quality requirements and the evaluation quality characteristics” (ISO 25000).

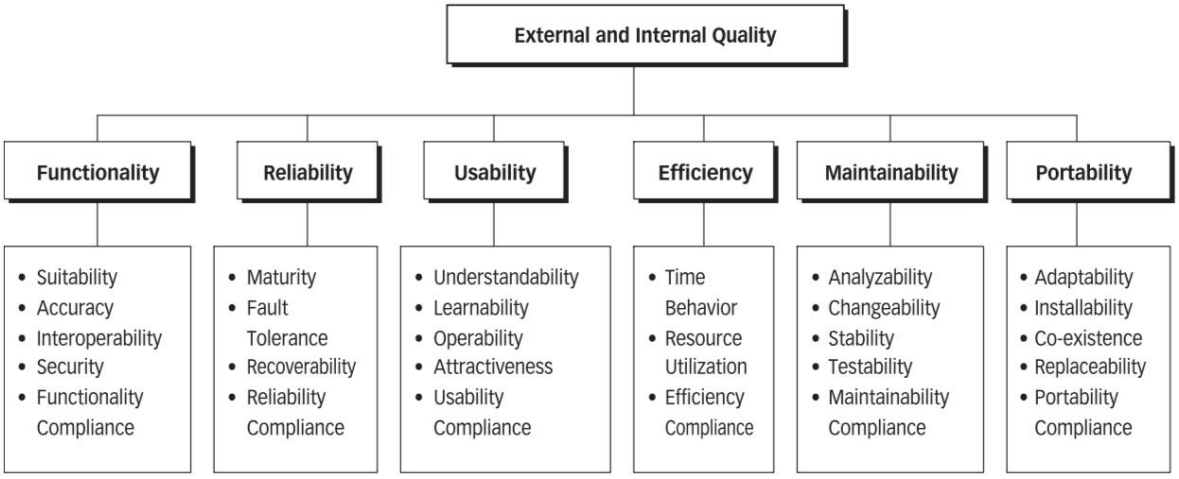

Figure 1: Model for external and internal quality – ISO 9126 (Abran, 2010, p. 208).

However, according to Dromey (1995, 1996), some properties of products are related to multiple quality features or sub-features. For instance, different forms of redundancy can influence maintainability and efficiency. He also criticized IEEE's top-down approach to first single out a small set of quality characteristics on a higher level and then, disassembles them further into subordinate characteristics. He states that this approach provides indication of what, for example, maintainability is about, however, leaves the subordinate terms in the obscure state. Similarly, diverse alternative quality frameworks are suggested to provide for more flexible relations among the various quality perceptions. Therefore, a lot of communities and organizations have customized present models to determine quality for themselves considering their own market environment and business, such as the quality attribute list CUPRIMDSO IBM used for their own software products or Hewlett-Packard's FURPS metric (Kan, 2002; Tian, 2005).

According to the standard ISO 9000:2015, quality assurance is defined as "part of quality management focused on providing confidence that quality requirements will be fulfilled". For most software development companies, quality assurance is defined as "dealing with defects". In fact, "quality assurance is to ensure that few, if any, defects remain in the software when it is delivered to its customers or released to the market" (Tian, 2001). Hence, "software quality assurance is the systematic activities providing evidence of the fitness for use of the total software product" (Rajasekhar & Shafi, 2014, p. 4). As such, the quality assurance central activities can be seen as those to assure that few defects left in the software system. Multiple QA activities and related techniques may be used to face with defects effectively and efficiently and thus, ensure quality of software. If there are any defects, QA must ensure that those will cause only minimal disruption or damages. Tian (2005) and Zhu (2016) stress that *defect prevention, defect detection and removal*s as well as *defect containment* are the best ways to overcome resulting defects.

Defect prevention is defined as "a critical step or activities in any software development process" (Soe, Santosa & Hartanto, 2018, p. 2). It can be prevented through blocking or removal of error source, and thus hinders certain types of mistake from being inserted into the software. Many of the associated processes suppose that there are known error sources that lead to error injection. Human error, as the main cause of software defects, can be the essential to prevent and understand them (Huang, Fuqun & Bin, 2017). In the case where the reason for faults are insufficiently precise design and implementation that which lead to non-compliance with the specifications and requirements, formal methods can make it easier to preclude such nonconformity (Tian, 2005). This paper assumes that the application of agile methods instead of traditional software development methods might result in those deviations.

For most software solutions used today, defect prevention is unlikely to prevent accidental fault injections 100% effectively. Therefore, *defect reduction and removal activities* are needed to remove all errors under given project limitations. One technique to face this issue is software inspection which is a well-known quality assurance alternative and therefore, recognizable to nearly everyone software QA experts. "Software inspection is a quality assurance metrics that can be applied to all software development phases" (Shahzadi & Umair, 2016, p. 5). Inspection is frequently applied to code as well as to specifications, designs, user manuals and other documents. The earliest work in software inspection has been done by Fagan (1976). He defined error detection efficiency as follows:

$$\frac{Error\ found\ by\ an\ inspection}{Total\ errors\ in\ the\ product\ before\ inspection} * 100\% \quad (1)$$

Another defect detection approach is *software testing* which is now the most performed SQA activity. Malik (2017, p. 38) states that „software testing is a process of finding software bugs while executing a program so that we get the zero defect software“. It is “a verification process for the assessment of software quality and a process for achieving that quality” (Jan et al, 2016, p. 682). If an error is detected, the execution record is then examined to find and correct cause root. Due to its significance for SQA, testing is further examined for agile methods in the following chapters.

Even though the aforementioned defect reduction processes can decrease percentages of errors, they cannot entirely remove them. Still, this way of error reduction may be less adequate for safety-critical systems. However, that small number of residual faults may only be run under infrequent conditions and thus, making it unmanageable to generate a vast number of test cases to encompass all these conditions. Instead, the idea of tolerating those faults arise the idea of defect containment. In these systems, backup units and spare parts are employed to hold software systems in operational conditions at the presence of failures of unit or part. Software fault tolerance methods contain “recovery blocks and N-version programming (NVP)” (Tian, 2001, p. 14). Recovery blocks use repeated executions (Powell et al., 2011). If errors are noticed, a part of the latest execution is repeated, hoping that this implementation will not cause to the same error again. NVP uses parallel redundancy in which n-copies of programs, fulfilling the same functionality, runs in parallel (Tian, 2005). Even though agile methods can be used for safety-critical systems if applied properly (Mwadulo, 2016), this paper does not further investigate the defect containment method as this approach does not typically identify but tolerate faults which is a sharp contrast to defect reduction and removal activities.

3. AGILE SOFTWARE QUALITY ASSURANCE

From an agile viewpoint, quality was described by Ambler (2005) to be a result of agile practices itself. These aspects of agile quality removed the necessity for huge documentation but leave agile quality in a state of a rather abstract concept that is now hard to define (Mnkandla & Dwolatzky, 2007). Given that the majority of the agile methods offer a small number of instructions on how testing diverse quality characteristics should be managed, which is now the most commonly performed SQA activity, integrating testing practices and agile activities is demanding (Itkonen et al., 2005). In Itkonen's et al. (2005, p. 202), it was elaborated major challenges of agile principles in regard to testing from the traditional viewpoint. They pointed out that for continual delivery of valuable software as one of agile principle, challenges such as short time cycle testing, without exceeding the deadline in testing are recognized. When it comes to “responding to change even late in the development” principle, what is challenging is that testing cannot be found on realized specifications. Given that the agile approach depends on the face to face communication, developers and business people involved in testing process can lead to misunderstanding in communication potentially causing confrontations. They also stated that working software is the main measure of progress, therefore, information of quality is needed in early-stage and usually during the development. Finally, Itkonen's et al. (2005) said that testing process is easily rejected due to „simplicity sake“.

Furthermore, when it comes to the fundamental testing principles, Itkonen et al. (2005) identified contradictions in agile testing considering those principles. For example, one of basic testing principle is independency but in agile methods, tests are written by developers for their programs, and testers rotate among developers or they are one of them. It indicates that testers are woven in development team, so they are not independent enough. Also, they should skip testing own code due to hardness to notice errors and test does not explore if you do not meet or understand customers’ specification. Moreover, to achieve effectiveness and efficiency, testing demands persons with particular knowledge and skills. On the other hand, in order to obtain quality, testing by customers is possible if they have specific experiences to take care or conduct testing, and unfortunately this is not always the case. Another problem is to find the correct result of the test and detect non-conformances in software - known as the “oracle problem”. In agile methods, automated tests are dominant and the question arises as to whether they are good enough to find these code defects. One of traditional attitude to testing software is a destructive attitude focusing to explore and find problem. According to Zhou, Govindaraju and Jones (2019), conformity testing “is exercised to assure that an entity meets a specific requirement and/or regulatory standard”. It “assess the functionality of a software system met the required specification and to identify whether the system is defect-free or not” (Hasan et al., 2019, p. 1). In agile methods, it is rather focused on presenting the characteristics of product work than investigating the problem cause and system may not work even though unit tests passed. However, testing process is not only to find failures but to provide

information to improve quality of product. In the agile approach, testing processes are mainly relied on conforming to good practice and check if these practices are followed but it does not give information about quality level of product and does not allow assessing the quality that is reached.

4. METHODOLOGY

On the bases of the foregoing conclusions, it can be considered that the introduction of additional testing practices leads to agile development processes. In order to closely understand and clarify these cons and challenges, the work of Itkonen et al. (2005) is reviewed in the upcoming chapter. In their paper, Itkonen et al. (2005) used a temporal pacing outline to recognize QA practices in present agile methods based on the “heartbeat, iteration and release time horizons”. Founded on the Cycles of Control (CoC) framework, developed by Rautianen (2004), as part of an agile development process, the following chapter tries to gain a better understanding of the dynamic nature of ASWD and the QA practices.

4.1. Cycles of Control Framework

The CoC framework is a generic frame for depicting incremental and iterative development of software and can, therefore, be utilized to describe agile development (Itkonen et al., 2005). The framework is found on the idea of time pacing in which a fixed time period is divided into multiple fixed-length segments, each with its own budget and delivery date (Eisenhardt & Brown, 1998). At the end of each segment there is a control point at which a process is evaluated. Also, adjustments to the plans are made if found necessary. Changes can only be performed at these control points, accomplishing persistence and establishing flexibility to change plans and adapt to changes in the environment simultaneously at specific time intervals. “These time intervals, or time horizons, set the rhythm for product development. In accordance with the time pacing idea, the schedule (due date) of a time box is fixed, whereas the scope (development functionality) is not” (Rautiainen & Lassenius, 2004, p. 6). Fixing the end date implies that, if finishing all product requirements by that date is not possible, the scope will be diminished so that the system is prepared by that fixed date. Therefore, „Therefore, demands must be rank so the team can make scope suiting by themselves (Rautiainen, 2004). In Figure 2 is illustrated an cycles of control building blocks.

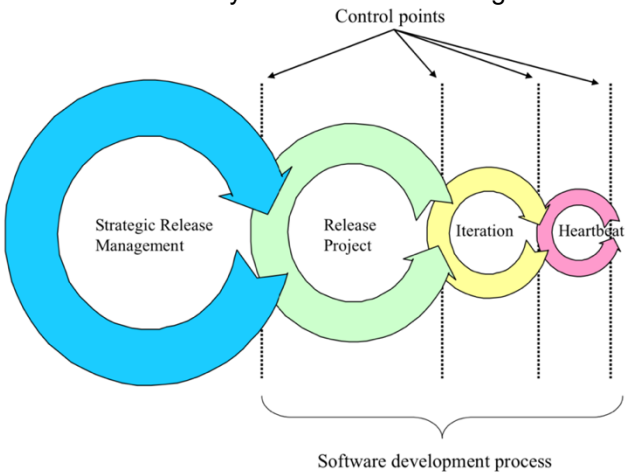

Figure 2: Cycles of Control building blocks (Rautiainen, 2004, p. 23).

“Strategic release management deals with the long-term plans for the product and project portfolios of the company and provides an interface between strategic decision making and product development” (Rautiainen & Lassenius, 2004, p. 6). Every unitary product release is operated as "a time-boxed project" and managed within the cycle of release project. Every project is divided into "time-boxed" reduplications "where partial functionalities of the final product release are developed" (Rautiainen & Lassenius, 2004, p. 6). Every-day-work is synchronized and controlled in heartbeats (Rautianen, 2004). Figure 3 shows that the cycles can be outlined on a timeline as well. This shows how the time-horizon of strategic release management bridges 2 release projects, built-in 3 interactions and the work is coordinated with daily heartbeats. In the next subsections, the meaning of the different time horizons from the QA perspective is described.

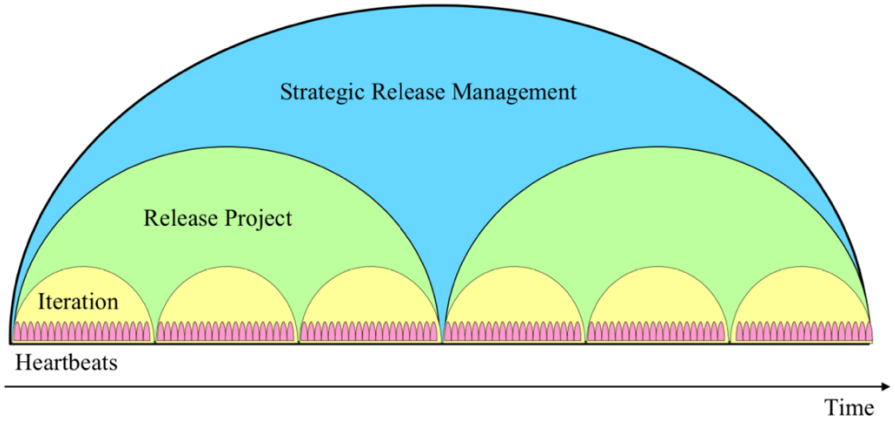

Figure 3: Cycles of Control on a timeline (Rautiainen, 2004, p. 24).

4.2. Heartbeat, Iteration and Release QA

As part of the coding tasks and design, *heartbeat quality assurance* involves practices that put up "quality into a piece of functionality during its implementation, meaning that the implementation tasks are not regarded to be completed until these QA activities have been performed" (Itkonen et al., 2005). These practices are a vigorous base for the agile development process and endeavor to assure good in each development task because these activities supply with immediate feedback to the developers. The heartbeat quality assurance practice instance is automated unit testing. Developers have to write down unit tests for every code that they make, and progress is considered only after the tests are finished and passed. „Rhythm is the key and heartbeat activities are managed and monitored according to the heartbeat rhythm" (Itkonen et al., 2005, p. 5). Also, the diverse roles have to be in touch and harmonize their work in each heartbeat. On the heartbeat time horizon, QA is a very strong in agile methods. As *Table 1* shows, the majority of the QA practices is based on the "heartbeat time horizon" as the shown methods emphasize a unit testing, regular builds, inspections of code and design, and short integration cycles (Itkonen et al., 2005).

Table 1: Agile methods' QA practices on time horizons (Itkonen et al., 2005, p. 205)

	"Extreme Programming"	**"Feature Driven Development"**	**"Crystal Clear"**	**"DSDM"**
Release	-	-	-	-
Iteration	- Evaluating the acceptance test results	- "Separate system testing"	-	- "Integration, system and acceptance testing inside each timebox" - "User testing" - "Evolutionary prototyping" - Reviews of documents
Heartbeat	- "Test-driven development" - "Continuous integration" - "Pair-programming" - "Acceptance testing" - "Collective code ownership" - "Coding standards" - "Simple design and continuous refactoring" - "On-site customer"	- "Unit testing" - "Regular builds" - "Design inspection" - "Code inspection" - "Individual code ownership"	- "Automated tests and frequent integration" - "Side-by-side programming" - "Osmotic communication" - "Easy access to expert users"	- Unit testing - Reversible changes - Active user involvement

QA on the iteration time horizon includes processes focusing on meeting the iteration objectives. This comprises all implementation, testing and review processes that are not carried out for every heartbeat rhythm feature. Numerous specialized testers tasks belong to the iteration time horizon, involving testing reliability, performance and other quality dimensions on the system level that encompass the system wider

than functional testing. Overall, professional testers carry out activities that are indirectly connected to the development. These professionals write and execute testing throughout the whole iteration and have to harmonize their work with the developers. Since iteration tasks are time-boxed, it is vital to path the work development, progress, and communicates quality information continually, for example in heartbeat meetings. In agile methods on the iteration time horizon, QA practices are much fewer than the practices on the heartbeat time horizon as depicted in *Table 1*. Not many process/activities are defined for assuring the quality at this level (Itkonen et al., 2005). For example, XP depends on strong heartbeat practices and leaves only progress tracking to the iteration time horizon (Beck, 1999, 2000; Jeffries, Anderson & Hendrickson, 2001).

"The goal of *release quality assurance* is to ensure quality of the product on the release time horizon" (Itkonen et al., 2005, p. 6). Tasks embrace testing that cannot be done in the schedule of iteration, tasks of a divide testing group, and testing in numerous settings. A general way of involving QA releases is to have divided stabilization iteration. Since at the end of the release project the stabilization iteration assesses the quality of the work complete in earlier iterations, this stabilization process is not considered to be iteration quality assurance. It also entails that particular risks of quality are not detected until the last iteration (Itkonen et al., 2005).

Itkonen et al. (2005) says that on the release time horizon, it is not easy to discover any quality assurance practices in agile methods as shown in *Table 1*. The dynamic systems development method (DSDM) depict that in huge projects or by contractual limitations there might be an occurrence in which separate/split acceptance testing processes are needed outside the iterations, for example on the very release time horizon (Stapleton, 1997). Nevertheless, even in DSDM, these cases are regarded to be outstanding.

5. AGILE TESTING ENHANCEMENT

Agile methods depend on user collaboration but do not comprise plenty of practice of destructive testing. A few methods like XP provide a set of constructive developer activities aiming at producing quality without other testing than user acceptance tests. Other methods, however, do not provide such a set of practices and therefore recognize the need for specific testing practices also on the integration, system and acceptance level. As a result, it can be said that heartbeat QA practices could be enhanced by, for example, introducing the role of an independent tester, testing each completed feature in collaboration with the developer (Itkonen et al., 2005).

The session-based exploratory testing (ET) is an agile testing example on the iteration time horizon (Itkonen et al., 2005). Veenendaal (2018) describes ET as "An informal test design technique where the tester actively controls the design of the tests as those tests are performed and uses information gained while testing to design new and better tests" (Veenendaal, 2018, p. 50). As such, it does not rely on test cases which are predesigned but it is a creative, approach based on experiences in which test design, learning, and execution are parallel processes from which the outputs are instantly applied for further tests designing (Itkonen, Mäntylä & Lassenius, 2012). Itkonen et al. (2012) actually found out that testers applied their knowledge either as a test oracle for failure recognition or for the test design and thus, proved the application's effectivity of the testers' knowledge during ET sessions.

Exploratory testing based on sessions makes it possible to handle testing in short time-boxes and thus, appropriate for short iterations. Additionally, as mentioned above, the nature of exploratory testing supports the achievement of the destructive attitude that is needed for testing. In some situation, testing are required on the release time horizon, however, in lots of cases it might be better to embrace as many QA practices on iteration time horizons and the heartbeat to assure quality information earlier and to decrease risks of quality at the early stage of development.

4. CONCLUSION

This paper's aim was to investigate the level to which QA is covered in agile software development by the leans of Itkonen et al. (2005). This group of author compared the practices in plan-driven methods and in agile methods. In order to approach this goal, the theoretical foundations of software quality, specifically software quality frameworks with focus on the ISO 9126 quality view and fundamentals of quality assurance, have been elaborated from the traditional view of quality. Then, challenges and shortcomings of ASWD with regards to SQA have been identified by comparing agile principles with their corresponding challenges as well as comparing fundamental testing principles with contradicting practices in ASWD.

When it comes to principles, for example, it is noticed that agile methods lack direct quality metrics, which was identified as a potential shortcoming of the method. Also, independence of testing, specific skills, oracle

problem, and distructive approach were recognized as in confrotation with nowdays practice in agile methods.

Next, the research methodology for the upcoming chapter was presented. Quality assurance practices of agile methods were then discussed on the time horizons of Rautiainen's (2004) CoC framework presenting the quality building processes of the developer on the heartbeat time horizon. According to Itkonen et al. (2005), possibilities have been discussed to improve SQA in agile progress on iteration, the heartbeat, and release time horizon, and to describe how testing activities are located in an agile process. It can be recommended that independent tester could significantly improve agile testing and it opens question if supplement testing practice is needed.

By relying on the challenges and cons, it will be useful to improve ASWD activities by introducing added testing practices that are not initially covered in the agile methods themselves. For the iteration time horizon an independent tester role has been proposed and session-based exploratory testing for the heartbeat time horizon. It has been concluded that testing practices should be covered during these two time horizons.

This paper brings forth the following challenges for agile testing. First, evidence of the sufficiency of current SQA practices used for existing ASWD are required to show, whether enhancement is actually needed considering the differences between the single methods that more or less include explicit testing practices in their agenda. Second, additional investigate is needed to discover which testing practices work well in agile developments that can also meet the quality requirements demanded for traditional methods. For example, Behavior Driven Development or Acceptance Test Driven Development might be methods to investigate.

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QUALITY MANAGEMENT STANDARDS IN THE AUTOMOTIVE INDUSTRY - THE CASE OF AUTONOMOUS DRIVING

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Abstract: *Despite the technological advancement in the autonomous transportation industry the sufficiency of the current management systems has to be assessed. For discussing the question if current management systems cover the requirements for this industry we focused on the discrepancy between current norms and needed requirements. Hereby, the paper presents current standards in the automotive industry and offers and understanding on the needed change in standards for succeeding in autonomous car development. We conclude the paper with recommendations of more legal regulations for such new technologies and the need for optimizing established standards.*

Keywords*: Quality Management, Standards, Automotive, Autonomous Driving*

1. INTRODUCTION

The traditional automotive industry is facing major challenges and has to experience a radical change in the near future (Winton, 2019). Right now, automotive is one of the top contributors towards human made climate change with about 22 percent of the EU's top CO2 emission (European Parliament, 2019). The world population raises rapidly and leads to progressive urbanization that requires innovative transportation solutions, which put less strain on people's and global health. Current developments like the shift from ownership to car sharing result in additional challenges for existing business models (Thomas, 2019). These challenges demand fast change in the industry towards a more efficient, clean, and scalable future mobility. While traditional companies are still challenged with the consideration of alternative propulsion technologies, tech giants react with the concept of autonomous driving for vehicles.

A release of such an advanced car on the streets results in the necessity of rethinking safety in various dimensions. Aside of ethical concerns like the machine's ability for judgment and empathy, autonomous cars must be safe for their surrounding traffic and environment (Bhat, Aoki, & Rajkumar, 2018). Nowadays, there are various standards in the car industry which implement quality standards into the vehicle development and production, ensuring overall safety. The shift of the automotive industry to autonomous driving has brought up the importance of new benchmarks for the development and production process on the software and hardware side but also for general safety and security. Existing standards and norms have been adapted to the industry's progress over the years. Certainly, autonomous driving redefines the industry with sectors such as software development and self-learning algorithms that were not relevant before or at least not in such a fundamental way.

Thus, current quality standards of the traditional car industry need to be reconsidered, which leads to the question of this paper: Do current management systems cover the requirements for the autonomous transportation industry?

To comprehensively discuss this question, the paper is going to introduce the most relevant standards and management systems first. Various literature sources will build the base for this set of safety requirements. The following part will define the term of autonomous driving, its different driving levels and is going to explain how conventional car companies currently apply the featured standards. Before examining the future challenges for autonomous driving, the problems of these established norms will be analyzed and thus the research question is getting evaluated. A possible solution approach for safety requirements in autonomous driving is displayed subsequently.

Finally, needs for future transportation and resulting safety requirements are introduced, whereas the autonomous driving industry's prospective requirements are uncertain. The conclusion summarizes the paper's results and provides an outlook for urban matters of transportation.

2. STANDARDS IN THE AUTOMOTIVE INDUSTRY

2.1. Automotive Compliance Standard ISO 26262

ISO 26262 is a standard with the purpose for functional safety in vehicles and is known under the title *Road vehicles - functional safety.* The standard finds its application to safety-related systems which include one or multiple electronic systems (iso.org, 2019).

The ISO 26262 consists of ten volumes and since it is developed for passenger cars, it contains specific sections regarding automotive. With the automotive industry implementing more and more technical components into the cars, the need for safety-compliant systems is increasing. An example for complex components is control units in the car, like a cruise control system which automatically keeps the speed of the vehicle on a certain level. The system works by taking over the throttle of the car for maintaining a consistent speed which was set by the driver (National Instruments, 2019). For a correct application of this standard a set of steps is used to operate the functional safety. These steps also have the role of regulating the product development for the hardware, software and the overall system. It offers recommendations and regulations from the beginning of the conceptual development phase throughout the decommissioning. It also documents the entire testing process. These key elements of the ISO 26262 are:

- Automotive safety life cycle (including development, production, management, operation, service, decommissioning) and tailoring the processes' components
- Attempt for determining risk classes; Specifying item's safety requirements on base of the usage of Automotive Safety Integrity Level (ASIL)
- Validation and confirmation measures for ensuring the achievement of adequate safety level (National Instruments, 2019).

The entire production life cycle gets described as *Automotive Safety Lifecycle* which includes the following elements: requirement for a safety manager, the development of a safety plan, creation of a safety review, audit and assessment (Schätz, Voss, & Zverlov, 2015).

2.2. IATF 16949

The IATF 16949 is a standard based on the ISO 9001 developed by the *International Automotive Task Force* which combines existing requirements of internal and external quality management systems (IATF, 2016). Numerous car manufactures such as BMW, Chrysler, Daimler, Fiat, Ford, General Motors, PSA, Renault, and Volkswagen are part of the IATF. This standard was originally created as ISO/TS 16949 in 1999 by the IATF with the intention to unify the different assessment and certification systems in an international context in the supply chain for the automotive sector (Laskurain, Arana, & Heras-Saizarbitoria, 2018).

Nowadays, approximately 30% of all car manufactures stick to these standards apart of Asian manufactures: They have own standards for their suppliers and themselves (Facchinetti, 2018). IATF 16949:2016 as the newest version specifies quality standards for the composition, development, production and, if applicable, assembly, fitting and distribution, of automotive products, implicating those with embedded software (Gruszka & Misztal, 2017). The Implementation at the OEM must be carefully managed to be effective and accepted by the car manufacturer (Reid, 2005).

2.3. Automotive SPICE 3.1

ASPICE in version 3.1 is an industry specific version of the international ISO/IEC 15504 (SPICE). ASPICE is an acronym for *Automotive Software Process Improvement and Capability Determination*. Thus, it's a standard for performance benchmarking of a development process for embedded automotive systems. It was developed starting in 2001 in accordance with the requirements of ISO/IEC 33004 (Automotive SIG & VDA QMC Working Group 13, 2017). It is applied either to regulate the status for internal process improvement or for the process quality assessment of a supplier. Thereby, it acts as a tool for determining risks throughout the supplier selection (KUGLER MAAG CIE GmbH, 2018). Thus, since 2017 the German car manufactures Audi, BMW, Daimler, Porsche and Volkswagen only accept suppliers with accurate ASPICE assessments. To measure process quality ASPICE has a capability dimension which consists of six capability levels (CL) as shown in figure one. To archive an CL a process must accomplish associated subprocess attributes (PA).

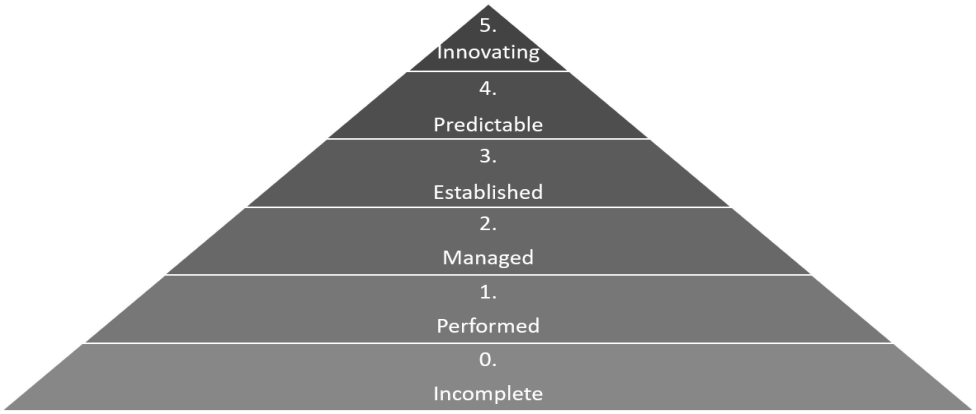

Figure 1: ASPICE process capability levels (simplified figure of KUGLER MAAG CIE GmbH, 2018)

In order to achieve the first stage an implemented process must reach its goal. It's considered as *performed* otherwise the process is classified as *incomplete*. The next stage is *Managed* whereas a process is recognizable as a simplistic sequence with basic feedback, although the outcome is not consistent. The *established* process provides a more stable result, reached through a uniform process. Beyond that a process in the *predictable* capability level offers a predictable outcome quantity at consistent quality. Perfection is reached through the *innovating* CL, which requires a process to continuously improve itself by comprehensive feedback data and by providing diverse process procedures to archive a goal as efficient and as effective as current conditions allow (Automotive SIG & VDA QMC Working Group 13, 2017).

2.4. SAE J3061

Connected vehicles offer a higher risk for cyber-attacks: The guideline SAE J3061 *Cybersecurity Guidebook for Cyber-Physical Vehicle Systems* is providing a process for ensuring better cybersecurity. SAE is an international organization for mobility technologies also known as Society of Automotive Engineers and published the guideline SAE J3061 in the beginning of 2016. Such a structured process is needed to implement security and safety into the product development. There is no guarantee for entire safety but a well-structured process with integrated security standards strongly decreases the risk of malicious attacks (Boran, Czerny, & Ward, 2016). The guideline provides a precise definition of the life-cycle process framework including information about tools and methods for the development of vehicle systems. It further specifies when and how to integrate cybersecurity elements into a development process.

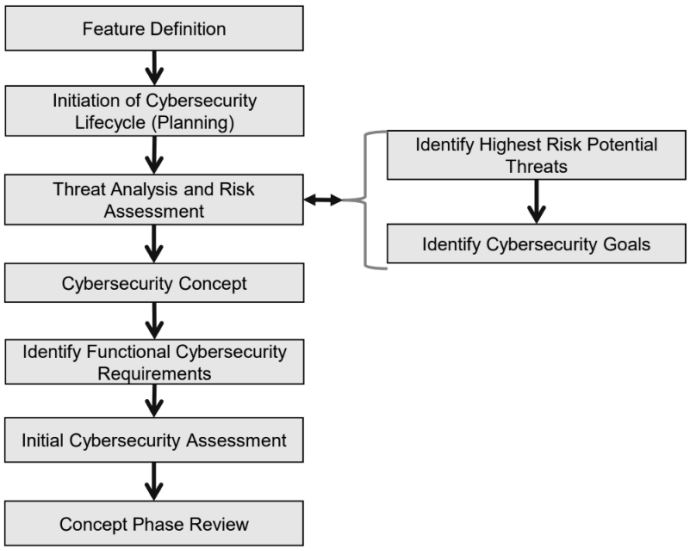

Figure 2: Conceptual process diagram with SAE J3061 (Boran et al., 2016)

As figure two shows, the SAE J3061 process flow starts with a feature definition to proceed with the initial planning of the cybersecurity (CS) life cycle; that reaches from the initial concept up to the scrapping of the vehicle. The next step consists of analyzing and assessing the threat and the risk for the technological component (Schmittner, Ma, Reyes, Dillinger, & Puschner, 2016). Hereby, the CS goals get identified on the base of the threats with the highest risk potential. When the assessment is concluded the CS concept is

designed followed by the identification of the functional CS requirements. The process ends with the review of the concept phase (Boran et al., 2016).

3. INTEGRATION OF ESTABLISHED STANDARDS IN AUTONOMOUS DRIVING

3.1. Autonomous driving levels

Autonomous driving means vehicles which can drive, park, and operate without the driver's influence. For the correct understanding of autonomy in terms of vehicles the (U.S. Department of Transportation, 2018) defined five levels of transportation shown in figure three that are widely spread throughout the industry. This includes everything from no automation where a driver always must be fully engaged, to full autonomy with an automated vehicle operating entirely self-sufficient (Barabás, Todoruţ, Cordoş, & Molea, 2017).

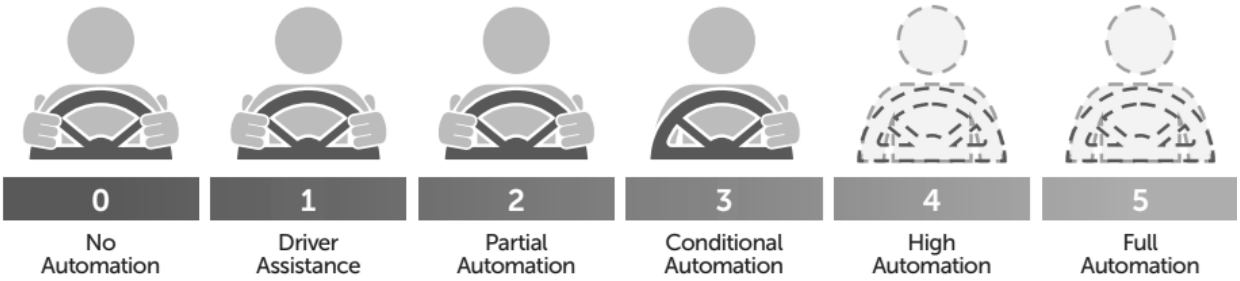

Figure 3: Levels of autonomous driving (U.S. Department of Transportation & National Highway Traffic Safety Administration, 2017)

Cars without any automation level need the driver to fulfill all the driving tasks. The first level of automation describes a vehicle being controlled solely by the driver apart of some driving assist features which can be included in the vehicle's design. Partial automation consists of combined automated functions, like acceleration and steering while the driver does not execute these functions but must be engaged in the task and monitor the traffic situation constantly. The third level urges the driver to be prepared to intervene in any situation where the car alters them to act, but they are not required to constantly monitor the road traffic.

The general understanding of autonomy is already reached within the fourth level: The car can perform all driving functions under certain conditions. The driver may has the option to control the vehicle (U.S. Department of Transportation & National Highway Traffic Safety Administration, 2017). Full automaton understands the vehicle as a full-time automated driving system in every aspect. The dynamic driving tasks can be managed by the car in every environmental and under all road conditions (U.S. Department of Transportation, 2018).

3.2. Current quality requirements

As presented in chapter two, manufacturing cars is subjected to the application of very high standards. When proceeding to developing cars with advanced support systems (level 2); far more complex electronic components, standards also must be adapted to these rising requirements for quality, safety, and security.

The previously presented standards should satisfy these demands; IATF 1649 and ASPICE cover especially those concerning quality, ISO 26262 covers particularly safety requirements and SAE J3061 mainly security needs. The transition towards autonomous cars (level 3 and above) leads to software components becoming critical and require much more intense safety regulations. Thus, already during the development process quality standards must be applied to ensure continuous sureness in such high complex systems. Further, there are autonomous components that decide for itself and particularly those must be considered in terms of safety. Therefore, in addition to the necessary safety requirements, reliability, availability, and maintainability (RAMS) are essential elements for autonomous vehicles (Lohmann & Zwaan, 2018). Below these requirements are briefly explained.

- Reliability - the ability of a product or a system to perform a certain function. It can be separated into two parts: Design reliability and operational reliability.
- Availability - the ability of a system to maintain itself to always perform correctly.
- Maintainability - determined by the simplicity of repairing or maintaining a product or system.
- Safety - is the requirement of not harming people, the environment, or any other assets during the life cycle of a system.

While most car manufactures are still trying to achieve these goals, RAMS is already the key element of the assessment in the rail industry (Chen, 2019). Most cars that are presented as *autonomous* like Tesla's are still

only level three. Level four is only reached by specialized research companies like Waymo (Wiggers, 2019). Fortunately, current demand trends force manufactures towards engineering projects with proper budgets for RAMS. Implementing RAMS on the supply side, meeting the requirements and gaining approval for operations distinguishes the companies acting in accordance with the policies and regulations from those that are capable of doing so (Lohmann & Zwaan, 2018).

3.3. Problems of existing quality norms

Regarding the high need for safety, current quality norms do not fulfill the requirements for artificial intelligence soft- and hardware. Therefore, certifications and standards will still be a necessity and not an option (Haydin, 2018). Since self-driving cars are a fairly new technology no manufacturer has reached entire autonomy by now (level 4 or 5). Scientists distinguish greatly in their oppositions: While some think it will take us at least decades to reach this goal (Gessner, 2019) enthusiasts like Elon Musk have ambitious goals being there in 2020 (Korosec, 2019). Certainly, the most advanced cars on today's roads are up to level three.

Another problem is the inconsistency in the industry for standards and norms, every car manufacturer develops with their various selections of standards or own established methods. This jungle of standards and the welter of new or adapted versions leads to a non-transparent industry. Moreover, this consistently leads to higher cost end efforts for the companies and causes inefficient development. The car manufactures want to produce marketable high quality products which are safe, secure, and innovative while keeping costs efforts as low as possible (Gifei & Salceanu, 2017). A consequence of that issue is shown by the following data of Statista in figure four. According to them, every second driver does not feel safe to drive an autonomous car because they deem them as not secure and unsafe. Other are afraid of the technology because of knowing too little about it or would not trust the car in mixed traffic (Häuslschmid, von Bülow, Pfleging, & Butz, 2017). Another emerging problem almost every fourth person is afraid of is the cars' insufficient cybersecurity and the risk being hacked.

Figure 4: Consumer concerns about autonomous cars (simplified figure of Richter, 2018)

All these problems must be tackled with new, improved and especially consistent norms. Most of the existing standards are outdated when producing self-driving vehicles: They were released before the development started and only fulfill their purpose in the regular car production.

Although, the companies are experienced in working with these established standards they also see the importance of better norms especially designed for autonomy (Union of Concerned Scientists, 2018). Therefore, they also want to educate people about the high safety and security standards which they will apply before cars are going to be on the streets to gain their trust in autonomous driving. One standard which explains this need for change is the existing and commonly applied norm ISO 26262. Table one compares the special features of high automated driving with the ISO 26262's approach.

Table 1: Comparison ISO26262 and high automated driving (inspired by Haydin, 2018)

ISO 26262	**High automated driving**
Small number of systems delivering a function	Highly distributed architecture
Hazards resulting from malfunction of electronic systems	Nominal performance and intended functionality may also cause hazards
Controllability by driver	Possibility of unintentional operation
The driver is in final control	Higher degrees of automation and faster reaction times
Safety strategies generally based on *fail silent*	*Fail operational* strategies becoming relevant
Vehicle has little external connectivity	External connectivity: cybersecurity issues are relevant
Software techniques based on deterministic approach to embedded systems	Use of machine learning

Although autonomous cars have complex systems depending on each other, the norm only deals with those delivering a measurable function which is only a small segment. Hazards are defined as malfunction ins electronic systems, whereas machine learning can always cause hazards. With ISO 26262 the driver is expected to be in control most of the time and there is almost no external connectivity considered. However, autonomous cars have a high degree of automation and connectivity which raise critical topics like cybersecurity (Coppola & Morisio, 2016). Failing strategies are dissimilar because a regular car's part failing strategy is termination, while an autonomous car must handle the driving as good as possible even when relevant systems fail. The current status shows the immense difference between what is currently applied in the industry and what will have to be applied with autonomous cars (Haydin, 2018). Although, the 2019 version called SOTIF which is described in section 4.1 covers some of these problems and leans to technologies like autonomy and machine learning.

4. FURTHER CHALLENGES IN AUTONOMOUS DRIVING

4.1. Proposed standard for autonomous cars

The conclusion so far: The established standards are not entirely enough for the requirements of autonomous driving. With this new technology, guidelines, standards, and norms yet must be developed. Safety of The Intended Functionality (SOTIF) is a standard still in the development phase which consists of guidelines for manufacturing autonomous vehicles of level 0,1 and 2. Even for these lower levels of autonomous driving experts struggle with finding definition and standards for safety. The SOTIF standard is being developed to guarantee the safety while driving an autonomous car for every party involved (Gifei & Salceanu, 2017).

SOTIF describes an advanced concept for autonomous vehicle architecture. SOTIF is based on ISO 262626, additionally it includes the procedures for analyzing risks of advanced soft- and hardware components. It further explains the identification and assessment of scenarios and events which lead to an impaired safety insurance. Ultimately, the standard's purpose is the decrease, validation and verification of risks and to state the needed requirements for autonomous driving (Dailey, Schlöffel, & Prawitz, 2019). Apart of the methods, the importance lies in the implementation: The autonomous vehicles undergo numerous tests and simulations which must be passed (Althoff, Stursberg, & Buss, 2009). These simulations take many factors into account for instance the weather, road conditions, the entire 4D surroundings, object's textures, and possible misbehavior of the driver (Heinzmann, Shafaei, Osman, Segler, & Knoll, 2019). These measures are essential for developing safe autonomous cars. The SOTIF process model consists of four phases as displayed in figure five: concept, implementation, verification, and validation (Schnieder & Hosse, 2019).

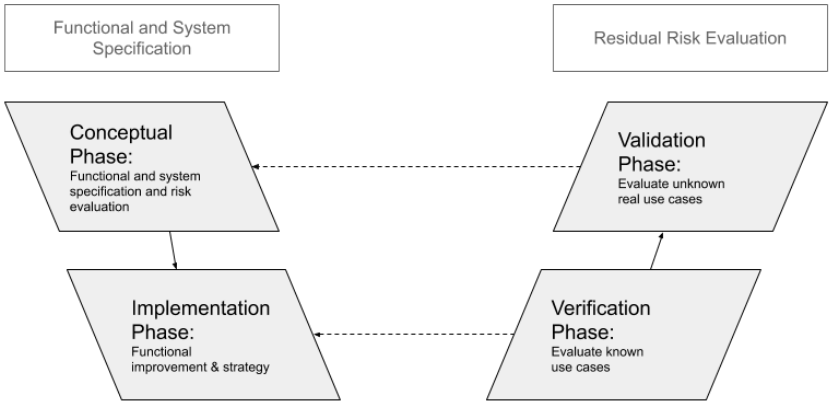

Figure 5: SOTIF Process V-model (simplified figure of Schnieder & Hosse, 2019)

The simplified model clearly states that the actual security assessment takes place during the conception and implementation phase. The result of the outcome is further ensured thru two additional testing stages. If a use case test fails during the verification phase the implementation phase rolls back again, because the errors have happened during the development and can be handled there. If, however, a real use case scenario fails throughout the second testing stage the process starts all over again at the functional system specification of the conceptual phase, as that defect is most likely related to wrong planning in the first place. This procedure ensures great safety trough testing in two different stages and rewinds when necessary. The actual elements of the four phases are explained in the following (Schnieder & Hosse, 2019).

The concept phase:

- Creating the functional and system specifications: A document that will be used during the entire development process. It consists of describing the functions' goals as well as describing multiple dependencies with other functions, influences, and interactions.

- Identifying risks: Based on earlier assessed danger of malfunctions the risk of an impact gets identified in a systematical way.
- Identification and assessment of dangerous scenarios: The goal is a specific identification of the system's weaknesses. Those are defined as scenarios leading to unintentional system behavior. The causes for such a behavior can be incorrectly working algorithms, sensors, actuator, or even humans.

The implementation phase:
- This includes extensive system improvements, limiting the algorithm's functions, increasing the driver's responsible instead of giving the car more responsibility, and preventing a high impact due to malfunctions.

The verification phase:
- The system and its components must be verified for safety reasons. Hereby, it will be reviewed if the system acts in certain hazardous scenarios as expected. It is essential that the tests are evaluated as safe and sufficient.

The validation phase:
- The system and its components get validated to guarantee that there are no unexpected risks in real test situations. The use of statistic assessments serves as additional proof.

4.2. Future transportation and its safety requirements

Various consulting companies predict, that future transport will be about more than just driving and getting from A to B (KPMG, 2019). In fact, it is about a whole new social concept of transportation, that integrates numerous aspects of life and therefore different industries. As Deloitte's graphic shows the physical vehicle development and operation is one of four key factors in the mobility future value system. The already mentioned trend of connectivity and the demand of a robust infrastructure is for security, technology, energy and streets is as essential as the vehicle itself.

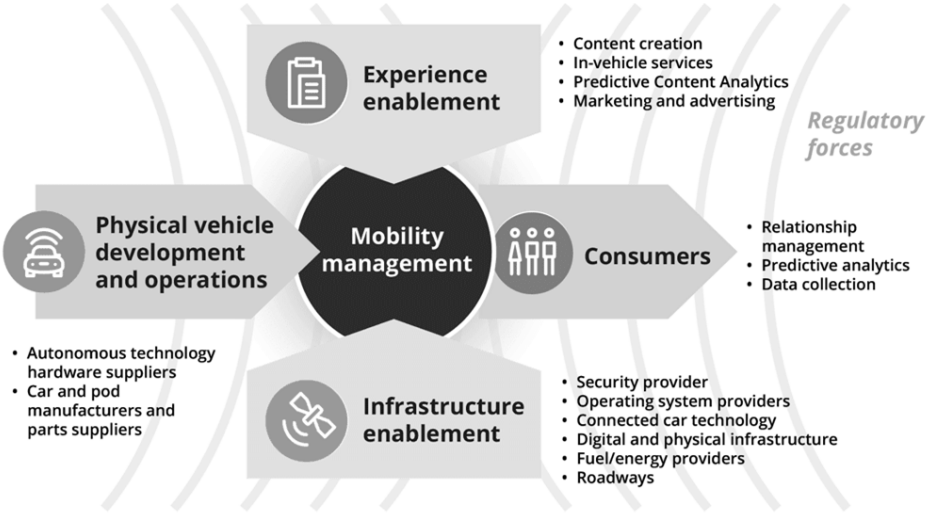

Figure 6: Future mobility value system (Rea, Stachura, Wallace, & Pankratz, 2017)

Further, the in vehicle-experience becomes relevant, wherefore content needs to be created - to talk to a digital assistant for instance. The in-vehicle environment creates time people can use for themselves. Ultimately, the customer relation management becomes important, to predict when and where people need a transportation to certain places (Rea et al., 2017).

To transform urban transportation into a smart mobility a close collaboration between the private and public sector is inevitable. Clear regulations are necessary (Hannon, McKerracher, Orlandi, & Ramkumar, 2016). Up to a certain grade we are already there, but still the demand for adapted standards which can test such algorithms and are prepared for safety and security concerns like interconnection of cars and their ability to drive themselves to repair stations will increase. Regulations gain importance to verify all relevant aspects and guarantee safety in this complex environment even though the existing diversity of similar standards might not outlast this change (Haydin, 2018).

5. CONCLUSION

Without regard on how our future transportation might look like: safety of the driver and of all road users is always the highest priority. We assessed four current quality standards in the autonomous transportation industry which lead to the following results: 1. Consistent and transparent regulations are needed, 2. The government has to proceed with updated laws for guaranteeing quality, 3. New quality standards adapting to the changing requirements of autonomous vehicles are needed, 4. Legal questions about responsibilities in the case of an accident have to be cleared. We concluded the evaluation of the norms currently in use shows there is potential for improvement and a need for change. The SOTIF model which is presented as one possible norm for autonomous vehicles is even based on one of the more established norms ISO 262626. It is obviously not a final guideline - it still needs further development and some fine tuning. Still, it is the first standard addressing primarily autonomous vehicles. Now knowing that, the introductory question *If current management systems cover the requirements for the autonomous transportation industry?* can be evaluated: The answer is *yes* and *no*. Yes, they do cover some requirements, but that is not even the minority of them.

Research must be done hand in hand with developing new standards. A major help during the development of norms and standards has been proven by an open source approach. Completion in the development of standards harms the industry and ultimately affects the customers' safety negatively. Cooperation trough open standards and competition in the actual product delivery might be a more up-to-date approach (Wind River Systems, 2017). Not at least because in an industry worth more than a trillion US dollars in 2030 (KPMG, 2019) car manufactures only can benefit from the time and cost they spent collectively. Then, not having to apply various norms they can focus on the actual development and research of connected technologies. Nevertheless, the future of the automotive industry and its norms and standards are unclear. Today it cannot be assessed how drastic these changes in our infrastructure will impact the future of norms and standards in the automobile industry.

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NEW TRENDS IN AIR TRANSPORT BUSINESS RELATED TO PSO ROUTES

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Abstract: *Public Service Obligations (PSO) are air services that operate to remote or economically underdeveloped regions which are regulated and/or financially supported by governments. They represent short-term contracts that the government has entered into with airline/s. Nowadays, the new trends in air transport business related to PSO routes appear. The evidence of these trends is provided by comparative analysis of PSO routes in 15 European countries including Serbia. Based on presented analysis three groups of countries can be distinguished. Furthermore, the first group is related to the original aim of PSO routes, while the other groups represent the new trends in air transport business.*

Keywords*: Public Service Obligation, air transport business, government support for airlines*

1. INTRODUCTION

Since the beginning of the air market deregulation and liberalization processes, there has been a strong link between the region's connectivity with air transport and the economic growth and development of those regions. Therefore, it is necessary to facilitate mobility, that is, to connect people and markets between different regions. The existence of remote areas which would not establish air transport under strict market criteria due to insufficient demand, has led to the development of various public policies aimed at supporting the connectivity of regions where commercial airline operations are not sustainable. Public Service Obligations (PSO) are air services that operate to remote or economically underdeveloped regions which are regulated and/or financially supported by governments. There are two types of PSO routes – open and restricted. On the open PSO any airline can operate if it complies with PSO requirement and there is no exclusivity and compensation granted. If there are not airlines interested in operating the obligations have been imposed, restricted access to the route to a single airline and compensation of operational losses resulting from the PSO may be concerned. In that case only one airline can operate the PSO and if exclusivity is not sufficient to ensure the financial viability of service, then compensation is awarded (ERAA, 2016). The main benefits of a PSO programs are transparency, precise definition of users, limited amount of associated costs and incentives for efficiency and competition (Fageda et al., 2018). Conditions and requirements for the introduction of PSO are defined by Regulation 1008/2008 of the European Parliament and of the Council of 24 September 2008 on common rules for the operation of air services in the Community. The EU legal framework established by Regulation 1008/2008 guarantees the openness, publicity and transparency of the procedure of imposing PSO.

PSO represent short-term contracts that the government has entered into with airline/s. These contracts may specify flight frequency, minimum number of seats, type and size of aircraft, service time, maximum fare for some or all of the seats offered, discount rates for residents or passengers with special needs, earliest departure times and latest arrival times, the maximum number of stops between airports and the maximum waiting time between flights, membership of a shared reservation system, etc. Airlines may receive a subsidy from the state if they meet the above conditions for the contract duration. It is usually protected from the entry of other airlines into the market, leading to the creation of a monopoly. The airline that will operate the route is usually determined by a tender procedure at the community level.

PSO are introduced in Serbia in 2019 aiming to connect South Serbia with Germany, Austria, Italy, Hungary, Sweden, Slovenia and Montenegro. The routes are operated by Air Serbia from the Airport Constantine the Great in Niš. The goal of this paper is to describe and explain PSO based on analysis of 14 EU countries, as well as to point out differences and similarities between the schemes in Serbia and observed EU countries.

Following the introduction, literature review and examples from different regions in Europe are given, with reference to the great heterogeneity between the systems introduced. The third section presents a

comparative analysis of the PSO system in 14 European countries. An overview of the PSO system introduced in Serbia is given in fourth section. Finally, in the last section concluding remarks are provided.

2. LITERATURE REVIEW

PSO have been implemented in many countries. However, there is a significant heterogeneity and imbalance between different regions in Europe regarding the provision of PSO operations. Sometimes the priority is to guarantee air services in areas with inaccessible terrain or inclement weather, where land transportation is not an option because of the distance to the nearest city center. In other cases, the focus is on guaranteeing a connection to the national air transport network, in places that are unable to produce sufficient demand to attract commercial services. Some policies guarantee a minimum domestic flight supply when flight frequencies are necessary but low. The policy objective may also be to promote national cohesion by maintaining services in sensitive areas such as the outermost territories or islands. In some countries national governments are responsible for managing PSO (Iceland, Ireland, Portugal, Norway and Sweden), while in France, Germany, Italy, UK and Spain, it is task of regional authorities (Williams & Pagliari, 2004). Vast diversity in the selection of protected routes is identified across Europe and explore various aspects of the obligations that authorities impose upon routes and operators (Merkert & O'Fee, 2013).

The differences are also visible in terms of aircraft size, flight lengths, type of airline operating PSO routes, connectivity and subsidy amount. Apart from a small number of contracts with international traffic in France, Ireland and Finland, PSO routes are usually operated by national carriers and they often connect islands with the mainland market (Merkert & Williams, 2013). Williams and Pagliari (2004) provided an overview of European countries in 2001 based on percentage of total domestic scheduled seats accounted for by PSO routes, average PSO sector distance (km), and average seats per aircraft deployed on PSO routes. A comparison of subsidies granted under the PSO regime in Europe (Williams & Pagliari, 2004) reveals significant differences among and within countries in terms of the levels of average subsidy per passenger. Williams (2010) provides data showing large differences between countries in average subsidy per passenger and route maximum fares. Wittman et al. (2016) measure direct and indirect market access distinguishing three country archetypes: countries with a focus on creating access to the global air transportation network, thereby creating not only point-to-point, but also onward connectivity (US and Germany); countries with a focus on "lifeline services" which connect remote regions and islands to the nearest centers in order to provide access to important economic and societal infrastructure (UK, Norway, Finland, Sweden, Greece and Ireland), and countries with both network access and lifeline services, as PSO connect remote territories to each other and to mainland hubs (Spain, Portugal and France).

Numerous studies have analyzed the economic importance and effects of PSO implemented in European countries on the efficiency of operators. PSO routes are highly significant for remote and isolated communities and islands (O'Fee & Merkert, 2011; Calzada & Fageda, 2014). On the other hand, PSO reduce the level of competition and may have different effects in the frequencies, depending on national regulations. Evaluating the efficiency of 18 European PSO airlines (2007-2009) it is found that airlines reach better results in the early months of the PSO contract due to the absence of competition on the routes (Merkert & Williams, 2013). A pricing equation using data, at route and airline levels, for France, Greece, Italy, Portugal and Spain where a significant proportion of the territory is located on islands shows that the imposition of PSO does not seem to be effective in reducing prices (Fageda et al. 2017). Other studies analyze the implementation of the program in specific countries with the focus on air fares (Lian, 2010; Lian & Ronnevik, 2011; Calzada & Fageda, 2012; Di Francesco & Pagliari, 2012) Specificities of PSO in different regions are presented by Angelopoulos et al. (2013) – Greek routes, Pita et al. (2013) and Antunes et al. (2018) – Azores Islands, Pita et al. (2014) and Brathen and Eriksen (2018) – Norway, Devoto et al. (2016) – Sardinia, Martínez Raya and González-Sánchez (2020) – Spain, Andalusia.

Taking into account abovementioned, it is evident that there are many factors that influence the differences between the introduced systems. Great heterogeneity regarding the provision of PSO operations can be considered as positive as it allows policy flexibility for decision makers. This paper provides a continuation of analyzing the introduced PSO systems, whose contribution is reflected in the broader framework than the EU. Our paper differs from existing literature since we are mostly interested in comparison of PSO in Serbia, a non-EU state with PSO in EU states. In order to provide the comparison, an analysis encompasses 14 European countries and Serbia is presented in next chapters.

3. COMPARATIVE ANALYSIS

Based on the available data on PSO routes gathered from the list of PSO published by EU Commission for Transports (176 routes as of 18/9/2019) and the basic economic indicators of the observed countries in 2018 (Table 1), an analysis was conducted. Although Norway has the largest number of introduced routes (around 60), it is not included in this analysis for the reason that it is not a member of the EU. It should be

emphasized that a more detailed analysis was not possible due to the lack of information about passenger traffic on specific routes, actual annual seats offered and the fact that some routes were introduced in 2019.

Table 1: Socio-economic indicators of the observed countries in 2018

Country	Population (mil)	Area (thousands km^2)	Population density (people/km^2)	GDP (bil. EUR)	GDP per capita (thousands EUR)	Number of commercial airports (2019)	Number of passengers (mil) (2019)
France	67.0	547.6	122	2527.6	37.7	84+65[1]	214.3
UK[2]	66.5	241.9	275	2598.3	39.1	61	296.9
Italy	60.4	294.1	205	1896.3	31.4	42	193.1
Spain	46.8	499.6	94	1291.3	27.6	49	275.2
Greece	10.7	128.9	83	198.4	18.5	39	65.4
Czech R.	10.6	77.2	138	223.2	21.0	5	18.8
Portugal	10.3	91.6	112	219.0	21.3	23	60.0
Sweden	10.2	407.3	25	506.0	49.7	38	44.9
Finland	5.5	303.9	18	251.8	45.6	19	26.0
Ireland	4.9	68.9	71	348.1	71.7	8	36.5
Croatia	4.1	56.0	73	55.5	13.6	9	11.5
Lithuania	2.8	62.6	45	48.6	17.4	4	6.4
Estonia	1.3	43.5	30	28.0	21.2	5	3.3
Cyprus	1.2	9.2	129	22.7	26.1	2	11.1

Data source: https://databank.worldbank.org/indicator/NY.GDP.MKTP.CD/1ff4a498/Popular-Indicators and reports of CAA from different countries.

The data related to PSO routes are presented in Table 2. Although 30 of 176 routes were introduced during 2019, all available data were considered. The largest number of PSO routes and highest subsidies can be observed in France. Greece has nine routes less than France, but the annual compensation is 11 times smaller than in France. Due to different frequencies and operation costs on routes, the amount of compensation per seat is used to compare routes. This amount is calculated based on the minimum number of annual seats required by the PSO on routes with financial compensation (131 routes have compensation, but 114 were analysed due to lack of data). Compensation per seat is in range 18.23-112.33 EUR. It should be noted that the actual number of seats offered is usually greater than the required minimum. Interesting observation is related to Italy which has very high annual subsidies, but the lowest compensation per seat.

Table 2: PSO systems introduced in the EU (2018/2019) – indicators

Country	Number of PSO (dom.+int.)	Annual compensation (mil. EUR)	EUR/seat	PSO/1000 km^2	PSO/mil. inhabitants	PSO/10 bil. EUR GDP
France	33+4	92.2	29.52	0.07	0.55	0.15
Greece	28+0	8.3	63.25	0.22	2.61	1.41
Spain	23+0	1.7*	20.55*	0.05	0.49	0.18
UK	22+0	15.0	31.20	0.09	0.33	0.08
Portugal	20+0	30.8	52.59	0.22	1.94	0.91
Italy	11+0	52.1	18.23	0.04	0.18	0.06
Sweden	11+0	17.0	77.54	0.03	1.08	0.22
Croatia	10+0	13.9	30.25	0.18	2.45	1.80
Czech R.	0+3	0.8	23.04	0.04	0.28	0.13
Estonia	3+0	2.7	112.33	0.07	2.27	1.07
Finland	2+1	3.2	57.65	0.01	0.54	0.12
Ireland	3+0	8.3	50.72	0.04	0.62	0.09
Cyprus	0+1	-	-	0.11	0.84	0.44
Lithuania	0+1	4.9	80.13	0.02	0.36	0.21

Data source: The authors' calculation based on https://ec.europa.eu/transport/sites/transport/files/pso_inventory_table.pdf and Table 1.
**Not available information on 7 from 9 routes that have financial compensation, EUR/seat considering only two routes.*

Defined indicators that determine the number of introduced PSO routes by different socio-economic characteristics (surface area, population and GDP) are shown in the last three columns of Table 2. The number of introduced PSO routes per 1000km^2 of state's area is largest in Greece and Portugal, followed by Croatia and Cyprus. The average coefficient for all 14 EU Member States that have a total surface area of around three million km^2 is 0.06. Greece, Croatia, Estonia, Portugal and Sweden are well above the EU average (0.58) in terms of the number of PSO routes in relation to the total population, which indicates a

[1] The number of airports in France is 84, while number of airports in overseas French territory is 65.
[2] The UK was an EU member state in 2018. A referendum was held in June 2016, when 52% opted for leaving EU (Brexit). The last few years UK have been in a period of transition. The UK's exit date was January 31, 2020; however, it would happen by the end of 2020.

large number of introduced routes. When looking at the ratio of introduced PSO routes to total GDP (EU average is 0.17), a very large deviation of Croatia, Greece and Estonia is observed, which also indicates too many introduced routes.

From the total of 176 routes observed, 41 are open PSO routes and only nine are seasonal routes (Croatia has three, Spain and Portugal have two and Estonia and Italy have one each). Also, only ten routes (less than 6%) refer to international traffic. Routes are mostly served by domestic airlines. Only 12% of PSO routes are being served by non-domestic airline. Considering connectivity it can be seen that 36% of routes (64 of 176) connect the remote region to the capital, and as many as 65% connect the islands (33% connect the island with the mainland, and 32% of the routes are between islands). In Greece 71% of the routes connect islands with mainland, and additional 21% are being established between islands, while 15 (of 28) routes, provide the connection with Athens. Main reason for introducing PSO in Sweden is to provide connection to the capital (82% of routes). In general, the main reasons for the introduction of PSO routes are the existence of peripheral or developing regions as well as thin routes (Figure 1). The most frequently PSO justification is providing air service to/from remote area. The highest share can be observed in the case of remote region, alone or combined with the low demand and/or region development (85%).

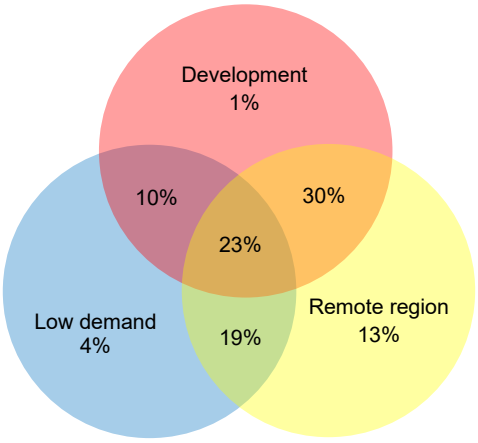

Figure 1: Reasons for introducing PSO

Given that different aircraft are used on PSO routes and that there are also large variations in terms of distance, an analysis of countries was made according to these factors as well (Figure 2). The average leg distance in the analysis indicates that over 90% of PSO routes in the EU refer to domestic air traffic. As many as 137 routes (78%) refer to short-haul flights whose length do not exceed 500km. Routes above 1000km can be observed in the case of France and Portugal (remote islands territories), Cyprus (which is island) and Lithuania (international route). Most routes up to 200km are being operated in the UK (17), followed by Spain (ten) and Greece (nine), due to the fact that all of them have rugged coastline with many small islands. Given that there are so many short-haul flights, it is not surprising that airlines use aircraft with small capacity. Aircraft with up to 20 seats are mostly used in the UK and Estonia, and partially used in France, Sweden, Croatia and France, while Italy, Cyprus and Lithuania use only larger aircraft.

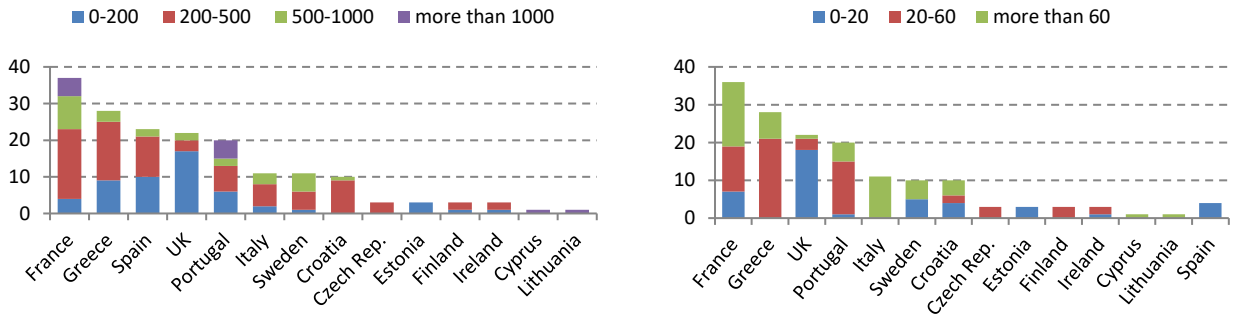

Figure 2: Number of PSO according the leg distance (left) and aircraft seat capacity (right)

Considering the analysed set of countries, some similarities related to PSO routes can be noted and three groups of countries can be distinguished. UK, Ireland, Finland Sweden and Estonia introduced PSO from the same reasons – remote (inaccessible) regions and extremely low demand. The examples are islands in UK (mostly in Scotland), Finland and Estonia, or remote places on the mainland of Ireland and Sweden with some airports located in the far north. The main feature of the airports in these regions is that they are small

airports with low annual number of passengers (several to 20 thousands of passengers, with the maximum of 60 thousands passengers per year). It should be noted that 82% of UK routes are served by small aircraft with the capacity of up to 20 seats, while in Estonia this percentage is 100. Both, small and aircraft with the capacity over 60 seats are used in Sweden.

Another group consists of France, Spain, Italy, Portugal, Greece and Croatia, where PSO routes are support to tourist area. They mostly provide connections from islands to the mainland and cities. The examples are French overseas territory (Guadeloupe, Martinique, Reunion and French Guiana – part of the mainland of South America) and Corsica in the Mediterranean; the Canary Islands in Spain; Sicily, Sardinia, Pantelleria, Lampedusa in Italy; the Azores and the Madeira archipelago in Portugal; islands in Greece and the Adriatic coast in Croatia. Considering that these PSO are tourist oriented, as well as that the distances are larger, the usage of medium and large capacity aircraft is reasonable.

Cyprus, Czech Republic and Lithuania represent the third group of countries characterized by international PSO routes that connect these countries with the large cities in the EU. The examples are Vilnius-London, Larnaca-Brussels, Brno-Munich, Ostrava-Munich, and Ostrava-Vienna. International PSO routs that represents link to large cities can also be seen in the case of France connecting Strasbourg with Madrid, Prague, Amsterdam and Munich. After highlighting the main features of the PSO schemes in EU, a comparison with scheme in Serbia should be made.

4. PSO IN SERBIA

This chapter describes introduction of PSO routes in Serbia. Routes to 12 new destinations from airport Constantine the Great which is located in Niš are announced as PSO routes by the Decision of the Government of Serbia. PSO routes are going to be subsidized by Government from 1 July 2019 to 31 December 2021. The Decision to introduce the new routes was preceded by a Government Regulation defining that PSO routes can be announced if they refer on the route to the airport which serves one or more developing regions in Serbia, as well as on the routes with traffic up to 100 thousands passengers per year to any airport. In order to be declared a public interest, the conditions are that transportation by other means of transport does not meet the needs of the region, that there is no commercial interest in operating scheduled air services, and that the route is important for the economic and social development. The Ministry of Construction, Transport and Infrastructure carried out an international tender for the selection of an airline to serve 12 PSO routes. A national airline, Air Serbia was selected, fulfilling all the requirements of a tender.

The subsidized flights to 12 European destinations (Table 3) started from 15 July 2019. The Ministry and Air Serbia signed a contract on the provision of services, which enabled connections to Nuremberg, Hanover, Bologna, Tivat, Frankfurt/Han and Gothenburg from July and to Friedrichshafen, Karlsruhe, Salzburg, Rome, Ljubljana and Budapest (which is abolished after few months) from August. All routes are flown twice a week, except for Niš-Tivat which is a seasonal route with a frequency of three flights per week (in total 25 flights per week). During the summer season routes to Nuremberg, Hanover, Bologna, Tivat, Frankfurt/Han and Gothenburg have larger frequencies than required by tender conditions (in total 31 flights per week).

The consistency of PSO introduced in Serbia is being re-examined mainly due to the differences with other PSO systems. Although Serbia is not an EU member state, it is obliged to apply all EU regulation due to the fact that Stabilization and Association Agreement between the European Union and Serbia was signed in 2008. Serbia has undertaken obligations to adequately control state aid and to prevent distortion of competition.

Government Regulation was adopted on the basis of EC Regulation 1008/2008, but there are several important differences between them. EC Regulation underlines that PSO could be designed to lift hurdles to the economic and social development of regions or cities, but they cannot be established with the aim, directly or indirectly, to promote or support a particular air carrier or to develop a particular airport. The Commission considers that if the market cannot provide a satisfied level of service, then member states may consider introducing PSO routes to and from less served regions. PSO routes are most commonly used in domestic air transport, since the essence of European PSO routes is to connect regions within a country, that is, to link an underdeveloped region with an economic center. Regulation 1008/2008 does not limit PSO to routes within one and the same member state. They may very well be applied to any intra-EU route that fulfils the conditions of the Regulation. In Europe, PSO routes are mostly served by national airlines, as is the case in Serbia. The essential reason for introducing PSO routes is not fully applicable in Serbia due to the existence of good land connectivity. Alternative transport modes (bus and rail) meet the needs of the region to be connected with the capital. Domestic air traffic in Serbia could cover two routes, from Niš to Belgrade and from Niš to Kraljevo, but subsidizing only these two domestic routes would not be reasonable. Therefore, it could be said that the goal of introducing 12 international PSO routes is justified. The Niš Office for Local

Economic Development and Projects has selected the destinations of the new routes and conducted a feasibility study on routes that are not commercial but significant for the development of this part of Serbia, tourism, economy and citizens. The residents of these less developed districts certainly benefit from the routes introduced because it was up to the city and Airport to suggest potential routes of public importance that the Government could financially assist. In terms of external migration, it could be said that there are many Serbian expatriates in Austria and Germany, which largely justifies the five routes introduced to cities in Germany. Routes to Ljubljana and Tivat significantly reduce travel time to these cities. Although there is a direct flight from Belgrade to Rome, it does not exist to Bologna. Travelers wishing to reach this destination have previously had to use the airports in Timisoara or Budapest. Although Niš is farther from Belgrade than Timisoara, the airfare to Bologna is much cheaper, and the travel time to Niš is shorter due to Belgrade-Niš highway and fact that passengers do not have to cross the state border. The introduction of the Niš-Bologna route also benefits travelers/residents outside the observed area.

Table 3: PSO routes from Niš

Country	Destination	Date of route introduction	Distance (km)	Weekly frequency of return flights		Aircraft type/capacity
				Summer season	Winter season	
Germany	Nuremberg	15th July	1070	3	2	A319/125 seats
Germany	Hanover	16th July	1360	3	2	A319/125 seats
Italy	Bologna	16th July	858	3	2	A319/125 seats
Montenegro	Tivat	16th July	275	4	3	A319/125 seats
Germany	Frankfurt/Han	17th July	1330	3	2	A319/125 seats
Sweden	Gothenburg	17th July	1720	3	2	A319/125 seats
Slovenia	Ljubljana	1st August	668	2	2	A319/125 seats
Hungary	Budapest	1st August	515	2	2	A319/125 seats
Austria	Salzburg	2nd August	851	2	2	A319/125 seats
Italy	Rome	2nd August	806	2	2	A319/125 seats
Germany	Karlsruhe	3rd August	1226	2	2	A319/125 seats
Germany	Friedrichshafen	4th August	1080	2	2	A319/125 seats

In addition to being international routes, they provide connection to secondary airports rather than to hubs (Paris, Moscow, Istanbul, London or Amsterdam), which could indeed offer indirect connectivity. Considering the fact that the Niš-Budapest route was canceled due to insufficient demand, it raises the question of how important indirect connection is to the citizens of this region. This does not exclude the possibility of introducing routes to the hubs in the future, as further development of the region will also change the needs and priorities of residents.

PSO must respect the principles of transparency, non-discrimination and proportionality, which applies in particular to the required tender conditions. The tender is usually carried out in two phases - the initial tender seeks airlines that are willing to offer non-subsidized services (open PSO routes with no entry ban); the second tender invites airlines to submit bids on the basis of a subsidy (“exclusive” routes without competition). Also, the airline application deadline must be at least two months from the date of publication. It is permissible to publish a tender for a group of PSO routes, when justified for reasons of operational or administrative efficiency. The tender conducted in Serbia was transparent and published in the Official Gazette. As in many other countries, the first phase of the tender was skipped. However, the terms of the tender, such as the application deadline, the size of the aircraft required, the number of employees and the call center, may be considered discriminatory. Namely, number of required aircraft maintenance personnel (4), pilots (10), flight attendants (15), and call center staff (15) is too large. It is very difficult to organize so many employees in such a short term especially since it is required that all except the pilots must speak Serbian and all of them must have a security clearance issued by the Ministry of Internal Affairs of the Republic of Serbia, A requirement for an air carrier to operate air services on PSO routes was to have two aircraft based in Serbia not older than 20 years with a minimum of 125 passenger seats. The quality of service was related to the air carrier's ability to offer connected flights, the cabin luggage weight and the global distribution system.

In Serbia, only route to Tivat is short-haul, and as many as six routes are longer than 1000km, which leads to an average leg distance of 979km. Only Cyprus, Lithuania and France have higher average leg distances than Serbia. In Serbia, Cyprus, Czech Republic and Lithuania all PSO routes are international, but Serbia has the more introduced international routes than all considered countries in total, which is why there is a significant deviation from other countries when it comes to the length of the routes. Routes in Serbia are mostly operated by A319, in Croatia with A319, A320, Q400, CRJ-1000 and Italy requires aircraft with an average of 166 seats on half of its PSO routes. Total amount of subsidies in Serbia is 10.4 times smaller than in Italy, which has a similar number of routes, but when comparing subsidies per seat (15 EUR/seat in Serbia, based on annual estimation according to weekly frequencies, seasonality and minimum seat capacity required), the difference is smaller.

The surface area of Serbia amounts 88,360km^2, in 2018 there were about seven million inhabitants and GDP amounted 46 billion EUR (6,595 EUR per capita). All indicators that determine the number of introduced PSO routes by different socio-economic characteristics (surface area (0.14), population (1.72) and GDP (2.61)) are above the EU average. The largest deviation is in relation to the number of introduced PSO routes according to GDP. Therefore, it can be said that Serbia has more PSO routes than EU member states. Although the number of introduced PSO routes per 1,000km^2 of state's area and per million inhabitants in Serbia is less than in Greece, Portugal and Croatia.

Whether the number of routes is too large or not compared to the EU, after the introduction of PSO routes in Serbia, an evident increase in the number of passengers is noticed. From the opening of Constantine the Great Airport to the past few years, the number of passengers did not exceed 30,000. A significant shift was made by signing contracts with low-cost airlines Wizz Air (2015) and Ryanair (2016), as well as with SWISS national airline of Switzerland, after which the number of passengers increased by almost 10 times. Passenger traffic in 2018 totaled 351,581 passengers and in 2019 reached 422,255 passengers, representing a 20% growth. The average monthly growth of passenger traffic after the introduction of PSO routes at the Niš Airport was 49.2% (from Jul 2019 to Feb 2020 compared to the corresponding months in 2018 and 2019). If July is excluded as the first month (operations started in the middle of the month), the average growth rate is 54.5% with the largest deviation in October. Niš Airport handled 78,772 passengers during the first two months of 2020, representing an increase of 61.5% compared to the first two months in 2019. Overall, it added extra 29,900 passengers in just two months in 2020 and 70,674 passengers in 2019.

5. CONCLUSION AND FUTURE WORK

Public service obligations have been introduced in many countries and are being implemented worldwide. There is significant heterogeneity and imbalance between different regions across Europe regarding the delivery of PSO operations. Differences exist in terms of aircraft size, leg distances, type of airlines serving PSO routes, connectivity, objectives, subsidy amounts and administrative bodies. This paper shows that 14 observed countries can be divided into three groups. The first group (UK, Ireland, Sweden, Finland and Estonia) represents PSO routes in their original form introduced with the goal to connect remote and inaccessible areas with cities and/or the mainland using small aircraft due to low demand. The second group (Spain, Italy, France and Portugal, and Croatia partially) also connects remote, but tourist areas such as islands (or coast). The third group (Czech, Lithuania, Cyprus, and France partially) encompasses international PSO routes characterized by low demand which connect cities and may have positive impact on the development of the region. The last two groups represent new trends in air transport business. Based on comparative analysis of European PSO routes in 14 EU countries, it can be observed that PSO routes in Serbia have fit in with EU route characteristics. Considering all abovementioned, it can be concluded that Serbia belongs to the third group having international PSO routes (only 10 of 176 routes in EU are international) that connect cities from different countries. Finally, the main reason of PSO introduction in Serbia could be development of region where airport Niš is located. Generally, the expansion of the air traffic network, both domestic and international, affects the overall national development, increase global connectivity and increments the standard of living of the residents. PSO lines introduced in Serbia certainly have a positive effect. Average monthly growth of passenger traffic largely justifies the introduction of PSO routes. This is evidenced by the data on passenger traffic from the airport Constantine the Great after the introduction of PSO routes.

The contribution of the analysis from this paper is reflected in the comparison of introduced PSO schemes. An even broader framework could be achieved if all the countries that have introduced PSO routes were analyzed, regardless of whether they are members of the EU or not. More detailed analyses are possible if they include data on the number of passengers on PSO routes, frequencies, costs or the amount of compensation per seat or per RPK, but they require greater transparency in the form of data provided by states and airlines, and these could be directions for future research. This analysis of all introduced routes could indicate routes that need to be abolished and then existing capacities can be used for other destinations, which would increase direct and indirect connectivity to the global air transport network.

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E-LEARNING AS THE EMERGING LECTURING PRACTICE IN THE HIGHER EDUCATION INDUSTRY

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Abstract: *Over the last decade E-Learning as a research field has grown rapidly. E-learning can be a very effective way as additional support for traditional learning that does not require a specific time and place. Utilize of E-learning original teaching materials are becoming an effective way of learning that meet the expectation of students. The aim of this research is to examine how important role lecturers play in higher education, in order to support the distance learning process. Therefore, it was carried out a survey at the University of Belgrade in Serbia where a total of 417 students participated. For data processing, linear regression analysis was employed. Obtained results showed that the influence of lecturers and the quality of E-learning have important implications on the behaviour intention of students to use E-learning*.

Key words: *E-learning, Quality, Students Behaviour Intention, Lecturer Influence.*

1. INTRODUCTION

Constant changes and development of the modern education system are a consequence of the application of information and communication technologies (ICT). The adoption of ICT has facilitated the formulation of new pedagogical methods and the implementation of several distance learning modalities. However, in post-transition countries, such as Serbia, despite technological innovations and financial support to education, E-learning has not yet widely accepted (Farid et al., 2015). One of the motives of this work is the phenomenon of the new virus COVID 19, which caused a pandemic around the world, forcing human isolation, which disrupted the traditional education system. Universities around the world had to respond to the new challenge and ensure that studies continued at the desired level of quality, but online.

Therefore, distance learning in such a situation has become a necessity and the only way to continue the teaching process (Das De et al., 2020). The aim of this paper is to examine the influence of lecturers on quality of E-learning, which together has a significant impact on the student behaviour intention of use E-learning.

2. THEORETICAL FRAMEWORK

The literature review has exposed the gravity of the dimension the students' intention behaviour. The intention of the student's behaviour can be defined as the individual dedication of the student to perform certain behaviour (Hanif et al., 2018). At the same time, it addresses the experience of technological innovations in the learning process (Sánchez-Prieto et al., 2017). The influence of the lecturer has a great effect on the student's intended behaviour in using E-learning. It should be added that the use of ICT in education requires a constant re-examination of the importance of lecturers and universities, as well as the adequacy of the tools used in distance learning, which affect the results of the acquisition of material by students (Rodrigues et al., 2019). In addition, the ability and willingness to adopt new E-material is influenced by the personal characteristics of the student, such as the way of learning, motivation, or the level of previous knowledge (Venkatesh et al., 2003). According to Milošević et al. (2015), most authors in the literature express the opinion that the readiness of professors to introduce and use new technologies in education would contribute to the good motivation of students. Perceived Quality of E-learning differs because of the personal characteristics of each student and belongs to the subjective determinant (Uppal & Gulliver, 2018). Al-Fraihat et al. (2020) determined the quality of E-learning as a method of an alliance between the student and the education context to qualify the student. Due to the growing popularity and the growing need for E-learning, the quality of E-learning should be one of the priorities of universities in order to meet the expectations of their students and maintain the desired level of productivity. Some authors point out

that the development of E-learning is directly related to the quality of the E-learning environment (Farid et al., 2018). Therefore, the quality of E-learning is not easy to set and monitor, but it is essential for the success of this type of education (Brosser & Vrabie, 2015). Other authors describe the quality of E-learning as a difference between a student's expectations regarding that service and their experience of its use (Agariya & Singh, 2012). One should keep in mind the stakeholders can have a significant impact on the quality of E-learning, and thus, their expectations and needs should be meet properly. This brings to the fore the complexity of the E-learning quality problem (Brosser & Vrabie, 2015). Thus, the quality of E-learning is a degree to which educational institutions meet the requirements of stakeholders and interested parties (Martínez-Caro et al., 2014). Learning systems are greatly influenced by students' perceptions of lecturers as authorities (Gil-Madrona et al., 2020). The key issues in E-learning are innovative changes and support for students to become good E-students by lecturers (Levinsen, 2007). Hence, the next hypotheses are built:

H1. Lecturer Influence (LI) has a positive impact on Quality of E-learning (QEL).

H2. Lecturer Influence (LI) has a positive impact on the Students Behaviour Intention of use E-learning (SBI).

H3. Quality of E-learning (QEL) has a positive impact on Students Behaviour Intention of use E-learning (SBI).

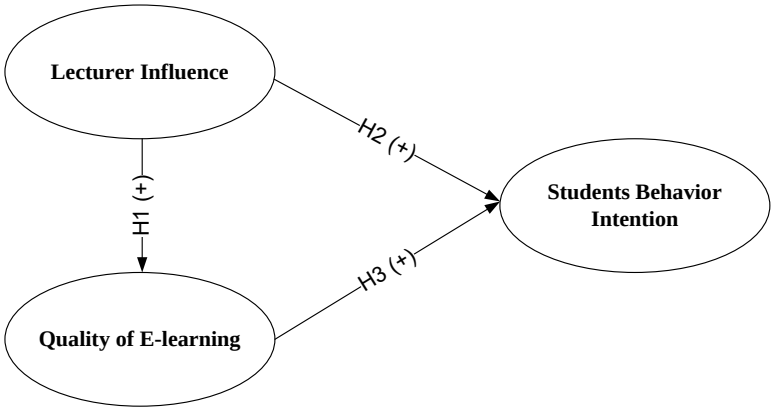

Figure 1: Conceptual model

3. METHODOLOGY

3.1 Sample and collection of data

This research was conducted at the University of Belgrade among the student. The online questionnaire was used which consisted of 2 parts of questions such as demographic characteristics and groups of questions that measure the attitudes of the respondents. A total of 417 students participated in research.

The purpose of this research was to discover if the students are familiar with the E-learning concept. The first part of the questionnaire consisted of eight questions, and the second part of the question consisted of 14 questions grouped into 3 groups. The first group of questions concerns the Influence of Lecturers that is an important component in the encouragement and the use of innovation in learning among students. Therefore, this group of the question relates to using E-learning as recommended by the faculty, and that the lecturers can help students use E-learning, as well as that the lecturers are the main authorities that initiating to use of E-learning. The dimension that measures the quality of E-learning is exclusively related to the services provided to students during the use of E-learning. Hence, the group of the question that applies to Quality of E-learning is relating concerning accurate and reliable information that students receive through E-learning; search speeds and timely retrieval of information; communications and feedback, and E-learning applications that are easy to navigate and download. Finally, the group "Students Behaviour Intention" contains questions that induce future behavioural intentions of students in self-initiated use of E-learning for study purposes. If the faculty allows it, students will use E-learning more often with the increased use of E-services in the future, as well as recommendations that the students will give to others to use E-learning given that experience they faced during the intensive usage of the digital platforms of learning during COVID 19 period. For assessment of the answers, the five-point Likert scale was employed. The defined hypotheses were tested by utilizing regression analysis and data processing were used software package SPSS v.25.

3.2. Analysis of research results

To establish the internal consistency, Spiderman Brown Coefficient (Ho, 2006), and the omega test (Nannally, 1978) was employed. The obtained resultants of reliability coefficients for all three groups of questions are within the suggested values >0.7 (Nannally, 1978; Deng & Chang, 2017) (Table 1). The internal consistency of all groups of questions was confirmed.

Table 1: Coefficient of the internal consistency

Constructs	No	Spearman Brown coefficient	Omega
Lecturer Influence	3	0.706	0.598
Quality of E-learning	6	0.740	0.726
Students Behaviour Intention	5	0.859	0.886

To investigate whether there is a relationship between two variables or two data sets, correlation analysis was used (Table 2).

Table 2: Correlation analysis

	Lecturer Influence	Quality of E-learning	Students Behaviour Intention
Lecturer Influence	1		
Quality of E-learning	0.633	1	
Students Behaviour Intention	0.357	0.565	1

Correlation and regression analyses are closely linked. Both methods encompass the relationship between two variables, with the correlation dealing with the size and direction of the relationship, while regression focuses on predicting the relationship. As for a prediction, if two variables are perfectly related, and the value of one is known, it is almost possible to predict the result of the other variable perfectly (Ho, 2006). Hence, in order to establish the functional relationship between two or more variables regression analysis was carried out. In this research, the impact of Lecturer Influence on Quality of E-learning, as well as Lecturer Influence and Quality of E-learning on the Students Behaviour Intention of E-learning, were considered.

Table 3: Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	0.636[a]	0.404	0.401	0.726	0.404	140.825	2	415	0.000
a. Predictors: (Constant), Lecturer Influence, Quality of E-learning b. Dependent Variable: Students Behaviour Intention									
2	0.633[a]	0.401	0.399	0.489	.0401	278.028	1	416	0.000
a. Predictors: (Constant), Lecturer Influence b. Dependent Variable: Quality of E-learning									

Table 3 depicts the results of R Square Change where in the first model is 0.404, which means that 40.4% of the variation of the dependent variable such as the Behaviour intention of E-learning is explained by controlled variables such as the Influence of Lecturers, Quality of E-learning. The second model represents that the R^2=0.401, which means that 40.1% variation such as the Quality of E-learning is explained by the controlled variable the Influence of Lecturers. Adjusted R Square is a set coefficient of multiple determinations that is introducing because R Square may increase incorrectly due to the introduction of new independent variables.

Statistical analysis was utilized in order to determine if the Influence of Lecturers and Quality of E-learning have important impacts on the Behaviour Intention of E-learning, as well as whether the Influence of Lecturers has significant impact on the Quality of E-learning. Table 4 presents the value of VIF that demonstrates the level of multicollinearity (Cohen & Cohen, 1983). The value of VIF is an indicator of the percentage of variation in the independent variable that does not occur in other independent variables. Very low VIF values indicate overlap or division of the predictive power of independent variables. Independent variables whose VIF values are greater than 10 are unacceptable and they must be subjected to further analysis (Ho, 2006). The defined hypotheses were tested by using regression analysis and depicted in Table 3, where the path coefficients are depicted in Figure 2. Path analysis shows that the variable of the Influence of Lecturers directly impacts the Quality of E-learning. Also, the analyzed variables (the Influence of Lecturers, Quality of E-learning) directly affect the Behaviour Intention.

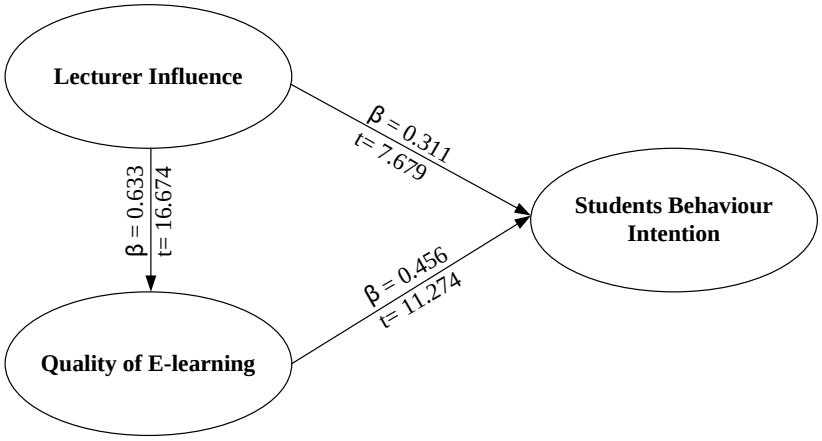

Figure 2: Path analysis

Table 4: Coeficients beta regression

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	T	Sig.	Tolerance	VIF
1 (Constant)	1.763	0.128		13.728	0.000		
Influence of Lecturers	0.519	0.031	0.63	16.674	0.000	1.000	1.000
a. Dependent Variable: Quality of E-learning							
2 (Constant)	-0.293	0.234		-1.252	0.211	-0.293	0.234
Influence of Lecturers	0.336	0.044	0.311	7,679	0.000	0.877	1.141
Quality of Elearning	0.680	0.060	0.456	11,274	0.000	0.877	1.141
a. Dependent Variable: Behaviour Intention of E-Learning							

The beta coefficient is an unstandardized measure of sensitivity or correlation between variables. In Picture 2 it is depicted that the Influence of Lecturers has the highest impact on Quality of E-learning β=0.663; t=16.674; p<0.00, that confirms hypothesis H1. Also, the Influence of Lecturers has a positive influence on Behaviour Intention to use E-learning, where the values are β=0.311.; t=7.679; p<0.00. Accordingly, hypothesis H2 is confirmed. Path analysis depicted that Beta value between Quality of E-learning and Behaviour Intention to use E-learning is positive with β=0.456, with the presence of a high level of statistical significance (t= 11.274), where the hypothesis H3 is confirmed.

4. DISCUSSION

The purpose of this research is to examine the influence of lecturers on the quality of e-learning, which together has a significant impact on the behaviour intention of students to the use of e-learning. Based on the collected data on the basis of the online questionnaire, the internal consistency of the measurement scale, and the correlation relationship between the examined constructs were examined. Then, three hypotheses were developed, which were presented by the proposed model (Figure 1) and tested by regression analysis presented by a path analysis (Figure 2).

To test the internal consistency, Spearmen Brown and Omega coefficients were used, whose values for each construct are above the recommended values of 0.7, thus confirming the reliability of the measuring scale. Table 2 presents the result of the correlation analysis for all three examined constructs. Therefore, obtained results depict that there is a positive correlation between all groups of questions with statistical significance at the level of 0.01, which confirms the same direction of variables.

This research offers an insight into which constructs are important as a prerequisite for the behaviour intention of students in the use of E-learning. The path analysis examined all variables such as Lecturer Influence, E-Learning Quality, and Behaviour Intention to use E-learning. Through the regression technique, the strength of each individual pathway was estimated. The findings show that the Behaviour Intention of students is influenced by the constructs Influence of Lecturers and Quality of E-learning. These two relationships show positive results and have statistical significance on the Behaviour Intention of students.

The importance of these relationships is confirmed by previous research that has dealt with them (Levinsen, 2007; Milošević, 2015; Farid et al., 2018; Rodrigues et al., 2019). Then, the Quality of E-learning is influenced by the Influence of the Lecturer, and also this connection is positive with a very high statistical significance. Similar findings can be seen in previous research (Delva et al., 2019; Gil-Madrona et al., 2020), that examined the relationship between the impact of lecturers and the quality of E-learning, pointing to the importance of this relation. Therefore, it can be concluded that all three hypotheses were confirmed and that they are consistent with previous research.

5. CONCLUSION

In the last decade, the educational system is facing a very dynamic development of network science and technology. The digital world is becoming the support of digital life, as well as it's the basic factor of modern life. This research aimed to examine whether the influence of lecturers plays a key role in achieving the quality of E-learning at the University of Belgrade. Besides, the paper examines the impact of dimensions such as lecturers' influence and quality of E-learning have a significant effect on student behaviour intention to use E-learning. To quantitatively show the extent to which the three variables are related, a correlation coefficient was calculated. In this research, it was discovered that there is a significant correlation among variables (Influence of lecturers, Quality of E-learning, and Behaviour intention of use E-learning). For testing the hypotheses and predicting the relationships were utilized regression analysis. Obtained results by this analysis show that all hypotheses are confirmed because of their positive direction with statistical significance. It is noted that Lecturers Influence has the highest impact on the Quality of E-learning. On the other hand, the least direct impact is noticed between Lecturer Influence and Student behaviour intention. However, additional indirect influence on the behaviour intention of students is also appeared by the Quality of the E-learning construct. In the nutshell, in order to influence the intention of student behaviour, lecturers need to contribute to the achievement of a higher quality of learning and studying .This paper is only estimated three latent variables, which is the main limitation, though, in the future, we expect to conduct research using more variables. This future study will assess students' experience with various E-learning platforms, students' expectations or their motivation to use this useful platform in their study.

ACKNOWLEDGEMENT

The research presented in this paper was done with the support of the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-68/2020-14/ 200131. Also, this research is financially supported through the projects of the Ministry of Education, Science and Technological Development of Serbia, No. III47003.

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E-BUSINESS AS A PRECONDITION FOR QUALITY AND SUSTAINABLE DEVELOPMENT OF DYNAMIC TRANSFORMERS IN THE ECONOMY

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Abstract: *Technological progress spreads rapidly and it is followed by continuous development and improvement of the electronic environment. The enterprises are interested in evolving E-business for creating a competitive advantage in the dynamic digital market. To achieve a long-term competitive advantage, E-business needs to focus on quality and sustainable development. The aim of this paper is to examine the current possibility of digital technologies in SMEs in Serbia and to analyze E-environment tools as a basis for improving E-business and achieving higher quality. For this purpose, four features that affect the progress of E-business in Serbia were investigated, such as computers and computer networks in enterprises; availability of Internet in enterprises; business analysis through websites and E-commerce, the impact of social networks, and using of cloud services. For the needs of the research, secondary data were used and conclude that Serbia continuously improves factors that impact on E-business.*

Keywords: E-business, Digital technology, Quality, Sustainable Development, Entreprises

1. INTRODUCTION

Internet technologies have been adopted by many enterprises all over the world to advance business and improve the execution of their activities. Enterprises invests a lot of money on information and communication technology (ICT) to develop process abilities and increase quality, and therefore to improve their competitiveness (Benitez, 2018). One of the most important trends we observe in an increasingly digitized landscape is that Internet technology allows enterprises and individuals to interact across the earth. There are factors in the electronics market as well as in the classic market, such as the development of new technologies globalization, consumers that are sensitive to the price, Internet, new communication, and distribution channels that influence development entrepreneurship (Ščeulovs & Gaile-Sarkane, 2014).

The advantage of using ICT is an increasing challenge for developing countries, such as Serbia. Nowadays, enterprises have a lot of benefit from e-business. Digital technologies are transforming economic sectors and empower them to do run faster and better in their business activities. The scientific research depicts that proper and skillful use of ICT can provide significant development of enterprises. The growth of digital technologies occurs quickly and the E- environment constantly develops and improves with it.

Small and medium enterprises (SMEs) are the headstone of many economies. The SMEs covers 95% of enterprises in the world (Hadi Putra & Santoso, 2020). As the largest part of the Serbian economy, SMEs provide as much as 99.8% of the available jobs (www.statistics.rs). They create over 70% of value added, generate 56% of employment, and contribute 46% of the overall exports. That indicates good conditions for the development of tools for E-business in SMEs in Serbia. The purpose of this paper is to investigate the current potential of ICT in SMEs in Serbia and to analyze internet business environments as a basis for advanced the E-business and achievement of a higher quality of business performances. The rest of the paper is organized as follows. First is presented the importance and variety of E-business in the previous empirical studies. Second, the legal framework of E-business in Serbia is represented. After that, the next section is explained methodology that was used for data analysis and summarized the results of the study. Finally, the conclusion of the paper and findings are in the last section.

2. THE IMPORTANCE AND TYPES OF E-BUSINESS

A new business model such as E-business transforms the essential business processes between regulatory parties, business partners, communities, employees, customers, and suppliers, causing comprehensive changes in the way businesses operate (Wu et al., 2011). One of the major changes in the business in the digital era is the adjustment of the electronic environment and the Internet of entrepreneurial needs. The term “E-business” first was defined by IBM's marketing and Internet team in 1996 (Amor, 1999; Gerstner, 2002). E-business activities include the sharing of job data, evolving business models, and maintaining business relationships by way of inter-organizational information systems. According to Pilinkiene et al. (2013), E-business can be defined as a set of tools and processes which enables enterprises to use the Internet on the based information technologies. Basically, E-business is about handling business electronically via the Internet. Therefore, E-business systems are described as any economic or administrative transaction or transfer information that organizations make available through the digital network (Cegarra-Navarro et al., 2007).

Realizing E-business is a good way for enterprises to improve employee job efficiency and productivity by using enterprise applications. E-business conducts and integrates different digital technologies, such as enterprise applications which consist of systems, including customer relationship management systems, and knowledge management systems, trust mechanisms, enterprise resource planning systems, and supply chain management systems (Lai & Chen, 2009). In previous research has verified that E-environment ensures a lot of opportunities and possibilities for enterprises, in particular for SMEs, that have restricted resources. Utilization of E-tools picks up the profitability and effectiveness of enterprises, as well as its competitiveness on the market (Ščeulovs & Gaile-Sarkane, 2014). E-business in SMEs has been examined in many scientific research (Hadi Putra & Santoso, 2020). The technology adoption model (TAM) is a method that very often uses to investigate the level of E-business utilization in SMEs. Ghobakhloo and Tang (2013) were used this method to foresee the role and intention of use E-business in SMEs.

In depends on the trading partners, there are several types of E-business: business to business (B2B), business to consumer (B2C), consumer to business (C2B), consumer to consumer (C2C), citizen to the government (C2G), government to citizen (G2C), government to government (G2G) (OECD, 1999; Chaffey, 2007; Banerjee et al., 2012; Gharib et al., 2017). Further, many types of online activities are involved in E-business. Numerous E-business solutions create different benefits for SMEs, such as enterprise resource planning, supply chain management, E-marketing, E-commerce, and others.

3. LEGAL FRAMEWORK OF E-BUSINESS IN THE SERBIA

Through an effort to reach the level of adaptation and use of IT areas that EU countries have, Serbia has adopted a strategy for the development of the information society (Serbian IT strategy, 2010). This strategy envisages, among other things, the adoption and development of e-business within organizations. Furthermore, Serbia defined the project “E-business development” (E-business development in Serbia, 2014) in which the development of E-business in SMEs (Ilin et al., 2017) is especially observed.

The first legal act in Serbia that regulates electronic business is the Law on E-Commerce, passed 2009 (Law on Electronic Commerce, Official Gazette of RS no. 41/2009). The primary aim of this Law was to define guidelines for protecting participants in E-commerce, while, on the other hand, service providers have clear defined legal frameworks for doing their business. Amendments of this Law in 2013, were related to the restricting information services and clearer and more accurate notification about illegal content (Official Gazette of the RS, no. 95/2013). Also, this Law was improved with amendments in 2019, within were more closely defined the contracts in the electronic form, sales on the Internet, and electronic commerce which is increasingly represented in the market (Official Gazette of the RS no. 52/2019).

Serbia passed the Law on Electronic Document, Electronic Identification and Trust for Electronic Transactions (Official Gazette of the RS, No. 94/2017, hereinafter - the Law). This Law regulates the use of e-documents, electronic identification, e-stamps, e-signatures, and similar elements.

This Law enabled public authorities and private organizations to perform electronic identification of people to whom the appropriate service is provided. This is especially important for the banking sector. Also, legal transmission of documents by email is now considered valid between public offices and individuals / legal entities, which is a substitute for registered mail (Official Gazette of RS, No. 94/2017).

4. USE OF ICT IN ENTERPRISES IN SERBIA

This section depicted the secondary data, which represent outcomes of a survey of the Statistical Office of Serbia about using digital technologies in enterprises in Serbia (Statistical Office of the RS, 2019). The study

was taken in April 2019 on a representative sample through a phone consultation. The survey was anonymous, and the information gathered from the study included the responses of 1597 representatives of enterprises in Serbia. From the 1359 enterprises were obtained the correct answer (85.1%). The demographic statistics of the study respondents are presented in Table 1. The survey involved nine types of industries, from the small, medium, and large enterprises from four regions in Serbia.

Table 1: The structure of analyzing enterprises (*Source: www.stat.gov.rs*)

Enterprises		Size			Region				
		Small (10-49)	Medium (50-249)	Large (>250)	Belgrade	Vojvodina	Sumadija and Western Serbia	Southern and Eastern Serbia	**Total**
Type of industries	Manufacturing industry	188	177	158	127	152	146	98	**523**
	Electricity, gas, steam and air conditioning supply; Water supply and sewage	20	23	25	13	18	21	16	**68**
	Construction	27	27	26	26	21	18	15	**80**
	Wholesale and retail trade	95	58	45	46	58	55	39	**198**
	Traffic and storage	27	27	20	17	23	19	15	**74**
	Accommodation and food service	60	30	2	31	24	18	19	**92**
	Information and communications	60	38	15	52	26	17	18	**113**
	Real estate activities; Professional, scientific and technical activities	50	47	12	50	22	22	15	**109**
	Administrative and support service activities; Repair of computers	47	24	31	53	24	15	10	**102**
	N	574	451	334	415	368	331	245	**1359**
	Percentage	**42.2**	**38.2**	**24.6**	**30.6**	**27.1**	**24.3**	**18.0**	**100**

Notwithstanding the SME area has proved trading potential in the recent years, some industries are continually growing and developing, due to the number of strong and progressive SMEs (www.ceves.org.rs). Unlike the EU, which has 6.4% of small enterprises and 1% of medium-sized enterprises, Serbia has only 3.2% small enterprises, 0.7% medium-sized, while over 96% of the economy are micro-enterprises. The obstacle is that micro-companies are infrequently able of making progress, even after building an outcome of leading quality. Hence, it is important to consider methods to encourage more SMEs so they can grow strong and successful, and to increase their possibilities to develop from small into medium and big sized companies. It is always important, as today, to understand trends and accommodate to a modern market requirements in order to achieve business sustainability. That was the main reason why the focus of this research is on small enterprises (which have 10-49 employees), medium enterprises (which have 50-249 employees) and large enterprises (which have more than 250 employees). These enterprises are the bearers of the economics of Serbia, and in the rest of the paper were evaluating the current state of all relevant features of ICT and determined the level of development of e-business in SMEs. This study included 42.2% of small, 38.2% of medium and 24.6% of large enterprises (Statistical Office of the RS, 2019).

The considered sample was including all enterprise categories and regions in Serbia. The survey was cover 42.2% small enterprises, 38.2% medium enterprises, and 24.6% large enterprises. From the region of Vojvodina was participate 27.1%, from the region of Belgrade 30.6%, a region of Sumadija and Western Serbia 24.3%, and in the region of Southern and Eastern Serbia 18.0%, as can be seen in Table 1. Regarding the type of industries analyzed in the paper, the largest number is from the manufacturing industry (523 enterprises). Then follows, wholesale and retail trade, were 198 enterprises. 113 enterprises from information, and communication. The next is from real estate business 109 enterprises and administrative and support companies' service activities 102 enterprises, while less than 100 enterprises from other types of industries were analyzed (Figure 1), (Statistical Office of the RS, 2019).

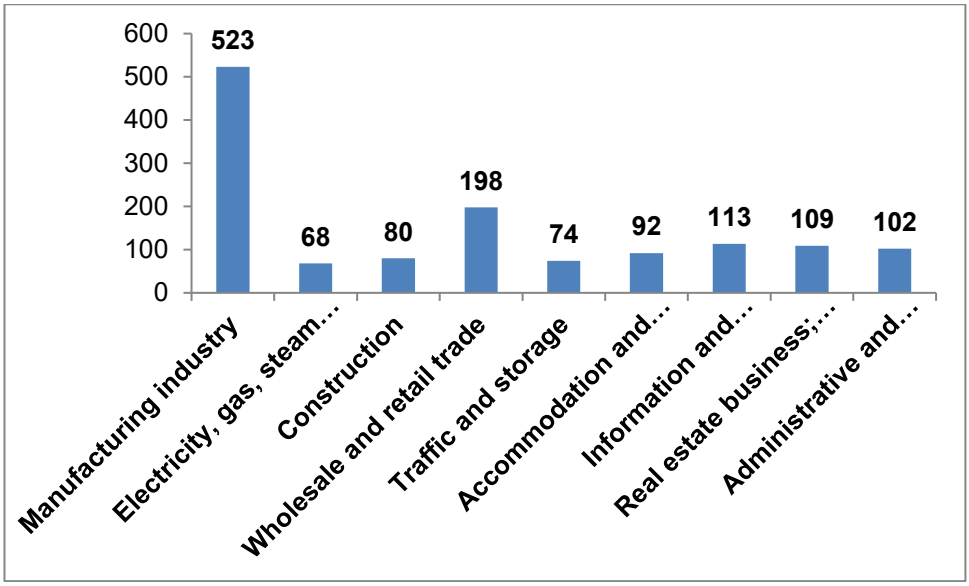

Figure 1: Analyzed types of industries
Source: www.stat.gov.rs

The main features that affect the improvement of E-business in Serbia analyzed are below: computers and computer networks in enterprises; availability of Internet in enterprises; business analysis through websites and E-commerce, the impact of social networks and using of cloud services.

4.1. Computers and computer networks in enterprises

An enterprise network is a framework for improving an organization's communication and linking computers and devices throughout departments. The computer networks in enterprises are usually configured to expedite and facilitate access to data and insight into analytics. However, there are systems that may be configured to monitor and report on a single or a particular kind of activity. These systems can or cannot capture or copy data that triggers the event. All of this depends on the application being used and the settings which were chosen (Nahm & Ishikawa, 2005).

Respondents from all categories of companies stated that they use a computer in their business (100%). In addition to the above, the conducted research also analyzed the extent to which employees use computers in business. Of the total number of companies, 30.5% stated that only a quarter of employees use computers. In 18.6% of companies, between 25-49% of the employees base their jobs on the use of computers, 13.2% of companies in a slightly larger number use computers 50-74%, and in as many as 37.7% of companies more than three quarters of employees use computers for daily activities.

A very important segment is the professional staff working in companies. Analyzing this segment by type of industry, it can be concluded that the most dominant industry that employs 76.1% of ITC professionals belong to Information and communication, while the least 7.4% of professionals are employed in traffic and storage (Statistical Office of the RS, 2019).

4.2. Availability of Internet in enterprises

By rising the use of the internet, enterprises have found means to advance main business functions to save capital, expand performance, get access to important data, boost performance, and cooperate over borders. Grasping the usefulness of the internet in business can help companies be certain to get the complete benefit of the advantages this technology can provide for companies (Denić et al., 2018). In addition to finding communication, information, acquisition, and sell products, enterprises can use the tools of the Internet for human resources and staff management, supply chain management, marketing, and accounting.

The chronological trajectory of market research on the presence of Serbian SME companies on the Internet in the last 10 years indicates an upward trend. In 2010, 96.8% of companies had an Internet connection, while according to data from 2019, this percentage is higher and amounts to 99.8%. From the entire number of enterprises that have Internet 97.1% of enterprises have a broadband Internet connection. When it comes to Internet connection speed, the largest number of companies, 43.6%, use a flow rate between 10 and 30 MB, which is the average flow rate. 79.1% of enterprises ensure portable devices which enable mobile Internet link utilization mobile telephone networks (Statistical Office of the RS, 2019).

4.3. Business analysis through websites and E-commerce

By rising the use of the Internet, enterprises have found means to advance main business functions to save capital, expand performance, get access to important data, boost performance, and cooperate over borders. Grasping the usefulness of the internet in business can help companies be certain to get the complete benefit of the advantages this technology can provide for companies (Denić et al., 2018). In addition to finding communication, information, acquisition, and sell products, enterprises can use the tools of the Internet for human resources and staff management, supply chain management, marketing, and accounting (Ibahar & Cebi, 2017).

The website is owned by 83.6% of companies in 2019, which is an increase of 1.0% compared to 2018, and an increase of 3.2% compared to 2017. The structure of websites by type of activity is shown in Figure 2.

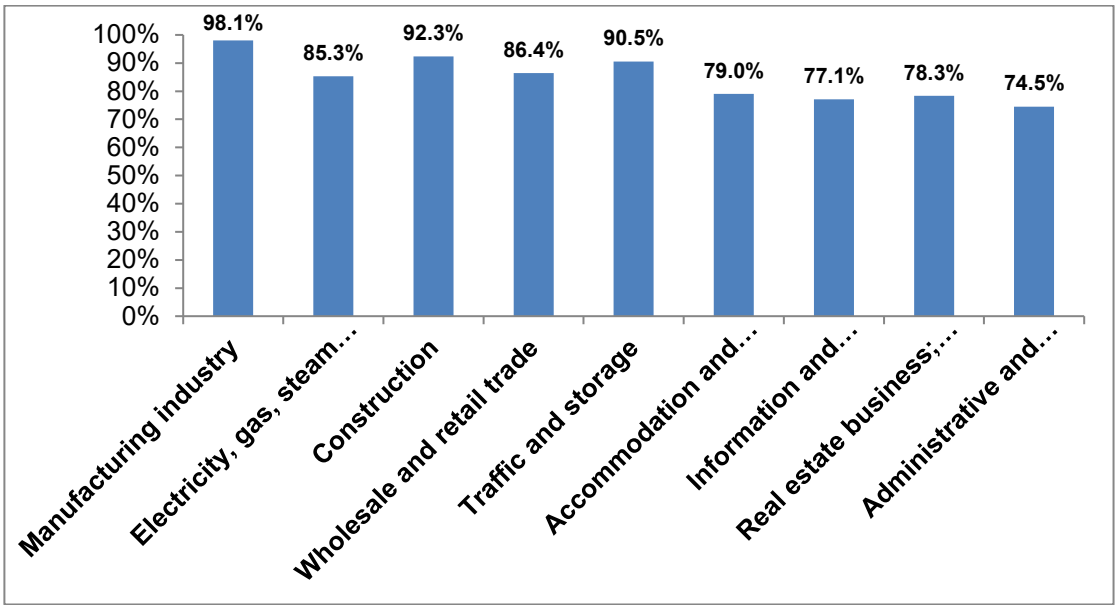

Figure 2: Number of enterprises websites in Serbia (%)
Source: www.stat.gov.rs

It can be noticed that the largest number of websites have companies in the field of Construction (92.3%) and Traffic and storage (90.5%), while companies in the field of administrative and support service activities and computer repair service use the least websites in their business. In general, the obtained results are quite encouraging because it can be spotted that enterprises in Serbia are trying to keep up with trends in the global market. Companies most often provide through the website: content on the website adapted for regular guests 79.3%, descriptive of price list and characteristic of goods or services 86.2%, and the opportunity for visitors to get acquainted with the products or services 66.6%. If we consider the composition of enterprises according to size, the following results are obtained: 93.1% of large enterprises own a website, 93.7% enterprises of medium-sized own a website, 80.5% of small businesses own a website. It can be concluded that medium-sized companies have a minimal advantage over large ones with a small percentage difference of 0.6%. The differences are noticeable depending on the territorial unit. 84.0% of enterprises in Belgrade, have a website, 91% in Vojvodina, 78.9% in the region of Sumadija and Western Serbia, and in the Region of Southern and Eastern Serbia 75.4% of enterprises, which is the least developed region in Serbia (Statistical Office of the RS, 2019).

Analyzing the parameters of E-commerce during 2018, in Serbia 42.3% of enterprises distributed products or services according to the Internet, which is a jump of only 0.4% compared to the previous year, and 0.9% compared to 2016 year. When considering the structure of the size of enterprises, we receive the following results: large, medium-sized, and small enterprises commission products or services online in the following percentage 40.3, 37.4, and 43.6, respectively. The results indicate that in the field of E-commerce, small enterprises that have implemented this modern form of shopping in their business have become the most active. While the number of enterprises that accepted orders directly from the website was only 27.5% during 2018, except for email orders via the Internet (Statistical Office of the RS, 2019).

When asked about the share of the part the overall turnover which gets on the basis of orders through the Internet, the managers of enterprises contributed the next answer, which is shown in Figure 3..

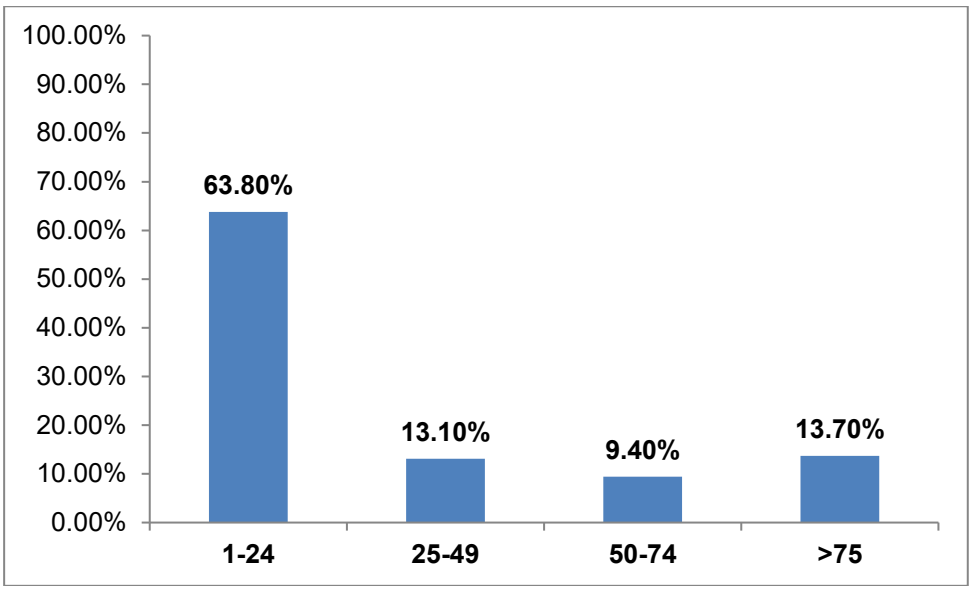

Figure 3: Share in turnover in 2018, which was realized based on online orders
Source: www.stat.gov.rs

4.4. The impact of social networks and using of cloud services

By following market trends and satisfying expectations customers, enterprises have to utilize information technology to integrate data. Social networks are very important aspects of digital business and one of the most powerful marketing channels to reach out to customers (Ioanid et al., 2018). Therefore, social networks changed the mode of the business and can help businesses to build the brand. By employing the social network strategy, enterprises can notably improve their recognition of the brand. Also, the interaction between enterprises and buyers through social networks, may improve sales and increase brand loyalty. Applying cloud services in the enterprises can get a significant effect on the business process development because it provides the unlimited capability for using resources. This concept enables enterprises to build, run, and optimize their business process by utilizing flexibility. However, due to the elasticity of the resource, these cloud services can have many problems, which can cost a lot of enterprises, when the services which provide the business processes are not optimized (Lee & Wang, 2019; Lacheheub et al., 2020).

Social networks are increasingly present in the business of enterprises. The results of the research show that 47.4% of enterprises used one of the social networks (Facebook, Instagram, YouTube, LinkedIn) for the promoting and selling activities of the enterprise. Of the total number of enterprises 35.7% are from the field of information and communication, 31.8% are from accommodation and food service and 24.9% provide real estate business services (Statistical Office of the RS, 2019).

21.9% of enterprises pay for cloud services by the Internet. Cloud services include ICT services that are accessed via the Internet for the use of software, data storage space, etc. Cloud services have the following characteristics: they are located on the servers providers, can be used at the request of the user, users pay based on the way of usage, or the capacity of the space (Statistical Office of the RS, 2019).

5. CONCLUSION

Digital technologies, which based on artificial intelligence, virtual and augmented reality, 3d-printing, the internet of things, have become part of everyday business in many enterprises. A lot of existing studies portray SMEs as slow-growing into using E-business when they compare with large companies on the market. The results of this study suggest that SMEs in Serbia is an invest significant effort in the development of digital technologies, and provide sustainable development of dynamic transformers in the economy.

The contribution of this paper is to identify the room for improving the business of SMEs in a dynamic transformation in the economy. The recommendation for SMEs in Serbia should be continuously working on their development, improving their electronic business environment through the application of modern technologies rendered in Industry 4.0. They should also manage the implementation of e-business standards as well as standards for management systems, in order to ensure competitive advantage and sustainable success.

This research has some limitations. Analyzing precondition for quality and sustainable development of E-business in SMEs is based only on secondary data from the Statistical Office of Serbia. It is necessary to include data from empirical research and investigate key factors that have an influence on the quality of E-business in SMEs.

Taking into consideration the current data on how to best improved e-business use among SMEs, in developing countries such as Serbia, in the future can take advantage of opportunities on the market afforded by E-business to expand on the new and often distant markets or supply-chains on a global level.

ACKNOWLEDGEMENT

The research presented in this paper was done with the support of the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-68/2020-14/ 200131.

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QUALITY IMPROVEMENT IN THE AUTOMOTIVE INDUSTRY BASED ON LEAN & SIX SIGMA CONCEPTS

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Abstract: *We live in a world of rapid change where organizations are focused on customers and satisfying their needs. To survive, they must find way to stay competitive by lowering costs, mistakes and waste in process. A large number of companies decide to launch improvement projects. In order to achieve measurable positive benefits, Lean and Six Sigma are used. Improvement is manifested in different ways, and the problem that will be the topic of this paper is focused on Quality Improvement. The aim of this paper is to provide an overview of Quality Improvement through Lean & Six Sigma concepts, associated methods, tools and techniques, as well as an analysis of the automotive industry. In addition to the theoretical background, in order to get an answer to the question of the role and importance of Lean & Six Sigma concepts, influence of these concepts on Quality improvement in Automotive industry, the research was performed.*

Keywords*: lean, six sigma, automotive, quality, quality improvement*

1. INTRODUCTION

Market dynamics and product complexity are two of the key factors in transition management. With the advent of mass production, economies of scale have also emerged - a concept that says that due to the increase in the volume of production, costs per unit of product decrease (Celli, 2013). Customer needs are more sophisticated, and the optimal price is expected at every moment. That is why most organizations try to find a way to increase productivity and reduce costs on a daily basis. The goal is, among other things, to achieve competitiveness on the market. As Antony, Unidoh and Gijo (2016) state in their paper, implementing a Lean manufacturing system is one of the best ways to accomplish this. The practice has shown that usage and implementation of Six Sigma methodology as an addition to Lean methodology results with an improved process, product or service that meets the customer expectations on the highest levels.

The first part of this paper is theoretical and provides an overview of the basic definitions of Quality, Quality Improvement, Lean & Six Sigma concepts and a brief analysis of the automotive industry. The second part of the paper is research whose main goal is to get an answer to the question of what role and importance Lean & Six Sigma concepts have in the automotive industry, which tools are most commonly used and what impact their application has on improving quality in the organization. The last part of the paper includes the presentation of research results, their analysis and the final conclusion of the research.

2. LITEATURE REVIEW

2.1. Quality and Quality Improvement

„Quality“ is the term which has everyday use, because people are using it for different purposes, with different entities and in different places. Quality is defined by the International Standards Organization, ISO 9000:2015 as “the degree to which a set of inherent characteristics fulfils requirements”. In order to achieve a certain quality, it is necessary to plan, design, create and improve it. ISO 9000:2015 defines quality management as coordinated activities to direct and control an organization concerning quality. The quality improvement is a part of quality management, focused on increasing the ability to fulfil quality requirements (ISO 9000:2015). To achieve quality improvement, it is necessary to reduce and reach a lower level of variation. This role is performed by preventive, corrective measures, as well as the maintenance of an improved system. The approach to quality improvement comes down to neutralizing disturbances in raw materials, processes, products and resources (Filipovic & Djuric, 2009). We can best connect this concept with Juran's trilogy of quality (Juran, 1970).

2.2. Lean & Six Sigma concepts

Lean & Six Sigma are two initiatives that represent the most effective business improvement techniques that focus on the process of continuous improvement. They are implemented to improve the business processes, eliminate shortcomings, reduce cycle time, deliver quickly with minimal costs and speed up the process in finding the best solution or ensure excellence in operational and business management (Cabarkapa & Sekulovic, 2019)

In simple terminology, the term “Lean” was defined by Womack as integrated, unique production flow, just-in-time; pull approach flexible, teamwork organization with multiple skilled workforce; active involvement in problem-solving by cause analysis, close integration from raw material to the customer through partnerships. (Gibbons & Moore, 1997). Lean's idea is to eliminate and reduce all types of waste or in Japanese "Muda”.

The most common practices related to Lean production are related to removing bottlenecks, competitive benchmarking, program of continuous improvement, time reduction, timely production, maintenance improvement, preventive maintenance, capability measurement, Kanban, quality management programs, reengineering, safety improvement programs, etc. (Shah & Ward, 2003). Although not all methods are applicable in all organizations, it is still possible to make a selection of appropriate and recommended methods (Rewers, Trojanowska, & Chabowski, 2016): Method 5S, FMEA – Failure Mode and Effects Analysis, Five why?, Kaizen – continuous improvement, Just in Time delivery (JIT), Kanban, Visual Management, Key performance indicators (KPI), Value flow mapping, Poka Yoke, Standardization of products and processes, Gemba walk, SMED Single Minute Exchange of Die, Total productive maintenance (TPM), Heijunka and Jidoka.

On the other hand, Six Sigma can be defined as a flexible and comprehensive system with the goal to achieve sustainability and maximization of business success (Francetti, 2015). The Six Sigma concept changes the classic approach to defect repair by focusing on process correction (Muralidharan, 2015). Six Sigma is one of the most well-known quality improvement methodologies that seek to address deficiencies in processes dating back to Motorola, and other organizations which have adopted this concept (General Motors, Ford, Xerox, GE, etc). The symbol for variance is represented by the Greek symbol sigma (σ). The higher the level of σ quality, the less likely it is that defects will occur in the process (Breyfogle 2003). Some of the tools that are used: Ishikawa Diagram, Brainstorming, Affinity Diagram, CTQ, Statistics, Random Sampling, Pareto Diagram, Process Capability, Multivoting, Control Chart, FMEA, Gantt Chart (Belekoukias, Garza-Reyes, & Kumar, 2014). The Six Sigma approach focuses more on quality and improved measurement, problem-solving, application of statistical tools and techniques, increased profitability, reduced process variations and damage rates (Ferrin, Miller, & Mithler, 2005).

If an organization wants to achieve the highest level of quality, it must eliminate delays and all potential losses. The quality improvement methods based on these two concepts have proven effective in many successful companies in recent years. The integration of these principles can bring great improvements because together contribute to the elimination or reduction of the shortcomings of both principles.

2.3. Automotive industry

The era of innovation and new business models which entering the market is affecting organizations to seek and develop new methods to improve process efficiency and effectiveness to reduce costs and gain new customers. There are two basic trends in this industry - specialization and increasing the competitiveness of suppliers as well as integration on a business or technological basis of final manufacturers. The quality strategy is also included in the part of the big strategy. Quality Management in the automotive industry is encouraged and promoted through the IATF 16949:2016 standard and through other international and national manufacturers' associations (Sekulovic & Cabarkapa, 2019). The automotive industry, in addition to the IT industry, is becoming one of the key industries for growth of the labor market. The growth of this trend is predicted due to the application of new technologies. (Wickham, 2017). In order to survive, this industry has put quality in the focus of its activities and work processes. In addition, savings and minimizing the negative impact on the environment are just some of today's imperatives needed for survival.

The Serbian automotive industry has a tradition of more than 70 years, dating back to 1939 in the city of Kragujevac, where Zastava, the Serbian producer of motor vehicles, produced automobiles under the license of Fiat. Zastava's suppliers manufactured under strict, high-quality production standards that enabled them to work with other western car manufacturers such as Mercedes, Ford, PSA and Opel. (Development Agency of Serbia, 2019). The first truck in Yugoslavia was produced in the Engine Industry Rakovica in 1940 when the production program of the factory was enriched by the production of the Prague RN 8 truck, under the license of the Czechoslovak company (Ministry of Economy Republic of Serbia, n.d.).

Today, the automotive industry is one of the truly prominent sectors in Serbia. By 2019, about 70 international companies have invested in this sector, which has invested more than 2.1 billion euros, according to the data of the Development Agency of Serbia. In recent years, Serbia has made efforts to present itself as a dynamic and progressive industry. According to the Development Agency of Serbia, about 50,000 people work in the field of the automotive industry. The long tradition of this industry is also revealed in the education system of Serbia.

3. RESEARCH

3.1. Research methodology

The ultimate goal of this research was to provide a real situation and a mutual connection between Quality Improvement and the application of Lean & Six Sigma concepts, in addition to the scientific literature that confirms a positive correlation among them. The data collection methods used during the research were examination and observation. The survey was conducted in two ways: through interviews with direct representatives of the target group and through a written survey distributed through the social network *LinkedIn.* The second method of data collection involved observing the object of examination on the spot, direct sensory observations, which enabled access to original, authentic data without the passage of time and data transmitters that could affect their deformation. The survey questionnaire was developed with the aim of collecting the data needed to determine the state of application of Lean & Six Sigma concepts, familiarity of employees with them and generally the impact that their application in organizations has on quality.

The target group of this research were employees in the automotive industry, regardless of the workplace and the hierarchical level in the organization. The response rate from the survey was 51.25% i.e. the questionnaire was filled out by 206 respondents out of 400 sent questionnaires.

3.2. Research results

3.2.1 Population and sample characteristics

The target group of this research are employees in the automotive industry, regardless of the organization size, workplace and the hierarchical level of them in the organization. The structure of the respondents is as follows: 42% of respondents are from organizations with over 2000 employees, 40% of respondents from organizations with 500 to 2000 employees, 16% of respondents from organizations with 100 to 500 employees, while a small percentage (4%) are respondents from organizations with less than 100 employees. These results indicate that the results of this research will actually best reflect the situation in large systems.

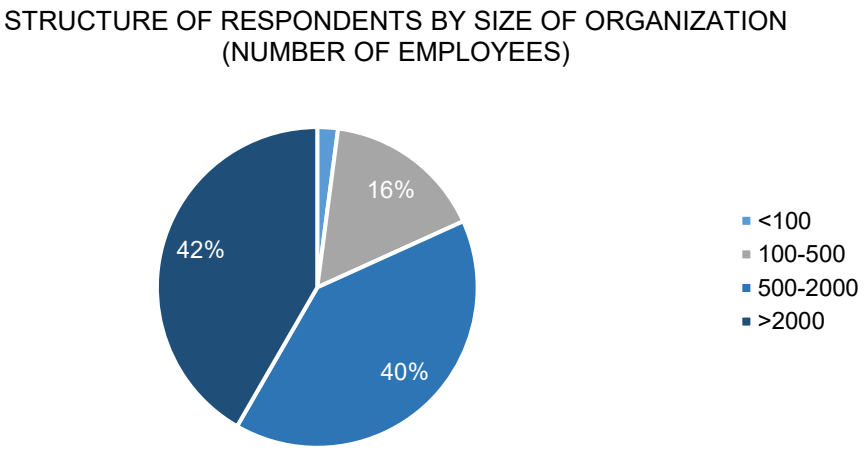

Figure 1: Structure of respondents according to the size of the organization

The idea of the research was to determine how employees at different hierarchical levels are familiar with these concepts. The greatest response is received from specialists/experts/ engineers, ie technical support for certain areas. According to Mintzberg's theory, each organization consists of five parts. The authors wanted to include employees at all levels in this research in order to get a more realistic picture.

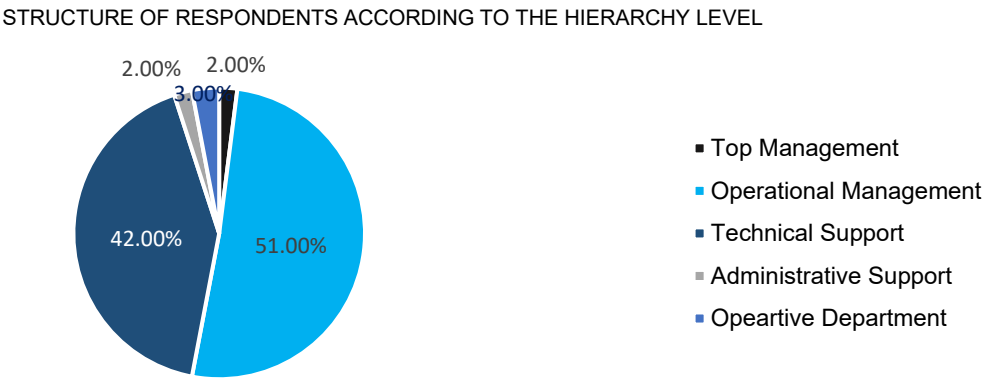

Figure 2: Structure of respondents according to the hierarchy level

3.2.2. Familiarity of employees with Lean & Six Sigma concepts

In order to check how much employees from the automotive industry are familiar with these concepts and in order to make a parallel between their level of familiarity and final results, they had a few questions to answer. The results show that 45.41% rated their knowledge of the Lean concept with the highest score, while a very small percentage of respondents gave a score of 1 (2.55%)

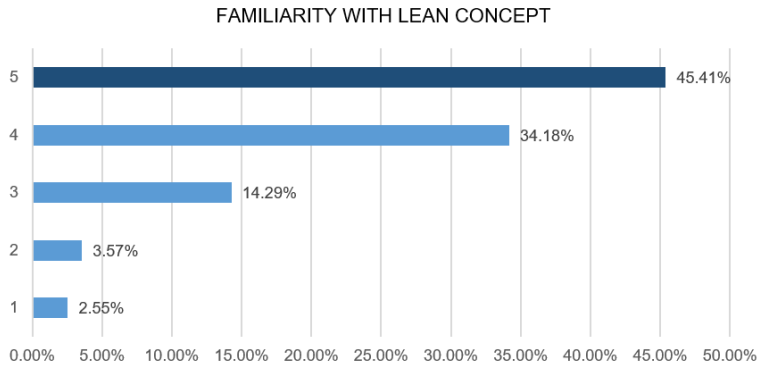

Figure 3: Familiarity with Lean concept

The distribution of answers to the question of respondent's familiarity with the Six Sigma concept is slightly different. Namely, the results show that the largest number of respondents rated their knowledge with an average grade 4 (37.76%), a slightly lower percentage with a grade 5 (28.06%). The lowest percentage of respondents gave a grade 1 (5.10%).

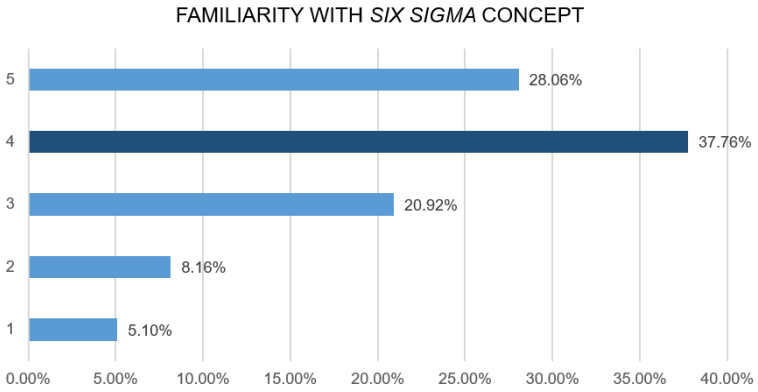

Figure 4: Familiarity with Six Sigma concept

In order to confirm and strength this data, after examining employees familiarity with the concepts, respondents had a question related to an opinion on the familiarity of other employees in their organization with these concepts. The highest percentage of respondents (42.86%) gave a grade 3, while the lowest number of respondents gave a grade 1 (2.55%).

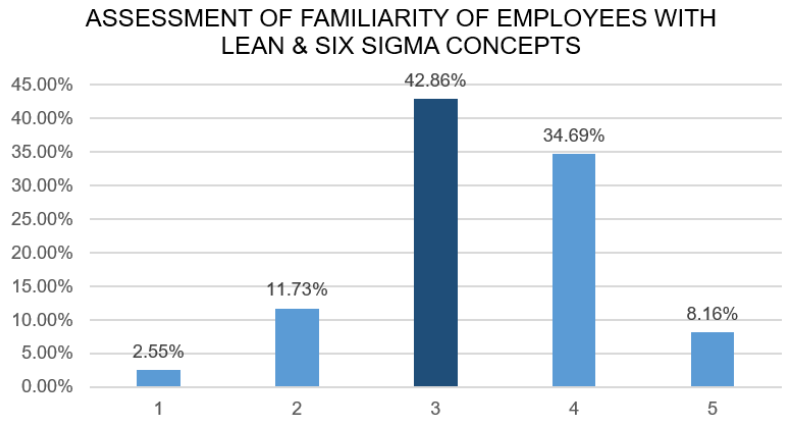

Figure 5: Assessment of familiarity with Lean & Six Sigma concepts

As the problem of employee awareness can be solved by trainings within the organization, the authors wanted to examine whether trainings on this topic are organized in these organizations at all. The results showed that 91% of respondents gave an affirmative answer, while only 9% of respondents stated that trainings are not organized.

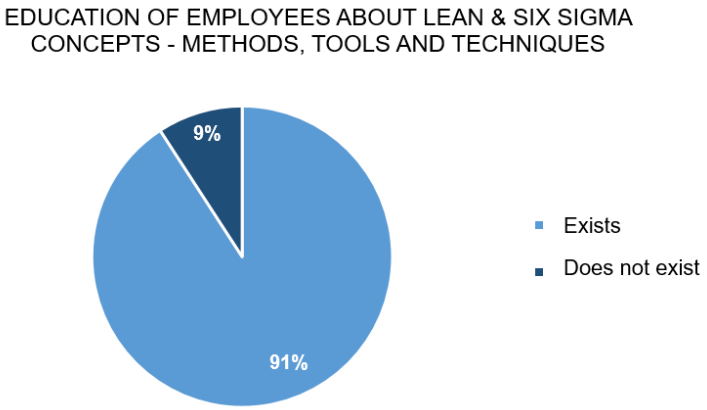

Figure 6: Education of employees about Lean & Six Sigma concepts - methods, tools and techniques

3.2.3. Application of Lean & Six Sigma tools

This part of the questionnaire was intended to determine the application, manifestation, effects of application and benefits that are achieved by applying these concepts. When asked whether and what concepts are applied in the organization, the following observation is noted: only Lean 18.37, only Six Sigma 11.73%, both Lean & Six Sigma 65.82% and other 4,8% stated that none of them are applied.

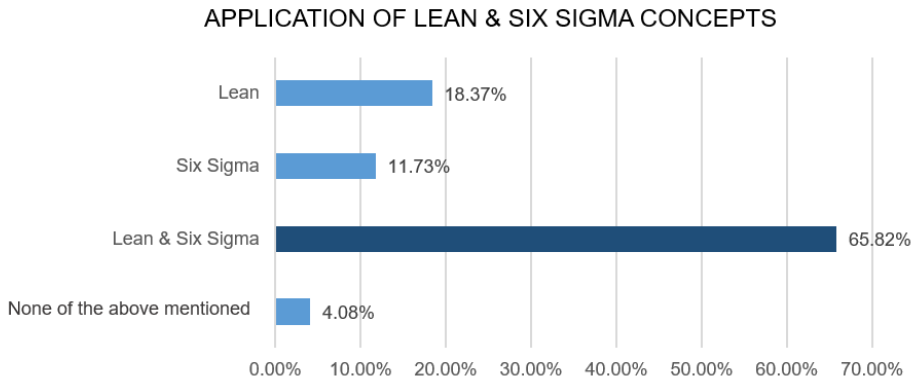

Figure 7: Applicability of Lean & Six Sigma concept

In order to determine where these concepts start, who initiates the application of the Lean & Six Sigma tools, this question was included in questionnaire. The survey showed that 37.76% of respondents indicated that it is a manufacturing sector. More precisely, not the production itself, but specially developed sectors, modeled

on the Toyota Production System (Bosch Production System, ZF Group Production System, Continental Production System, etc.). It is an interesting fact that the respondents included QUALITY in addition to this sector, connecting these concepts with it.

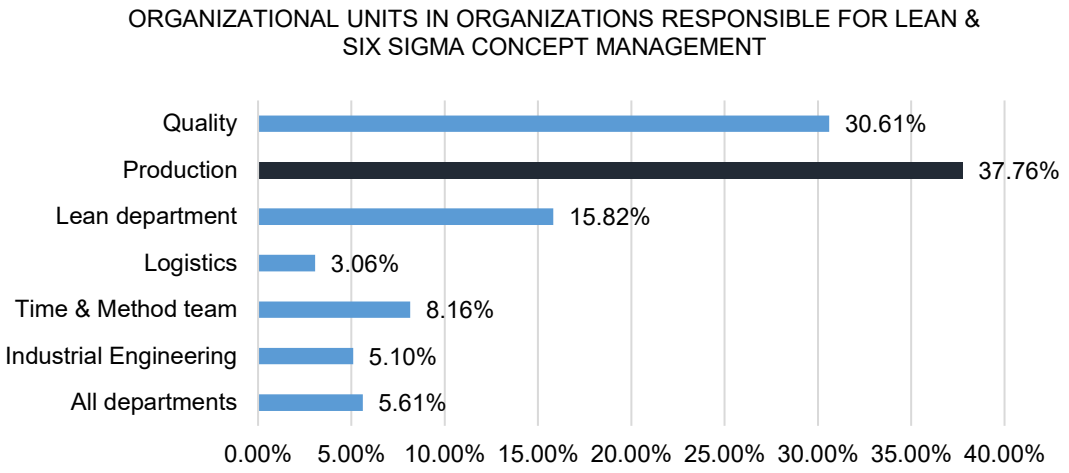

Figure 8: Organizational unit / sector in employee organizations responsible for managing Lean & Six Sigma concepts

Based on the literature review of Lean tools, and based on the interview with the employees, mainly mentioned and discussed tools are selected to be included in the list of tools.

The results of the survey (Figure 8) showed that the most common used tool is actually 5S (93.88%). In addition to this tool, standard work has been widely applied. Simply, without standardization in the automotive industry, where the complexity of machines and processes is at a very high level, the system would not be able to survive. The least used tool is Jidoka, ie automation with human intelligence. The authors of this research attribute this result to the fact that the employees are not familiar with the term Jidoka, and some details from the environment cannot be attributed to it. Also, the application of the so-called. Heijunka tools i.e. production leveling also belongs to the category of tools that are rated as less used.

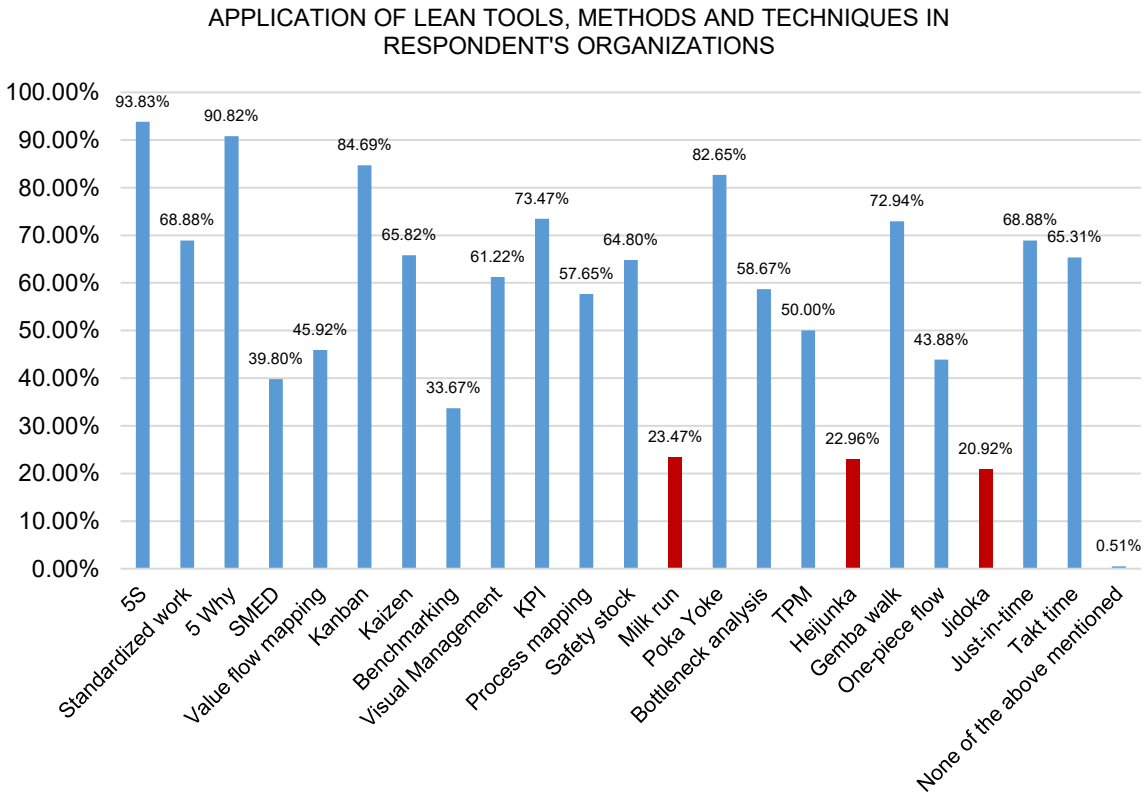

Figure 9: Application of Lean tools

As the number of Six Sigma tools is huge, the selection of was done based on most often mentioned tools in the literature. Research showed that he most commonly used Six Sigma tool is FMEA - Failure Mode & Effect Analysis (86.22%), the Process Flow Diagram (80.10%) and the Fishbone Diagram, the so-called Ishikawa diagram (78.57%). Tools - CTQ (Critical to Quality), QFD (Quality Function Deployment), and DOE (Design of Experiments) belong to the category of tools used in the smallest number of organizations.

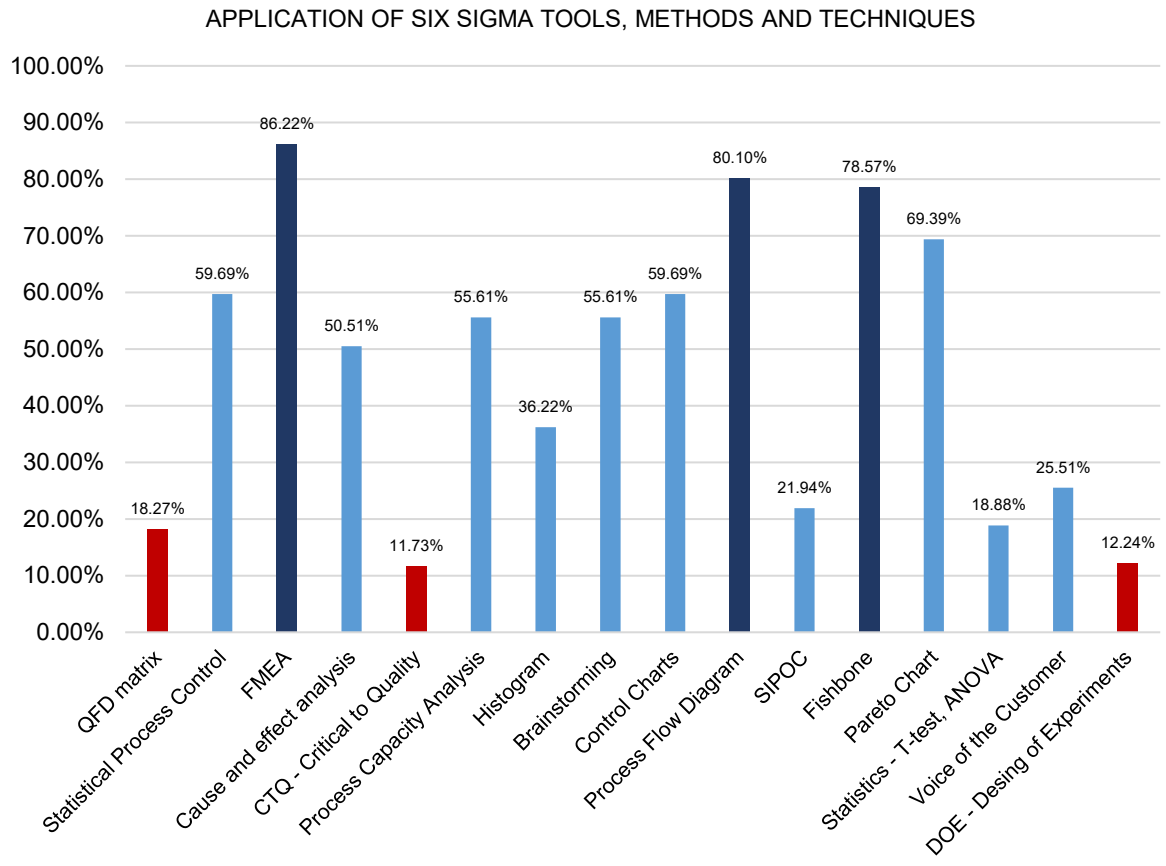

Figure 10: Application of Six Sigma tools

Tools are an important determinant in implementation of these concepts. An interview with employees of one organization showed that employees sometimes do not connect many of the tools they encounter on a daily basis with these concepts. Specifically, they do not have a broader picture of what the Lean & Six Sigma concepts actually encompass. That these tools, methods and techniques are really applied and whether it has become part of the culture of organizations is best shown by the completeness of the matrix.

The hypotheses for which they are employed are set, ie. respondents assigned a certain status ("strongly disagree", "somewhat disagree", "disagree", "somewhat agree" and "strongly agree"). The figure 11 best shows the distribution of respondents' answers.
Hypotheses:

- Resources in the organization are well used [1];
- Employees discuss work results on a daily basis [2];
- Recognizing and resolving losses is part of everyday work [3];
- Visual tools and resources are used within the organization and in its environment [4];
- Rules and procedures for each process within the organization are clearly prescribed [5];
- All employees have the opportunity to participate in the process improvement [6];
- The organization is constantly working to improve the process and organization of business [7];
- The production plant is arranged and everything is in place [8];
- Employees keep their jobs tidy [9];
- The organization is customer oriented [10];
- Employees improve their way of working every day [11].

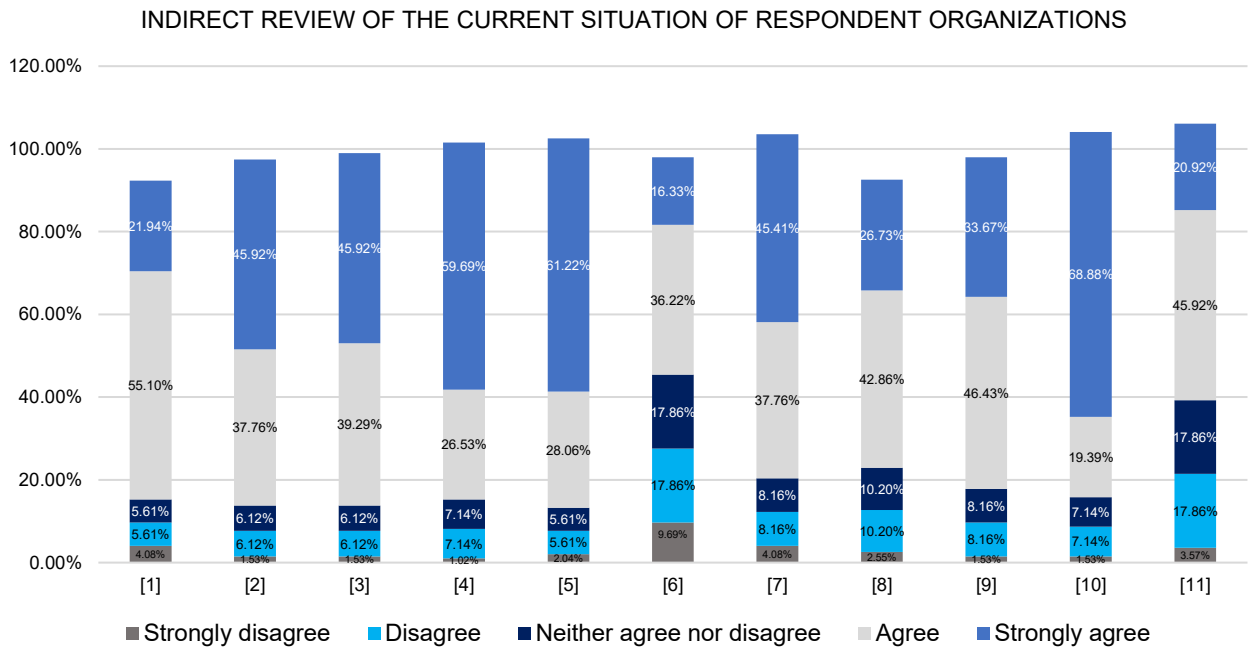

Figure 11: Indirect presentation of the current state of the respondents' organizations

3.2.4. Benefits and improvements of implementation of Lean & Six Sigma concepts

Last part of the questionnaire was intended to determine the manifestation, effects of application and benefits that are achieved by applying these concepts.

Taiichi Ohno (1988) has introduced the seven wastes, but this number has been expanded through time. Based on that, when asked which types of waste/losses the organization eliminated by applying these tools, methods and techniques, respondents answered that the largest percentage of this category includes: waiting time (64.80%), excess movement (58.16%) and production defective products (59.18%). Other categories are slightly less identified.

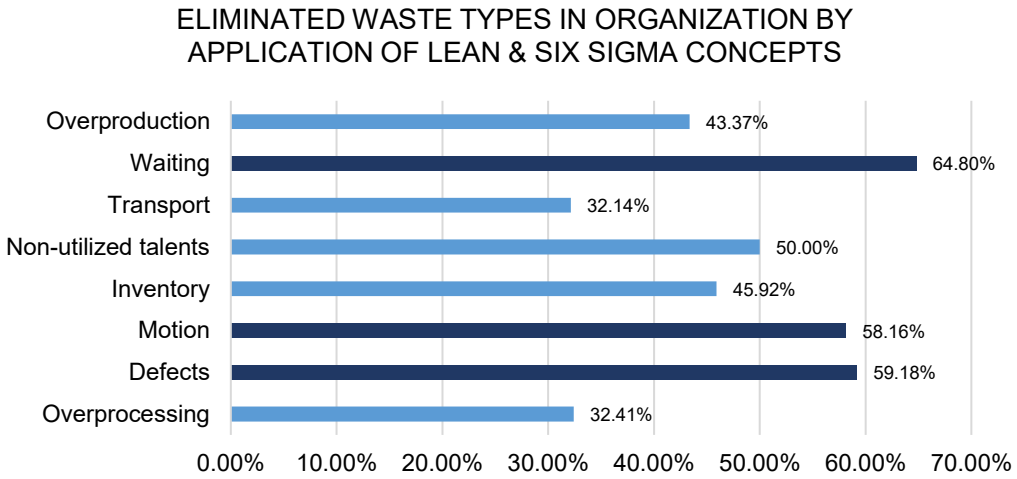

Figure 12: Types of waste / losses that the organization has eliminated by applying the tools, methods and techniques of Lean & Six Sigma concepts

In connection with that, respondents expressed their opinion on the benefits that the organization has achieved as a result of applying the Lean & Six Sigma tools. Literature review was the base for the selection of the benefits caused by implementation of Lean & Six Sigma tools. The most common benefits listed by employees:

- quality improvement,
- shortening the start-up time of machines and operations,
- reduction of the number of defective products,
- waste reduction and
- increase of productivity and capacity utilization.

The benefits for which the respondents found that the application of these tools does not have a great impact are improvement of cash flow and increase in inventory turnover.

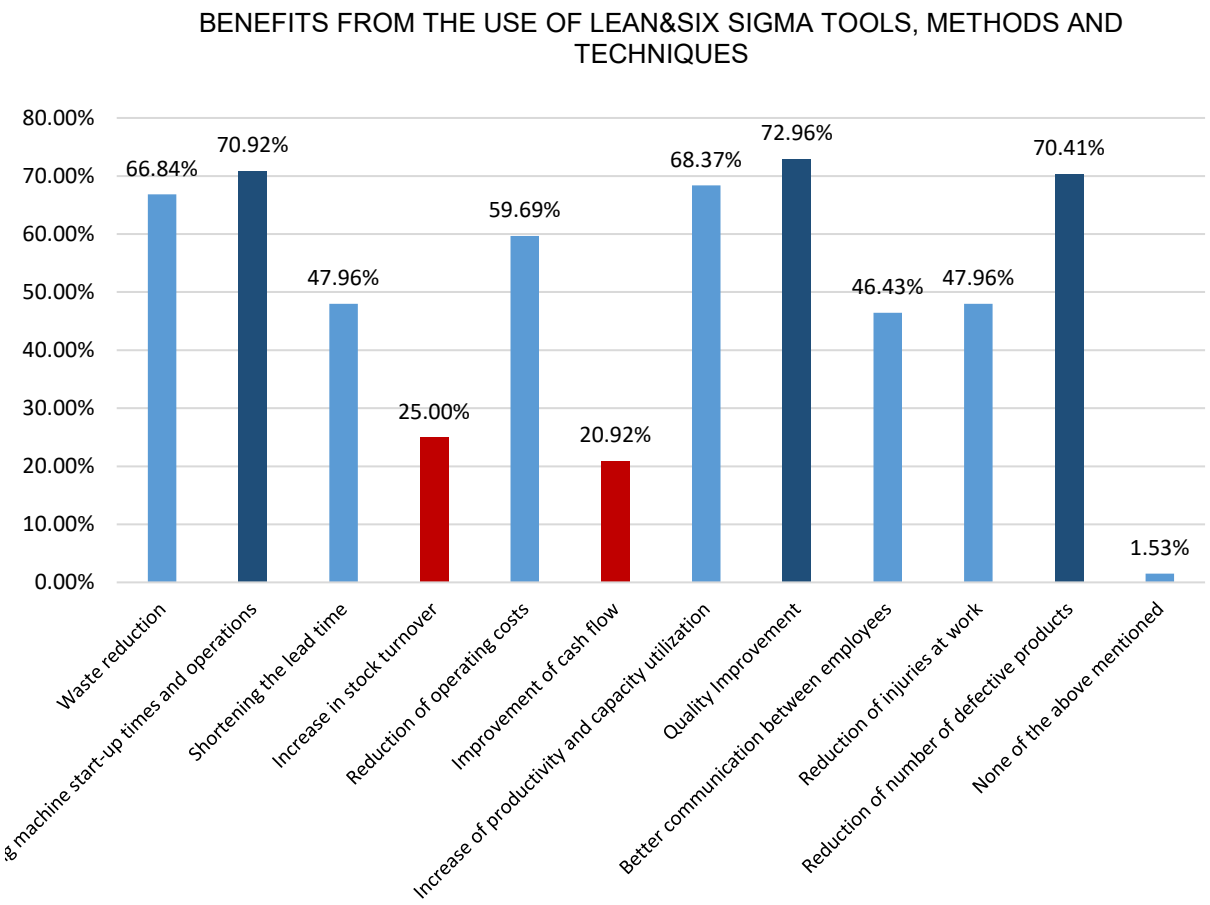

Figure 13: Benefits from the application of Lean & Six Sigma tools, methods and technique

As it could be noticed, the largest number of respondents stated quality improvement as the primary benefit of using Lean & Six Sigma tools (72.96%). In this regard, when asked to assess the potential impact of these tools, methods and techniques on quality improvement, about 60% of respondents gave a grade 5, about 30% of respondents gave a grade 4, about 7% of respondents gave a grade 3, while grades 2 and 1 gave insignificant percentage of respondents (~ 2%)

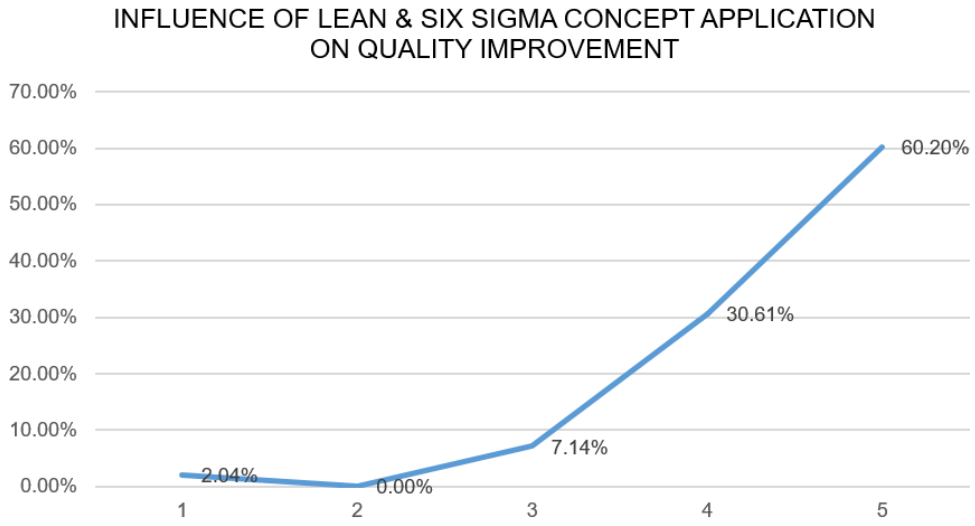

Figure 14: The impact of the application of Lean & Six Sigma concepts on quality improvement

3.3. Summary of research results

The research included questions that had the ultimate goal to confirm a positive correlation between quality improvement and the application of these concepts, a real situation and a mutual connection, in addition to the scientific literature.

As it could be noticed, this survey was filled in by employees from different sizes of organizations, but the largest number of respondents are from organizations that belong to the category of large organizations. This information is important because it indicates that the results of this research may first be related to this type of organization. The authors wanted to determine the general knowledge of these concepts and the recognition of tools, methods and techniques of the same by employees at different hierarchical levels, and included different categories of employees in the research. When selecting the respondents, the authors tried to select the employees who are mostly related to either the quality or the improvement of the system in order to avoid results that would not be relevant due to the ignorance of the matter by the respondents.

That there is a truly positive link between quality improvement and the application of Lean & Six Sigma concepts is proven in several ways:
1. Among the benefits that the respondents recognized as the most common are Quality Improvement (72.96%) and reduction of the number of defective products (70.4).

2. When asked which types of waste / losses the organization eliminated by applying these tools, methods and techniques, respondents answered that this category includes in the largest percentage: waiting time, excess movement and production of defective products (59.18%). Since each of these categories in some way affects the Quality Improvement, we can thus create and show an indirect connection and say that these tools, methods and techniques have impact on improvement of the production process and thus the production of products with defects is significantly lower.

3. Respondents in the research had a direct question concerning their assessment of the impact of the Lean & Six Sigma concept on Quality Improvement. The results showed that 60% of respondents gave the highest grade (grade 5), while 30% of respondents gave a grade 4 and then we have a slightly declining trend. This also implies that employees in this industry largely associate the results of the Lean & Six Sigma concept with Quality Improvement.

4. The completeness of the matrix best shows that these tools of methods and techniques are really applied and that they have become part of the culture of the organization. Hypotheses have been set, and employees, i.e. respondents assigned a certain status to these hypotheses. They had to evaluate every statement.
The author brings the following statements in direct connection with the improvement of quality:
- Employees discuss about work results on a daily basis;
- Identifying and resolving losses is part of everyday work;
- All employees have the opportunity to participate in the improvement and advancement of the process;
- The organization is constantly working to improve the process and organization of business.

The questionnaire included some more, but the author chose these four because they are directly related to improvement. The results show a very high percentage of respondents who confirmed and completely agreed with the accuracy of these claims. This directly implies and provides another confirmatory argument for the initial hypothesis of this paper.

5. The following facts show that the importance of these concepts for the organization is recognized:
- Familiarity of employees with the Lean concept - 45.41% rated their knowledge of the Lean concept with the highest grade (grade 5), while a very small percentage of respondents gave a grade 1 (2.55%).
- Familiarity of employees with the Six Sigma concept - the largest number of respondents rated their knowledge with an average grade 4 (37.76%), a slightly lower percentage with a grade 5 (28.06%). The lowest percentage of respondents gave a grade 1 (5.10%).
- Respondents assessed the familiarity of other employees in their organization with familiarity with these concepts. The highest percentage of respondents (42.86%) gave a grade 3, which is the expected grade, if employees from all sectors within organizations are taken into account.
- 91% of respondents confirmed that trainings on this topic are organized.

From these facts, the authors bring a preliminary conclusion that the role and importance of the application of these concepts has been recognized. In order for a concept to occupy a certain position in the organization, it is necessary for it to show good results. Good results can be associated with the greatest benefits that are recognized as a result of the application of this concept. In this case, they are improving the quality and reducing defects.

6. The authors of this paper determined that organizations in the automotive industry (according to statistics and respondents' answers) most often have the ISO 9001: 2015 and IATF 16949: 2016 standard applied. This fact is also of great importance because, according to Hoyle (2005), the purpose is to help supplier organizations in the automotive industry to establish a system that will ensure product compliance with customer requirements. Some other effects could also be continuous improvement, with emphasis on reducing variation and preventing supply chain defects.

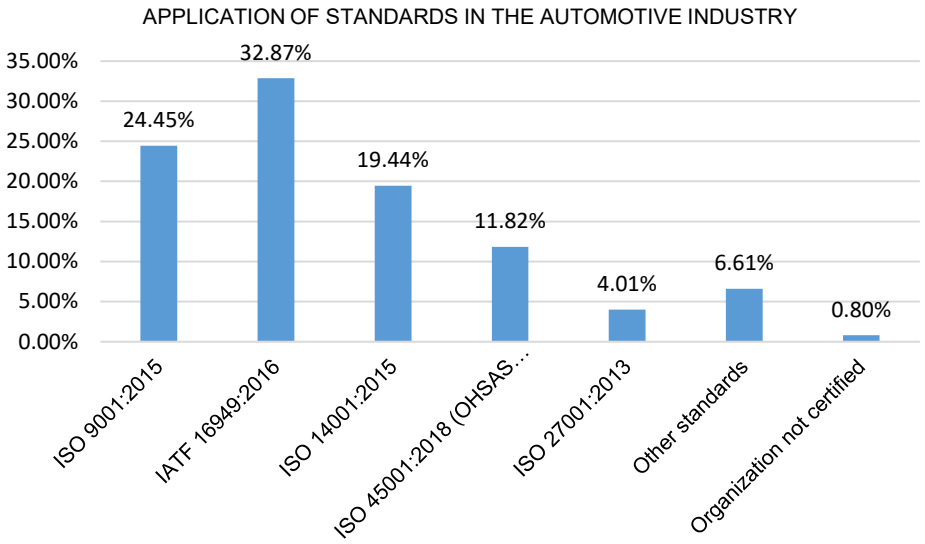

Figure 15: Application of standards in the Automotive industry

The five key pillars of the IATF 16949 standard (Bevilacqua, Ciarapica, & Giacchetta, 2011) are: Advanced product quality planning (APQP), Production part approval process (PPAP), Failure modes and effect analysis (FMEA), Statistical process control and Measurement system analysis (MSA). If we look at the key pillars of this standard, we can conclude that this also confirms positive correlation between Lean & Six Sigma concepts and Quality Improvement.

4. CONCLUSION

Realizing the set goals and tasks of the research, with the application of the established scientific methodology and the use of domestic and foreign scientific literature, conclusions were reached which adopt the general hypotheses of this paper. Everywhere, in every process, there are variations of different types and they can cause potentially unwanted results. This role is found in quality improvement, which is achieved by reducing variations to a new level. In order to achieve that, it is necessary to eliminate the causes of the problem, which is achieved through preventive, corrective measures, as well as by maintaining an improved system. Lean & Six Sigma have proven to be two initiatives that represent the most effective business improvement techniques that focus on the process of continuous improvement.

The results of the research confirmed that there is a positive correlation between the application of the Lean & Six Sigma concepts and Quality Improvement, i.e. that the application of these concepts can have both direct and indirect impact on Quality Improvement. Summarizing the results of the research and the conclusions of this paper, it can be stated that:

- there is a positive correlation between the application of Lean & Six Sigma concepts and quality improvement;
- the automotive industry is a very suitable terrain for testing and development of new methods and tools;
- employees notice the benefits and savings that are realized by applying these concepts and
- constant improvements and improvements have become an imperative of business and one of the conditions for survival in a rapidly changing market.

Like most research studies, this one has certain limitations. The biggest limitation is the sample of respondents, which consisted of employees from organizations of different sizes and different level of hierarchy. Also, what could certainly affect the results of the work is the time required for research and data collection, given the complexity of this topic. Given the complexity and breadth of these topics, the authors consider and recommend further research that can be extended to the connection of other management concepts with these concepts because, according to research conducted, the application of these concepts is increasingly permeated throughout the system.

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STANDARD ISO 50001: ADVENTAGES OF IMPLEMENTATION IN DIFFERENT INDUSTRIES

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Abstract: *This paper covers the advantages of application of the energy management system according to standard ISO 50001 in various industries. The data have been collected from the available scientific paper and empirical research conducted by companies that have already implemented standard ISO 50001. The conclusions on the advantages and disadvantages of ISO 50001 standard application have been drawn according to the comparative analysis and synthesis of the collected data from scientific papers and case studies of companies from different industries. The importance of a standard application does not depend on the industry itself, the size or geographical position but it depends on the management forms, top management financial support as well as the awareness and motivation of its employees. Recognized benefits of the implementation are significant energy savings in different industries, reduced impact on the environment, and improved reputation of companies from customers' point of view.*

Key words: *ISO 50001, energy management system, energy management, energy efficiency*

1. INTRODUCTION

At the United Nations (UN) Conference on Environment and Development, in 1992, in Rio de Janeiro, Brazil, the idea of sustainable usage of resources and preservation of the environment for future generations (SPARE) was affirmed. The importance of savings and usage of renewable energy sources for sustainable development and environmental protection (SPARE) was emphasized at the conference. In response to the importance of energy efficiency in the companies, the International Organization for Standardization (ISO) published the standard ISO 50001:2010 Energy Management Systems - Requirements with instructions for use in 2010, which should serve companies to manage energy performance and increase energy efficiency (Markovic & Savic, 2012). The requirements of the ISO 50001 standard follow the Deming PDCA (Plan-Do-Check-Act) cycle and aim to achieve sustainability (Yücel & Halis, 2016). According to the ISO 50001 standard from 2018, "energy efficiency" is defined as a quantitative relationship or other quantitative relationship between the outputs of performances, services, products or energy, and input energy. Both inputs and outputs should be clearly specified in terms of quantity and quality and should be measurable. Energy management is a "process for optimizing energy usage" (Lee et al., 2011). The ISO 50001 standard defines an energy management system as "a set of interconnected or interacting elements for the establishment of energy policy and energy objectives, as well as processes and procedures for achieving those objectives" (ISO 50001, 2018). Objectives may relate to energy availability, reliability of supply, energy efficiency, or the share of renewable energy sources in total usage or production of energy (CEN/CLC, 2010).

In line with this, the aim of this paper is to analyze and systematize the existing scientific knowledge on the implementation of the energy management system according to requirements of the ISO 50001 standard in different companies. The purpose of this paper is to reach a conclusion on the benefits of implementing the ISO 50001 standard in various industries, including both production and service-oriented industries.

2. IMPLEMENTATION OF ISO 50001 STANDARD IN DIFFERENT INDUSTRIES

2.1. Automotive industry

General Motors (GM) OBB is the largest vehicle assembly plant in Ecuador. In 2011, objectives related to energy performance and sustainability gained in high importance when General Motors took responsibility to reduce energy consumption per produced vehicle and to reduce 20% of CO2 emissions by 2020. After that, during 2016 the corporation committed, even more, when it took responsibility to supply 100% renewable

energy till 2050 (Clean energy ministerial - GM OBB, 2018). GM OBB is the first Ecuadorian industry that gained ISO 50001 certificate. In addition, the implementation of the energy system was developed as a pilot program created between the Ministry of Electricity and Renewable Energy and the United Nations Industrial Development Agency, with the aim to facilitate the implementation of this system in local industry (Clean energy ministerial - GM OBB, 2018). The approach to the application of energy management systems is based on continuous monitoring of energy metrics, together with setting effective objectives. LED lamps, a heating system through solar panels, as well as applications in charge of lighting turning on and off was launched (Clean energy ministerial - GM OBB, 2018). This allowed GM OBB to establish a baseline, an appropriate program, and to control actions focused on areas with the greatest impact on energy efficiency and improvements that contributed to the organization's performance. A parallel advantage of ISO 50001 certification was the training of a strong work team that is directly related to the engagement and development of people, in accordance with the corporate policy of GM OBB (Clean energy ministerial - GM OBB, 2018).

Nissan's energy costs represent only 3.3% of total production costs, corporate goals and customer expectations are focused on energy efficiency (Clean energy ministerial - Nissan, 2018). Nissan's Green Program promotes sustainability and sets ambitious environmental goals including an 80% reduction in CO2 per vehicle by 2050, which strengthens the reputation of the company as socially responsible (Clean energy ministerial - Nissan, 2018). The turning point of Nissan's "Green Program" was in 2016, when Nissan achieved the objective of reducing CO2 emissions by 27% in all production facilities of the company, based on tons of CO2 per vehicle compared to fiscal 2005 (Clean energy ministerial - Nissan, 2018). Nissan has demanded a commitment from its partners to energy efficiency. The company turned to the ISO 50001 standard to promote continuous improvement, to make changes in behavior fast, and to maintain success in long-term energy management (Clean energy ministerial - Nissan, 2018). Changing in the culture and convincing plant authorities to invest in energy efficiency (Giampieri et al., 2019) were a major challenge in the beginning (Clean energy ministerial - Nissan, 2018). During the initial phase of the implementation of the Energy Management System (EnMS), Nissan used the services of locally trained and certified experts (Clean energy ministerial - Nissan, 2018). Free tools provided by the U.S. Department of Energy enabled Nissan to be more disciplined and to prove the impacts of certain activities or projects on energy efficiency. The Energy Performance Indicator (EnPI) tool is proven as useful for detecting hidden energy waste and other low or no cost areas (Clean energy ministerial - Nissan, 2018).

2.2. Transport

Shenzhen Airport has established an energy management team that is interconnected on several levels (Clean energy ministerial - Shenzhen Airport, 2018). The consumption of some equipment energy and the area in use is currently measured through a digital energy management system. The statistics department of each organizational unit should record and analyze the monthly energy consumption. The team organizes an energy audit every year. Shenzhen International Airport has built a photovoltaic power plant (de Rubeis et al., 2016) with the largest installed capacity (14.5 MW) in the airport industry in China (Clean energy ministerial - Shenzhen Airport, 2018). Total energy production is 7526.52 million kWh; cost savings are about $89.45; and reduction of CO2 emissions is 69417.06 tons (Clean energy ministerial - Shenzhen Airport, 2018). Shenzhen International Airport has built the largest water storage and cold energy project in the airport industry in China, reducing power by 16.9 million kWh each year (Clean energy ministerial - Shenzhen Airport, 2018). The public area lighting system is fully equipped with LED lamps, a solar photovoltaic power plant is built, and the establishment of a research center for smart energy technology is planned. It will conduct research on green civil air travel from the perspective of best theories, patented technologies, applied technologies, and standards. Shenzhen Airport is focused on managing the green supply chain and establishing a green supply chain management system" (Clean energy ministerial - Shenzhen Airport, 2018).

The Dubai Roads and Transport Authority (RTA) has its own strategic plan and goal "Environmental Safety and Sustainability", that is in relation to clear objectives for energy performance improvement, with the key goal of making RTA an "energy-efficient organization" (Clean energy ministerial - RTA, 2018). ISO 50001: 2011 certification means that a holistic framework is implemented throughout the RTA that enables this vision to be realized. This approach has enabled the company to use the most advanced energy technologies to reduce energy usage and consumption, while increasing overall energy efficiency, including reduced energy costs and reduced carbon emissions (Clean energy ministerial - RTA, 2018). RTA has designed an energy management system that provides a systematic approach that encourages continuous improvement in order to make energy performances better. The company is focused on areas that support the reduction of CO2 emissions, such as electric buses, gas buses, subway and tram line extensions, electric taxis, hybrid buses, etc. (Clean energy ministerial - RTA, 2018). The scope of the RTA energy management system (EnMS) is defined as "regulation, planning, design, construction, management and

maintenance of integrated public transport networks in the Emirates of Dubai" (Clean energy ministerial - RTA, 2018). An EnMS project team has been established, with representatives from all operational areas and corporate departments, and includes technically qualified employees in energy, environment, sustainability, management systems, etc. The RTA energy management system can focus only on energy efficiency, not directly on energy savings because the key goal is to improve public transport in Dubai, that is to boost transport scope that will directly affect energy consumption and equivalent emissions "(Clean energy ministerial - RTA, 2018).

2.3. Banking

AIB is a financial services group operating predominantly in the Republic of Ireland and the United Kingdom and is the first financial services organization that gained ISO 50001 certification showing that certification of environmental management system is still rare in banking industry (Kılıç & Kuzey, 2019). The gradual implementation of the standard requirements has proven to be an effective approach (Clean energy ministerial - AIB, 2018). After the implementation, several non-financial benefits were noticed, such as the level of information and engagement of employees in a large organization of over 10,000 employees. All staff is energy-aware and many have contributed to improvements and opportunities to increase energy performance (Clean energy ministerial - AIB, 2018). The AIB puts a strong emphasis on operational control, training, and improving staff skills, which is a key impact on energy use. The application of ISO 50001 and ISO 14001 has significantly reduced documentation and administrative resources, as well as improved technical and systemic competence of key personnel (Clean energy ministerial - AIB, 2018). AIB has developed a top-down reporting system. Good data management and reporting system have proven to be core to managing and maintaining improvements in energy performances. Continuous development of training, awareness, and competence of all employees was the key to the success of AIB's EnMS (Clean energy ministerial - AIB, 2018).

2.4. Hospitality

Hilton has developed LightStay, a proprietary sustainability measurement system that allows each hotel to monitor and analyze over 200 sustainability metrics, including energy. LightStay, which use is needed for managing franchises all over the world through Hilton's brand standards, has enabled the company to set goals on the level of the facility, water utilization, and waste generation, as well as to track individual and collective performance in relation to corporate sustainability goals (Clean energy ministerial - Hilton, 2018; Rodríguez-Antón & Alonso-Almeida, 2019). Hilton has implemented EnMS through its LightStay system, which use is mandatory in every Hilton's facility since 2009. It managed to implement ISO 50001 in less than 12 months and to achieve cost-effectiveness from implementation in less than a year. The ISO 50001 standard has enabled Hilton to get a fast return on investment and the opportunity to lead a global improvement in the energy efficiency area (Clean energy ministerial - Hilton, 2018). Hilton's ISO 50001 certificate complemented the existing ISO 9001 (Quality Management) and ISO 14001 (Environmental Management) certificates, obtained in 2011. ISO 50001 certification has enabled Hilton to strengthen its leading position and credibility as a leader in corporate responsibility (Clean energy ministerial - Hilton, 2018). The brand standard requires hotels to enter energy, water, and waste data into the LightStay database on a monthly basis. It requires each facility to set reduction objectives and presents continuous energy, water, and waste improvement projects. With the help of LightStay's innovative and interactive engagement in hotels, Hilton has been able to institutionalize best practices in energy efficiency management and incorporate them into ongoing operations (Clean energy ministerial - Hilton, 2018).

2.5. Food industry

Bambi was a participant in the Pilot Project, which was organized in Serbia in 2016 with the support of the United Nations Industrial Development Organization (UNIDO). The project refers to the application of the UNIDO methodology in the implementation of energy management systems (Clean energy ministerial - Bambi, 2018). The company's goal is to continuously reduce its impact on the environment. Therefore, it strives to reduce the usage of natural resources and energy, the amount of waste it generates, and the emission of harmful gases as much as possible (Pradella, Loures, Costa, & Lima, 2019). Also, the company tends to continuously improve the efficiency and effectiveness of the processes and of the energy usage through continuous training of employees (Clean energy ministerial - Bambi, 2018). As a result of efforts and commitment, in June 2018, the company certified the energy management system according to the requirements of ISO 50001:2011. In addition to reducing energy consumption, the Energy Management System has enabled the company to increase process efficiency (Clean energy ministerial - Bambi, 2018). Thanks to the results of the Pilot Project, top management was fully dedicated to energy management from the implementation beginning. Reducing operating costs also allows the company to be competitive in the market in terms of prices (Clean energy ministerial - Bambi, 2018). Focusing on a simple system that is not complicated to operate, has enabled many members of the company to actively participate in all aspects of

EnMS. The knowledge gained through the application of ISO 50001 enables the simplification of other management systems in the company (Clean energy ministerial - Bambi, 2018).

2.6. IT industry

Google is the largest corporate buyer of renewable energy in the world. To reduce energy consumption, the company tends to build the world's most energy-efficient computer network by extracting more from every watt of power it consumes (Clean energy ministerial - Google, 2018). The company achieved: to equip each its office with high-performance servers, which are designed to use as little power as possible; to improve energy consumption in buildings by installing smart temperature and lighting controls and by redesigning the way power is shared in order to reduce energy losses; to use advanced cooling techniques, relying primarily on energy-efficient evaporative cooling; and finally, to apply machine learning to increase energy efficiency even more (Clean energy ministerial - Google, 2018). At the end of 2016, ISO 50001 certification covered 12 of Google's 14 energy efficiency representations, which is more than 98% of energy usage in the IT sector in 2016 (Clean energy ministerial - Google, 2018). When the ISO 50001 standard was published, the company saw it as an opportunity to establish a more structured and formalized EnMS and it gained recognition of the energy efficiency efforts by its customers. ISO 50001 is built on the basis of the "PDCA" concept, which ensures a strong energy policy and processes that strengthen EnMS, and creates a healthy audit program that confirms that EnMS is efficient, continuously monitored, evaluated and that respond to energy efficiency results while working on ways to make processes even better (Clean energy ministerial - Google, 2018). It took the company less than a year to establish EnMS. Due to the efforts of the entire company to reduce harmful gas emissions, the carbon intensity is constantly decreasing, even when the company grows the energy consumption increases (Clean energy ministerial - Google, 2018).

3. ADVANTAGES AND OBSTACLES TO ENMS IMPLEMENTATION

By analyzing previous case studies in companies from different industries, appropriate conclusions about the advantages and disadvantages of implementing the requirements of ISO 50001 can be made. Top management is responsible for energy efficiency results, but all employees in the company are engaged. The creation of energy teams that have the task to dedicatedly deal with the energy efficiency of all processes in the company leads to a clear awareness of responsibilities, tasks, and obligations to achieve defined objectives. During the implementation, it is necessary to involve all employees and insist on their commitment at all levels, because it is essential for the success of EnMS and ensures continuous improvement of energy performance. Management is there to provide the necessary resources, but also to spread enthusiasm and to motivate and reward employees who have new ideas and suggestions regarding the improvement of the energy efficiency process. The involvement of people and the development of energy culture is a crucial aspect of any implemented management system. Staff training and expertise are of great importance and each company tended to enable various training, but they did not hesitate to seek consulting help in order to reach defined objectives regarding energy efficiency as soon as possible.

The way companies measure their energy efficiency performances is different, but basically, each of them strives to have automated, transparent, comprehensive, daily, and documented systems. They tend all the results to be communicated in team meetings, to have everyone who has responsibilities involved in order to see timely the advantages and disadvantages of the business.

Even before the implementation of the ISO 50001 requirements, many companies focused their business on energy efficiency and environmental protection, which facilitated the implementation of the standard (with less staff, time, and money), but also contributed to the achievement of better results of its implementation. Companies that were already certified according to ISO 90001 and ISO 14001 were in a better position because all of the systems are based on a plan-do-check-act (PDCA) cycle. Based on case study examples, it can be noticed that the standard can be implemented in any form of business and that the size of the company does not limit its application, as well as geographical area, culture, or social conditions. States can use their subventions, pilot projects, regulations, and laws to influence companies to take more care of energy efficiency, which is in favor of these companies that already apply this standard and also impact others to strive for its implementation. "The implementation of energy management reduces energy consumption per unit of production by optimizing procedures and systems related to energy consumption" (Abdelaziz et al., 2011). Therefore, energy management helps companies to increase their profits by reducing both the threats that may arise due to environmental pollution and the direct costs of purchasing or producing energy. The selflessness in sharing experience and knowledge about energy efficiency reflects vastly the aspiration of all companies that each of them should turn to environmental protection and energy efficiency, and talk about it publicly. This can raise awareness of its importance and encourage many companies to start engaging in this process. But with the application of EnMS, companies should constantly strive to improve performance and be a leader in energy management.

Klassen and McLaughlin (1996) concluded that the market rewards companies that have received awards for investing in areas such as new or redesigned products and processes that have reduced their negative environmental impacts, improved their environmental systems, and developed strong management programs in their research. The biggest reward for the company is the increased number of customers of their products and/or services, with savings through the process of production and/or services provision.

"Some of the main obstacles in the application of energy management systems are not, as most expect, inaccessible or expensive technology. Practice shows that organizations have enough technology, even some organizations have invested very large amounts of money in the purchasing technology and modern machines. However, machines are not used in the right way, in terms of energy efficiency and the environment. In general, a large number of organizations in which the authors worked as consultants for the implementation of various management systems, the biggest problem were the people, their habits, and the existing inadequate organization. Employees are often in lack of technical knowledge, there is no systematic approach to work, the breadth and completeness in problem-solving" (Bozanic & Jovanovic, 2012).

In the case studies presented in the previous chapter, several difficulties in the implementation of EnMS are recognized. The time to implement the requirements of the ISO 50001 standard is from 11 to 18 months, and there are costs of development and implementation of EnMS, costs of new equipment, training costs, costs for certification and audit (Bozanic & Jovanovic, 2012). Much depends on the management of the company and their level of confidence in whether what they are doing is completely good and useful for the entire company. The limited resources that can be invested in energy efficiency each year must compete for priority with other important business drivers like quality, new programming models, etc. (Monari, 2008). According to the same authors, this required changes in culture and assuring plant leaders to invest in energy efficiency, which was a great challenge in the beginning. Energy efficiency has often a low priority comparing to other activities that directly bring profit to the organization, and is often separated from them. The biggest problems arise when there is no the support of top management or when they do not want to get too involved, because they do not see the obvious results of savings in the short term (Bozanic & Jovanovic, 2012). It is not easy for the energy management system to show cost savings and make a profit for the organization (Bozanic & Jovanovic, 2012).

“Obstacles to improving industrial energy efficiency are well documented and include (Monari, 2008):

- Lack of information on energy efficiency;
- Limited awareness of the financial or qualitative benefits from energy efficiency measures;
- Inadequate skills to implement such measures;
- Capital constraints and corporate culture lead to greater investment in new production capacities rather than in energy efficiency;
- Greater importance is given to solving the first costs compared to current energy;
- Costs, especially if these costs are a small part of production costs”.

3.1. Energy performance improvement analysis

By analysis of the presented case studies conclusions about the improvements in energy efficiency are made and shown in the following tables (see Tables 1-4). It is noticed that the company Google has improved its energy performance by 24% in a period of 3 years, at an annual level of 8%. Other companies, observed on an annual basis, had an improvement between 4.17% and 5.25%. Hilton is in the last place with a 2.33% improvement on an annual basis.

Table 1: Energy performance improvement analysis

Company	Energy performance improvement	Period	Per year
Google	24%	3 years	8% annually
Allied Irish Bank	21%	4 years	5,25 % annually
Rta	19%	4 years	4, 75% annually
Nissan Group	13,8%	3 years	4,6 % annually
Bambi	4,51%	1 year	4,51 % annually
Shenzhen Airport	13,12%	3 years	4, 37 % annually
GM OBB	20,85%	5 years	4,17 % annually
Hilton	18,6%	8 years	2,33 % annually

Hilton is dominantly in first place in terms of financially-related energy savings after the application of the ISO 50001 standard, with $97.963.176.25 per year, but it must be taken into account that Hilton has been applying the standard for 8 years, which is a much longer period comparing to other companies. In second place is Rta with $3.051.597.42.

Table 2: Energy saving analysis

Company	Overall energy saving after the implementation of ISO 50001		Per year
Hilton	$783.705.410	5.752.611 GJ	$97.963.176.25
Rta	$12.206.389.69	937.606.74 GJ	$3.051.597,42
Allied Irish Bank	$1.491.247	167.963 GJ	$372.811.75
GM OBB	$617.626	158.817.6 GJ	$123.525.2
Shenzhen Airport	$318.530.3	89.844.83 GJ	$106.176.77
Bambi	$110.000	8.050 GJ	$110.000
Nissan Group	$28.260	1.514.624 GJ	$9.420
Google	> $1 billion up to now (over 3 years)	/	/

3.2. Implementation cost and post-implementation savings analysis

Shenzhen Airport had a loss of $-414.089.39 for a period of 3 years after the implementation of ISO 50001 standard, due to excessive investment in the entire project of building photovoltaic panels and building the largest water storage and cold energy utilization in the airport industry in China. The company Rta had the highest earnings of $11.099.032.74 in the period of 4 years. For other companies, the implementation was cost effective, and in addition to covering the costs of implementation, earnings were successful.

Table 3: Implementation cost and post-implementation savings analysis

Company	Relation between implementation cost and post-implementation savings	Period
Shenzhen Airport	$-414.089.39	3 years
Nissan Group	$-69.740	3 years
Bambi	$+80.800	1 year
GM OBB	$+581.626	5 years
Allied Irish Bank	$+1.272.847	4 years
Google*	$+999.750.000	3 years *
Rta	$+11.099.032.74	4 years
Hilton	/	8 years

3.3. Analysis of CO2 emission reduction

The total reduction of CO2 emissions Hilton hotel achieved after the implementation of ISO 50001 is 769.356 tons, which brings it to the first place. It was influenced by the calculation period of 8 years, which is the longest observed period. Google with 3.8 million tons is in the first place, but the calculation period is not known. It can be seen that the application of the ISO 50001 standard greatly affects the preservation of the environment and the reduction of CO2 emissions in all industries.

Table 4: Analysis of CO2 emission reduction

Company	Overall CO2 emission reduction after the implementation of ISO 50001
Hilton	769.356 Metric tons
Nissan Group	132.199 Metric tons
Rta	81.362.06 Metric tons
GM OBB	20.463.44 Metric tons
Shenzhen Airport	14.959.73 Metric tons
Allied Irish Bank	9.015 Metric tons
Bambi	1.325.66 Metric tons
Google*	3.8 million Metric tons

4. CONCLUSIONS

Based on data about the implementation of energy management systems according to the requirements of ISO 50001 collected by exploring the database of existing and relevant scientific papers and empirical research of companies that have implemented ISO 50001, conclusions on the advantages of applying ISO 50001 was made. The improvement of energy performances in all observed companies in different industries is noticed. Large energy savings as well as the reduction of CO2 emissions were notices after the implementation of the requirements of the standard. The ratio of achieved energy savings and

implementation costs in most of the observed companies is positive, that is the savings are greater than the funds invested in implementation.

Based on the above, it can be concluded that the advantages of the application of EnMS are energy savings in various industries, as well as reduced environmental impact and improved reputation of the company from the customer's point of view. In addition, implementation obstacles such as lack and limited resources, long implementation period, staff training costs, equipment costs, and re/certification costs were identified. The paper limitation is scope of available case studies used for analysis although this standard could have a greater application in industries with higher energy consumption.

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SMART BUSINESS MODELS

AND PROCESSES

CONTENT

COMPENSATION MANAGEMENT IN IT COMPANIES IN SERBIA: POTENTIALS OF HR SECTOR

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Abstract: *Compensation Management is the process of creating, implementing and maintaining a reward system that is focused on improving individual, group, and organizational performance. Creating a policy of incentive compensation is complex and it is a challenge for human resource management. The aim of the paper is to indicate the development of human resource management systems in order to introduce better compensation and benefits for employees. The subject of the research was an IT company from the Republic of Serbia that employs more than 40 workers. Data relating to Compensation Management were collected using questionnaires and interviews with employees of the surveyed company. The results show the importance of establishing a quality HR sector, selecting appropriate compensation instruments and optimizing their level and structure for achieving the employee satisfaction and consequently company's strategic goals.*

Keywords: *compensation management, human resources, benefits, IT*

1. INTRODUCTION

Human resources are the most precious assets of any organization. Performing their everyday, contract-defined operations, human resources are the corner stone of any workplace (Khan, Aslam & Lodhi, 2011). In modern business, human resource management has become one of the critical factors for the success of the business system and organization development. Within human resource management, activities that are crucial for successful employee management are carried out, and they are related to job design, planning, recruitment, selection, training and development, rewarding, career development, relationship management, as well as retirement and leaving the organization (Stanl-Šušnjar & Berber, 2014).

Faster technological development challenges the old paradigm of human resources that employees are "company property". Now, the dominant new paradigm is that employees are, in fact, partners in the company (Darma & Supriyanto, 2017). According to Bhattacharyai Sengupta (2009), employees were traditionally expected to work hard and follow the instructions of superiors. In return, they had a secure job, salary and other, pre-defined incentives and compensation (bonuses, pension and rewards). With the change of organizational structure and strengthening of the human resources sector, workers' needs and Compensation Management systems also had to change. The age of globalization, in which competition among companies within the same industry is becoming stronger than before, motivates employers to improve the competitiveness, performance and sustainability of organizations through a Compensation Management system (Ismail & Abd Razak, 2017).

In order to understand compensation or its key role in modern organizations, it is necessary to understand compensation in the broadest sense. Therefore, we define compensation as the total package of rewards or payments offered by an organization to its employees (tangible and intangible, financial and non-financial, physical and psychological) (Caruth & Handlogten, 2001). In addition to financial rewards, there are employees who prefer a good work environment instead of a salary increase, because they prefer to work in a harmonious environment over a little more money for their engagement.

Khan et al. (2011) in their work state that Compensation Management is a complex process that requires accuracy and timeliness and if not implemented properly can lead to organizational problems. The ideal compensation policy encourages employees to be determined and motivated to work. It also helps organizations set realistic and measurable business standards. By creating attractive compensation packages, organizations gain competitiveness in the labor market. By leading this policy, companies will be

able to attract the most competent workers and achieve a long-term competitive advantage in the market (Ilić, Zolak Poljašević, & Vučenović, 2012).

With the arrival of foreign, multinational companies in the Republic of Serbia and inevitably increasing competition in the market, domestic small and medium-sized companies were forced to adapt and react in order to gain a competitive advantage. Aware that they do not have sufficient financial resources for "market competition", domestic companies are increasingly understanding the role of human resources and the HR sector in achieving organizational competitiveness. Research conducted by Leković and Šušnjar-Štangl (2009) states that 44% of the surveyed companies in the Republic of Serbia have a written HR strategy, while an unwritten HR strategy exists in 38% of companies, which places the Republic of Serbia in a higher rank compared to other countries.

According to official data, the average salary of employees, by sectors, for the period October 2018 - October 2019, in the Republic of Serbia is the highest in the information and communication sector (Statistical Office of the Republic of Serbia, 2020). According to the Regulation on Classification of Activities, Information Technology Activity (IT) belongs to the above mentioned sector (Official Gazette of the Republic of Serbia [SGRS], 2010). Consequently, we can say that the IT industry is currently the healthiest and most promising branch of the economy in the Republic of Serbia. In order to be able to hire the best developers at the required pace, the owners of local IT companies are trying to form a strong HR sector and provide their employees with additional benefits. Despite almost ideal working conditions, employers are faced with the lack of staff and turnover.

The aim of the research is to gain new knowledge about the importance of non-financial rewards, as well as to point out through a practical example the importance of adequate implementation of compensation policy in achieving the strategic goals of Hooloovoo. Additionally, we will show how this small domestic IT company has recognized the potentials of the HR sector in compensation management in order to compete equally with multinational IT companies, which are getting more and more present in the territory of the Republic of Serbia.

2. LITERATURE REVIEW

2.1. Compensation Management

In one of his statements, according to Maxwell (2007), Jack Welch says that if you choose the right people for your company and give them the opportunity to "spread their wings" with the reward, you will not even have to manage them. Compensation Management plays a key role in managing any organization.

In their work, Darma and Supriyanto (2017) state that compensation consists of two types: financial and non-financial. The financial compensation can be further divided into direct and indirect compensation. In the book Human Resources Management, Orlić and Ivanović (2019) also affirm that the compensation system in organizations includes direct and indirect forms of compensation and explain these terms in more detail.

Defining in a broader sense, compensation is any reward or payment given to an individual for a service rendered. It includes, but is not limited to, direct or indirect financial compensation (Caruth & Handlogten, 2001). It is actually the earnings of each employee for the work they do. Compensation refers to all forms of financial returns and tangible rewards and benefits that employees receive within the employment (Milkovich & Newman, 2004; Bhattacharya & Sengupta, 2009). Numerous scientific theories have explained that employees do not only work for money, but that there are other needs that employees want to meet through work (social and psychological needs, security needs, needs to use their potential and talent, etc.) (Khan et al., 2011).

Direct monetary compensation is the most obvious component of compensation. Sometimes referred to as cash compensation, direct compensation includes everything that involves paying cash to employees for work done or extra work (e.g., wages, salary, commission). Regardless of whether it is paid by the hour, on a monthly basis or calculated by some other method, direct compensation is the employee's discretionary income. Indirect cash payments include those things that the organization provides to its employees, which have financial value but employees do not receive money they can spend on what they want. This component of compensation is usually called a benefit. This category includes various forms of protection (health insurance, life insurance, disability insurance) and services (financial counseling, organization cafeteria, uniforms, free parking). Non-financial compensation, sometimes called psychological income, includes the opportunity for employees to do significant work, social interactions with colleagues, training, the possibility of promotion, recognition (Caruth & Handlogten, 2001). This type of compensation, whether in regular or certain periods, aims to maintain high employee morale (Resurreccion 2012).

Darma & Supriyanto (2017) define compensation as the ability and responsibility of a company to pay tribute to its employees for accomplishing a task and to show them that they value their work. Adequate compensation is one of the factors that affects employee satisfaction. Consequently, Bednarska and Szczyt (2015) state that employee satisfaction plays an important role in encouraging job-related values, such as work performance and productivity. High job satisfaction is expected to make employees more loyal to the organization, more motivated to work, feel happy at work, and ultimately increase productivity.

Compensation Management is one of the main tools for motivating company employees. Human resource management is, in fact, compensation and benefit management (Kumbhar et al., 2018). Having in mind the above, the compensation and benefits policy does not only create a link between the employer and the employee, but also conveys the message of how important the employee is to the company. Compensation Management refers to a wide range of compensation instruments that encourage the success of the individual, and consequently the success of the company. Thus, one of the basic goals of a good compensation policy is to generate the desired behavior of employees (Ilić et al., 2012).

Compensation policy, although it is a cost for the employer, it is also the basis of growth and development of the company, because it motivates the employee to work harder. Satisfaction with work and the company is the key to improve performance of any employee. Ismail and Abd Razak (2017) discuss different studies from the beginning of the 21st century and state that the research conducted by Takao and Naomi in 2017 revealed that the consciousness of Japanese companies on the importance of good Compensation Management has increased by 30% since 2000. Most importantly, the same study showed that the application of good Compensation Management increased employee productivity by between 26% and 30%. Therefore, both Bhattacharya & Sengupt (2009) state the need for modern organizations to design such a Compensation Management system that will support business goals and strategies.

2.2. Compensation management in the Republic of Serbia

In the Republic of Serbia, legal acts and regulations cover salaries and benefits. The continuation of this paper will present the most important rights of employees and obligations of the employer towards employees in the Republic of Serbia (SGRS, 2018). Employee rights include:

- the right to adequate earnings, safety and health at work, health care, protection of personal integrity, dignity of the person, rights in case of illness, reduction or loss of working capacity and old age, material security during temporary unemployment, as well as the right to other forms of protection, in accordance with the law and the general act, ie Employment Contract;
- the right to material protection in case of temporary inability to perform activities (the right to paid sick leave);
- the right to special protection during pregnancy and childbirth (female employee);
- the right to special protection for the care of the child;
- the right to annual leave (at least 20 working days), weekly leave (at least 24 hours continuously) and rest break during daily work (rest break during daily work is defined depending on daily working hours);
- the right to leave from work with salary compensation (paid leave) for a total of up to five working days during the calendar year, in case of marriage, childbirth, serious illness of a close family member, death of a close family member and in other cases determined by general act and an employment contract.

The employer is obliged to provide the employee with:

- salary for the work performed. Earnings are considered to be net earnings increased by payroll taxes, earnings contributions consisting of: contributions for compulsory pension and disability insurance, contributions for compulsory health insurance and contributions in case of unemployment (SGRS, 2020).
- reimbursement of expenses, as follows:
  - for travelling to and from work, in the amount of the price of a transport ticket in public transport (if the employer has not provided its own transport) for the time spent on a business trip in the country and abroad;
  - for accommodation and food for work and stay in the field, if the employer has not provided the employee with accommodation and food without compensation;
  - for food during work, if the employer has not provided this right in another way;
  - for recourse for the use of annual leave;
  - severance pay upon retirement (at least in the amount of two average salaries);
  - for funeral services in case of the death of a close family member, and to immediate family members in case of the death of an employee;
  - for damages due to an injury at work or an occupational disease.

According to Leković and Šušnjar-Štangl (2009), considering some elements of benefits for employees, conditions in the Republic of Serbia are more favorable compared to some countries in Western Europe and the USA (maternity leave, annual leave, unemployment insurance, it is also tolerated when an employee is fired through no fault of his own, etc.). What is evident is the problem of payment of compensation through benefits that are, as a reflection of the general low standard in the Republic of Serbia, reduced to a minimum income in cases of pension and disability insurance and unemployment insurance. The situation improved in 2008 when employers' payments to voluntary pension funds and especially in 2012 when employers' payments to voluntary health insurance (which is contracted independently of compulsory health insurance), as two forms of indirect compensation, were exempt from payroll taxes and compulsory social security contributions (SGRS, 2020). Thus, the social security of employees in the Republic of Serbia has slightly improved and approached the models that exist in developed countries. Still, this data only refers to one part of private sector and small number of public companies. Primarily in public companies in the Republic of Serbia, a reward system based exclusively on the basic salary and legally defined benefits is mostly applied. In connection with the above mentioned, there is a tendency for the younger generations to mostly decide to work in the private sector, where there is more competition and greater concern of the employer towards employees.

Therefore, in order to improve this general situation in Serbia, organizations and companies must design a system of Compensation Management that would give support to their business goals and strategies and at the same time have impact on higher levels of job satisfaction of employees. It is a task for HR sector in companies. The efficiency of HR sector is reflected on the application of good Compensation Management in companies that takes into account the needs of employees and stands as a intermediary between the employee and the employer, all with the aim of improving their performances and achieving higher goals of the company. We will try to prove this assumption by presenting a case study driven in one small IT company in Belgrade.

3. CASE STUDY

One of the domestic IT companies that recognized the importance of organized HR sector, as well as the importance of employee benefits, is Hooloovoo from Belgrade. Hooloovoo was founded in June 2016, by signing a contract with Kindred, but its start of business began two years earlier when the owner of Hooloovoo first made a deal with foreign company iGame, as an external contractor, to develop a team of five programmers. Throughout 2018, with the increase of scope of work, Hooloovoo needed a larger number of employed programmers, which reached the number of 40 by the end of 2018.

In addition to the focus on the constant engagement of quality programmers, attention was also focused on retaining the existing staff. The company had set itself high goals - to build an impressive brand and to be unique in the market. In order for all of the above to be achievable, it was not enough to offer employees only financial compensation and benefits provided by law. The company realized that it was necessary to create internal processes, in order to encourage employees to do their job the best they could, while maintaining the feeling that the company cared about them.

The owner of Hooloovoo has a clear view that the HR sector should be the bearer of a "good business culture" and to transfer and spread it through the organization. Accordingly, one of the first steps of the company in 2019 was to expand the HR sector. The way they came to hire new people in the HR sector (until then they had 2 employees), was declared the second best HR practice in 2019 in the Republic of Serbia according to domestic and foreign HR experts and associates. Through a series of professional blog texts, in the form of the campaign "I read the blog", they presented a creative solution. The end result was reflected in the employment of 2 new colleagues in HR. The crown of the campaign is the fact that they did not have to hire one of the agencies, an external partner or allocate funds. They invested only their creativity and time (HRExperience, 2019).

The expansion of the HR sector was also followed by its reorganization. Previously, as in most small companies, everyone was used to doing everything, depending on the time they had and how helpful they were. There were no precisely defined procedures, the HR sector could not organize and plan its work and follow what was happening. Most importantly, the various HR processes could not be completed to the end, both by individuals and teams. Finally, when the number of employees in the HR sector doubled, each of the programmers, either as an individual or a team, knew who to turn to and what for. Successful implementation of quality HR processes has begun and, among them, the development of indirect financial compensation and non-financial compensation with the aim of increasing the motivation of employees.

4. RESEARCH METHODOLOGY

After the successful "I read the blog" campaign, the HR sector of Hooloovoo doubled and grew from 2 employees to 4 people. Each employee in the HR sector got his own team and was in charge of implementing the HR process within it. This practically meant that each team, within the company, had a person in charge of coordination, selection and recruitment of employees for the team, performance management, administration, etc.

One of the first tasks of the HR team, after two employees in the HR sector went through a three-month period of adjustment at work in the company, was to establish a project team that would work on analyzing and improving the internal benefits program. The project team was led by the owner of the company Hooloovoo, and the team consisted of 2 employees from the HR sector and one person from the marketing department and operations and the author of this paper. They conducted a survey in 2019, in the third financial quarter (Q3). The total number of employees at that time was 46. Respondents were employed programmers at Hooloovoo who made up 41 of the 46 total employed people (the survey did not cover employees from project team).

The project team compiled a questionnaire, which was divided into two parts for the purposes of this research. When compiling the questionnaire, the team took care that the order of the questions was from simpler to more complex. The first part of the questionnaire contained a series of closed questions, where respondents expressed whether or not they used the benefits available to them. Closed questions involved compiling a list of all compensations and benefits that employees could use, both legally regulated and the benefits provided by the company (some of them were almost materially irrelevant, such as the lack of a company dress code). The second part of the questionnaire contained two open-ended questions. To the first open-ended question, respondents were asked to indicate which of the above mentioned benefits they considered unnecessary. Another open question gave the possibility to the respondents themselves suggest which benefit the company should introduce. The questionnaire was distributed to each respondent via mail.

Since the questionnaire research is a quantitative research method, after obtaining the results of the survey, and in order to obtain more detailed data from respondents and collect ideas, the project team decided to organise oral research through workshops (semi-structured interview), as a qualitative research method.

The workshops included 6-7 employees and the researchers and participants worked intensively on the topic of compensation. Interviews with participants were conducted at a convenient time for employees, so that they would not affect the quantity and quality of work tasks. Specifically, at the workshop, all financial and non-financial benefits were divided into 6 areas: health, sports, entertainment, humanitarian activities, finances and miscellaneous. Oral conversations with respondents were conducted in order for the project team to hear their opinions and learn personal experiences and observations. The discussions flowed naturally, from area to area, and the project team made an appropriate introduction in each workshop, presenting what the goal of the oral research was.

5. FINDINGS AND DISCUSSION

The results of the research showed that the project team acted correctly when, in addition to the questionnaire answered in writing, it organized an oral survey through the teams, because the questionnaire was filled out by 30 out of 41 respondents, which represented 73%.

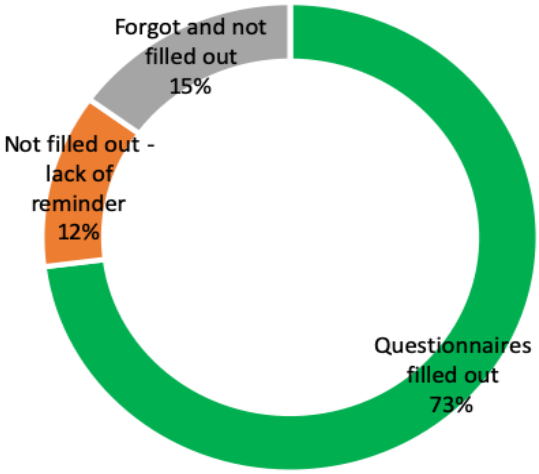

Figure 1: Number of respondents

Namely, 6 employees or 15% stated that they did not fill in the questionnaire, because due to focusing on performing daily tasks they forgot about it, while 5 employees or 12% stated during the workshop that the project team should have reminded them to fill in the questionnaire. This also reflects the importance of a quality and focused HR sector from which employees expect orientation, as well as reminders of obligations, etc.

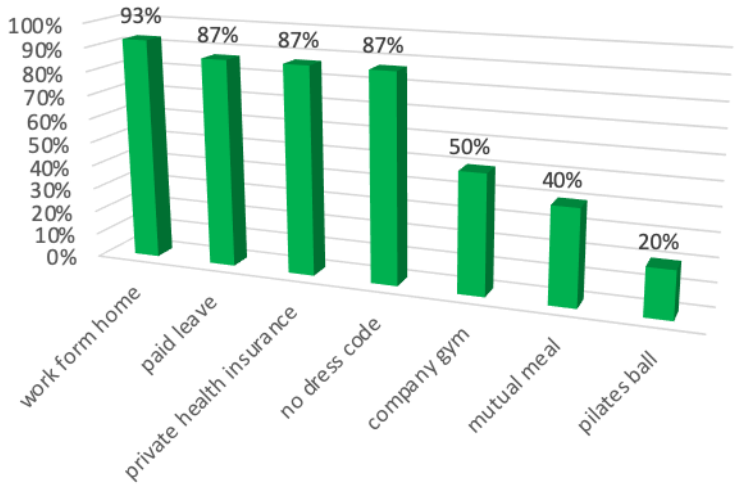

Figure 2: The most important existing benefits according to employees

Analyzing the questionnaire, it was concluded that among existing benefits in the company, paid leave (87%) meant the most to programmers when it comes to cash benefits, as well as the following benefits: occasional work from home (93%), private health insurance (87%), lack of dress code (87%). What the respondents pointed out during the workshops as positive but not decisive is that the company had its own gym and a professional trainer. They marked as less important benefits the following: mutual meal and pilates ball.

The employees had an opportunity to suggest the introduction of new benefits or the correction of some of the already existing. Suggestions for the benefits that the company should introduce were: to have desks that could be adjusted in height, to have an advisor to help them with investments and when taking a loan, as well as to have tickets for sports and cultural events. The correction was asked for the following existing benefits: more days of annual leave (until then they had 20 days of annual leave), a systematic examination with more control examinations within the voluntary health insurance (including a dentist and an ophthalmologist), as well as to have a differently organized food delivery.

Finally, the project team noted all the answers of the respondents and started to study what of that the company could implement and when it could start applying those benefits that are determined to be acceptable. Based on the results of the research, the company decided to introduce new benefits for its employees:

- Lecture on investing possibilities (held on February 2020);
- Team budget of € 50 per month per team member. Each team received this amount on a monthly basis and independently decided how to spend it. This was a step towards forming as independent teams as possible. One of the key results was greater team autonomy, and this was one step towards that.

The company decided to partially modify the existing non-financial compensation:

- The employees now have 25 days of annual leave.

As it is shown, the company has approved and implemented some of the benefits suggested by its employees. The idea of the company was to work according to the lean principle, constantly introducing new benefits, while measuring the results. They were guided by the idea that one should not assume what suits employees better, but experiment more with the implementation of benefits and, if employees are satisfied, the benefit is further developed, otherwise it is abolished. It is all a result of the efficient compensation plan implemented by recently developed and reorganized HR sector. One of the positive impacts that can be measured so far is the fact that since the research was conducted (six months period) the level of employee attrition was reduced from 9 employees in 2019 to 1 employee that has left the company in June 2020.

6. CONCLUSION

In the example of Hooloovoo, it can be seen the importance of not only financial and direct benefits, but also non-financial and psychological compensation that directly affects the motivation and work performance of employees. The employees consider the benefits in the form of health insurance, annual leave, financial counseling and physical conditions at work as highly significant. Constant introduction of new benefits, taking into account the attitudes and needs of employees, creates a feeling that the company takes care of them and their needs. When employees are satisfied with the benefits provided by the company, the work performance and motivation will be improved and fluctuation of employees will be reduced. Thus, the company will save time and resources spent on the selection and introduction of new candidates in work teams. Employer, therefore, is interested in maintaining employee satisfaction, in order to maintain the efficiency and effectiveness of the company.

Based on the theoretical hypothesis regarding Compensation Management and research findings in Hooloovoo, we consider that this is one example of good practice of Compensation Management in the domestic IT sector. Still, the research has certain limitations. First, we can't consider the possibility of generalizing the results, since the research was conducted in only one IT company with small number of employees. Secondly, there was a small number of survey respondents, so the answers probably are not completely representative for every IT company in Serbia. A period from conducting the research till the moment of writing the study is short (9 months) to show realistic impact of good Compensation Management of HR sector on the employee turnover. The impact of Compensation Management on the performance of the employees is hard to measure. It is difficult to identify the increase of the engagement among employees, but it possible to perceive the changes on their motivation and job satisfaction. If we take into consideration the generally accepted expectancy theory, it predicts that adequate compensation is one of the factors that affects employee satisfaction.

In order to overcome some of the limitations, we suggest a future research that would cover more companies in more cities, with different numbers of employees. This will give us a broader and more complete picture of the importance of adequate compensation policy and the quality HR sector for achieving the job satisfaction at employees and consequently company's strategic goals.

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THE ROLE OF OUTSOURCING AND OFFSHORING IN THE MODERN BUSINESS ENVIRONMENT

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Abstract: *Globalisation and high development of technology in the last couple of decades have caused some crucial reorganization of processes in modern companies. Many of today's organizations choose to let the other firms deal with some of the activities that were traditionally performed in-house, or to relocate their businesses to other countries in search of better economic, political or legal conditions. The outsourcing strategy allows them to use the capacities and capabilities of other organizations, while the offshoring provides them with the access to a wide range of different resources that might not be available in their home countries. Current trends indicate that these concepts are good solutions not only for large and strong companies, but also for small organizations or organizations from underdeveloped countries since they have the opportunity to provide specific services or products for those large companies and thus become important participants in global supply chains.*

Keywords*: outsourcing, offshoring, current trends*

1. INTRODUCTION

In search of preconditions for optimization of their performance, the organizations are analysing alternatives that maximize both economic efficiency and profitability (Pellicelli, 2017), so the current situation on global markets has forced them to reconsider certain functions in their value chains (Globerman & Vining, 2017). These reconsiderations have actually activated two main questions regarding the future organization of their activities, related with the participants that should carry out processes they are involved in and with the location where these processes should be performed. Having in mind decisions on these dilemmas, there can be identified four different sourcing options (Merino, 2017):

- in-house at the same location,
- by another company in the same location,
- by the same company, but in a different location, and
- by another company in a different location.

Globalisation trends have motivated modern organizations to reach for collaboration and cooperation among markets and partners, so the concepts of outsourcing and offshoring have emerged as two very important strategies, since they have grown to a great extent either by the number of organizations or by the number of nations that are involved in these deals (Kaur, Singh, & Majumdar, 2019). The progress in technology has led to substantial growth regarding the trade of products and services within and across the boundaries of organizations, both on national and international level (Brändle & Koch, 2017).

However, in order to successfully implement the concepts of outsourcing or offshoring, the organizations must redesign the processes and activities they perform (Contractor, Kumar, Kundu, & Pedersen, 2011). This redesign should be based on a resource and capability perspective which helps to create advantages that competitors cannot easily beat (Rodríguez-Díaz & Espino-Rodríguez, 2006). The analysis and redesign of processes is actually a key step in identifying obstacles and recognizing potentials for improvement that can be gained by leaving their completion to other organizations or by moving it to other countries.

2. THE PURPOSE OF OUTSOURCING

The concept of outsourcing can be defined in different ways, but it can be said that essentially this process implies leaving some activities to another company that can be located in the same or different country (Jaško, Čudanov, Jevtić, & Krivokapić, 2017). The term itself is a combination of the words "*outside*", "*resource*" and "*using*" or "*outside*" and "*resourcing*" (Bals, 2008), and clearly indicates that this approach represents the

strategic use of external resources with the aim of realizing activities that are traditionally performed within the organizations. It is interesting that the outsourcing can be observed in two ways. In the past this term meant that certain tasks were actually performed in the organization, and then they were left to some other, external associates (Kleindienst, 2016). Today, however, outsourcing also means hiring other organizations without trying to do these jobs internally, although there are managerial, technical, and even financial capacities for doing that in-house (Barrar & Gervais, 2006).

Outsourcing gained special momentum in the last decades of the twentieth century due to the trends and demands of the environment in which organizations operated at the time. Many companies in the last hundred years, and especially after the World War II sought to strengthen through the expansion, by taking over a different range of businesses, but they have become less flexible, which made it hard for them to adopt to the new market requirements (Handfield, 2006). In the 1970s and 1980s they began to consider more and more about focusing on key functions and leaving other processes to external partners in order to deal with mentioned problems. Traditionally, outsourcing meant the transfer of functions that were not related to the core business, but with the constant improvement of technology and innovation the list of functions suitable for outsourcing has grown (Jaško, Čudanov, Jevtić, & Krivokapić, 2017), so since the 1990s many organizations have decided to outsource even the processes that are crucial to their business. Organizations have actually realized that the focus should be on the availability of resources, not on ownership, so they increasingly started to use the capabilities and capacities of other organizations (Sobinska & Willcocks, 2016).

The motives for outsourcing are different, and must be considered in relation to the specifics of the organization that makes this strategic decision and the market in which it operates. However, it can be said that there are some key benefits that organizations that opt for outsourcing can gain, so they usually expect to (Jaško, Čudanov, Jevtić, & Krivokapić, 2017):

- reduce costs,
- improve quality,
- improve organizational focus,
- solve the problem of lack of capacity,
- increase flexibility, and
- implement changes.

Cost reduction is definitely one of the strongest incentives for outsourcing. Organizations that perform work in-house have to deal with a range of costs related to specific functions, starting from infrastructure costs, through operating costs, to the costs of training and development of employees that are performing these activities. On the other hand, there are organizations that specialize in doing these functions, and they can perform them much cheaper due to economies of scale (Barrar & Gervais, 2006). Since they are focused only on these activities, the complete investments they have are in the function of their development, in order to offer them to the market. If they manage to find a larger number of customers, they will be able to give them services and products at a lower price due to the relatively constant total fixed costs, which will enable them to become financially attractive to the organizations that want to save up on these jobs (Hill & Jones, 2008). In addition, these specialized organizations are able to increase their quality by focusing on a particular segment of products or services, which will, in combination with a lower price, certainly be very attractive for companies that are considering improvement of their final outputs.

Organizations that perform work in-house can also have problems in implementing and coordinating a large number of different activities. Management, and especially the one at a higher level, must take into account a wide range of tasks that are performed, and problems in them require great attention and commitment. Given the fact that not all activities are objectively equally important to the organization, a good solution can be to leave some of them to other contractors, thus improving the manager's focus on critical processes within the organization (Kleindienst, 2016). This helps in overcoming the problem of lack of human and expert capacity, because in the case of outsourcing there are no objective requirements (or at least not in such extent) for experts knowledge and skills within the organization, which is a significant relief in management processes (Needle, 2010).

Finally, organizations that decide to outsource some of their functions are certainly much more flexible than large, rigid companies, and that was one of the key reasons for growth of outsourcing. Today, the business environment is changing faster and faster, so organizations must react and adapt quickly in order to prevent jeopardizing their businesses. Those that are smaller or have a smaller number of functions are able to answer easier to the demands coming from the market, as they can faster adapt their offer to the new situation. In addition, any internal change at the level of the entire organization is easier to design and implement, because the organizational units themselves are more compact and better connected, which leads to their better compliance and a unique and common way of adapting to any factor of influence (Luecke, 2003).

On the other hand, outsourcing by itself carries certain risks, and some of them are related with (Vagadia, 2012):

- increased dependence on external associates,
- lack of quality control,
- difficult coordination of activities and participants,
- reduced opportunities for acquiring knowledge related to outsourced jobs,
- increased security risk.

Increasing dependence on others is probably the highest barrier for outsourcing. By leaving the completion of certain tasks to other entities, organizations consciously renounce the management of some processes or their parts (Lee, Huynh, & Hirschheim, 2009). Although this is also one motive for outsourcing, the management is often afraid of losing too much control over these processes. The problem arises when the dependence on the other participants becomes too strong, and then the organization becomes unable to find an alternative solution.

Leaving activities to others can also make it difficult to coordinate them. Although organizations are relieved of the burden of their operational performance, aligning them with the processes that remain in-house can be a serious challenge (Tan & Sia, 2006). Failure to meet deadlines or the required quality of products or services that are the subject of cooperation can negatively affect other processes within the company, and therefore outsourcing requires significant efforts of employees whose main task is to coordinate all the activities related to the specific output. In addition, reducing the number of employees engaged in certain jobs is a great benefit of outsourcing because it can significantly reduce costs, but at the same time leads to the loss of core competence and know-how, given that the organization is no longer engaged in these activities (Gimbert, 2011). This leads to the further loss of understanding of the specifics and problems, and thus can complicate potentials for in-house completion of these processes in the future, because in such situations the organization would have to make great efforts to regain control over them (Nujen, Halse, & Solli-Sæther, 2015).

Finally, the issue of security risk is especially current nowadays, and it undoubtedly arises due to cooperation with external partners. In order to carry out business efficiently, the companies must provide external collaborators with insight into certain sensitive or protected data, so there is always a fear of their misuse. The biggest fears are present when it comes to sharing personal (Webster, 2012) or financial (Patel, 2005) data, but organizations must be prepared for that risk if they choose to outsource business. Given all the above, it is clear that outsourcing must be based on mutual trust and respect of all parties involved (Langfield-Smith & Smith, 2003). That way, the foundations of successful cooperation will be created, and the client will be sure that the quality of the products or services provided by the external partners is satisfactory and in accordance with the set requirements, norms and standards.

Having in mind all the mentioned facts, the organizations in practice often have a dilemma when it comes to outsourcing certain functions. It is believed that the decision on outsourcing should be based on the strategic value of the activities, the specifics of the resources needed for their implementation and the assessment of the effectiveness of the alternatives (Reichard, 2015). This decision is influenced by a number of factors, and in addition to financial benefits, organizations decide to do it when they do not have enough competence to perform the tasks independently or when the implementation of these tasks in-house is not efficient enough (Misra, 2008). However, there are certain delusions about outsourcing, so organizations sometimes unjustifiably choose to use this strategy just because other organizations in the same industry are doing the same, or because they think it will solve the issues they have, but in fact they might not be aware that their problems are not properly identified (Hinkelman, 2008).

Business practice indicates that standardized products and services are more cost-effective to obtain from the market, and that it rarely happens that activities on specific products for which the organization is recognizable are left to external partners, at least while the innovative advantage lasts (Jaško, Čudanov, Jevtić, & Krivokapić, 2013). In general, it is considered that core activities, which provide a long-term competitive advantage, should always be performed internally, and that additional activities without strategic impact on the company can be relocated outside organizations (Kakabadse & Kakabadse, 2000). Usually, in practice, the functions with the lowest strategic value for the organization are outsourced first, and if it turns out to be a good decision, some significant functions are left later (Bragg, 2006). Traditional outsourcing functions are actually administrative and supporting functions (Dias, 2015) such as legal services, accounting services, facility maintenance services, etc., but today more and more organizations are choosing to leave even key processes such as production to other organizations (Hernandez & Haddud, 2018). Interestingly, although it is not recommended to outsource functions that involve direct interaction with users because it can be interpreted as the organization does not care too much about them, today many companies do the opposite and hire external call centres because it is more profitable (Misra, 2008).

Given the benefits that outsourcing brings, it is not surprising that this market has grown steadily in recent decades. Thus, it can be concluded that the value of the outsourcing market at this time has practically doubled in size in comparison with the beginning of the twenty-first century. Statistical data indicate that this market has grown significantly from year to year throughout the first decade of the observed period, but it has a relatively constant size in recent years.

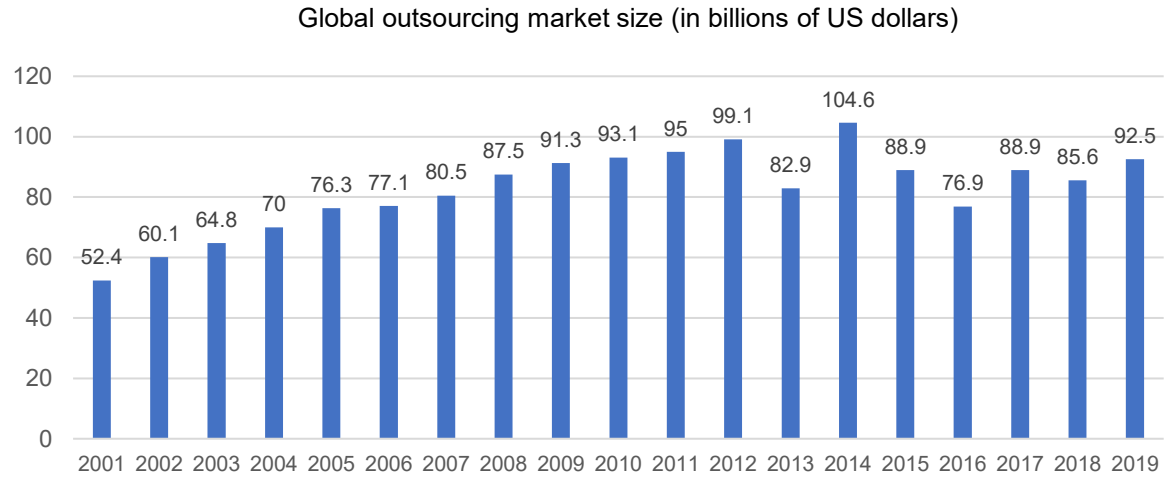

Figure 1: Global outsourcing market size 2001-2019 (Statista, 2020)

However, the essence of outsourcing is changing significantly, even in the last couple of years. It is interesting that nowadays, besides the classic outsourcing, there are some more modern forms of cooperation that are emerging thanks to the exceptional development of technology. Thus, for example, the concept of crowdsourcing is increasingly evolving in various business areas (Lenart-Gansiniec, 2018). Crowdsourcing is actually outsourcing to the crowd (Vlastelica Bakić, Cicvarić Kostić, & Nešković, 2014) as it is the act where an organization takes a function once performed by employees and outsources it to an undefined, generally large network of people in the form of an open call (Howe, 2006). Crowdsourcing has proven to be a particularly important strategy for development of entrepreneurship (Dellermann, Nikolaus, & Ebel, 2018) since it usually brings less risk and more freedom through the long-term orientation to entrepreneurs. It is considered that the future of business will involve more outsourcing, but also that the future of outsourcing will increasingly and inevitably involve more crowdsourcing (Malhotra & Uslay, 2018).

3. THE SPECIFICS OF OFFSHORING

In recent period it is practically impossible to talk about outsourcing without mentioning the concept of offshoring. These terms are related but neither implies the other (Olsen, 2006). Like outsourcing, offshoring can also be defined in several ways. Generally speaking, it can be said that it is the relocation of business processes beyond the country's borders (Winkler, 2009). Thus, in the last decades many services were offshored to certain low labour cost regions, and those decisions were often made based on low price, but ignored some important criteria such as additional cost and growing risks (Tate & Bals, 2017). Globalization, however, helped to eliminate the borders, which has made it easier for companies to move their business to other territories. Some of them decided to keep ownership on these activities in other countries, and the others, in addition to relocating from their territory, left those tasks to other partners, thus using elements of both outsourcing and offshoring, which is a combined strategy known as offshore outsourcing (Ramanathan, 2008).

Generally, offshoring can be observed in two ways, as nearshoring or farshoring. Nearshoring implies the transfer of functions to some countries that are relatively close to the one where the organization is located (Pearlson, Saunders, & Galletta, 2019) or to some countries that they share borders with (Chakrabarty, 2009). Organizations are opting for this move because they hope to take advantage of certain economic or political benefits that exist in a neighbouring country, without fear of geographical, cultural, linguistic or historical barriers (Pearlson, Saunders, & Galletta, 2019). Having that in mind, sometimes nearshoring does not differ much from moving jobs to other areas within the same country, because it still allows working in the same time zone, with people who are at a relatively short distance, which can significantly facilitate communication and coordination of activities. Farshoring, on the other hand, is the relocation of jobs to other distant countries, which are often located even on other continents. The motive for this kind of decision is usually related to financial factors, so many organizations from Europe or the United States have decided long time ago to conduct part of their processes in Asian countries, given that the costs are significantly lower than in their countries. Nevertheless, although farshoring still has significant financial savings compared to nearshoring, it should be noted that in some countries with traditionally low-labour-cost there is a constant growth of wages,

so many organizations choose to withdraw from them in search of other countries that provide better benefits (Frynas & Mellahi, 2015). Whether it is nearshoring or farshoring, decisions to relocate jobs to other countries are usually politically criticized (Peng, 2016) because they entail an increase in unemployment in home countries and strengthen foreign economies through investment in their infrastructure and labour force.

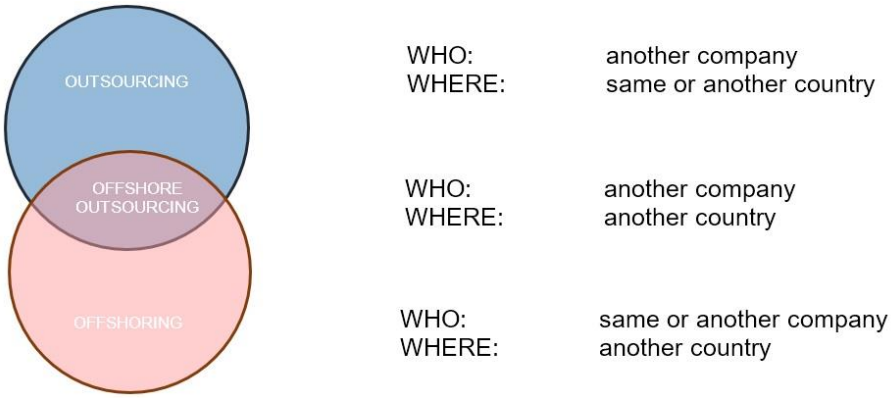

Figure 2: Relations between concepts of outsourcing and offshoring

The attractiveness of individual countries for offshoring can be observed in several ways, through different criteria. Most often, these criteria are of a financial nature, but they can also refer to legal regulations, the stability of the environment, the availability of an appropriate workforce, linguistic and cultural compatibility, and so on. Some of these criteria are in collision with others, so the high attractiveness in one of them brings with it the negative effects of some others. With this in mind, it is necessary to analyse certain composite indicators that will make it possible to assess the overall attractiveness of an area. One of such indicators is the annual Global Service Location Index (GSLI), which evaluates 4 criteria, and these are (Kearney, 2019):

- Financial attractiveness - includes subcriteria as compensation costs, infrastructure costs and tax and regulatory costs;
- People skills and availability - includes ITO/BPO experience and skills, labour force availability and education and language skills;
- Business environment - includes country environment, country infrastructure, cultural adaptability and security of intellectual property;
- Digital resonance - includes digital skills, legal and cybersecurity, corporate activity and outputs.

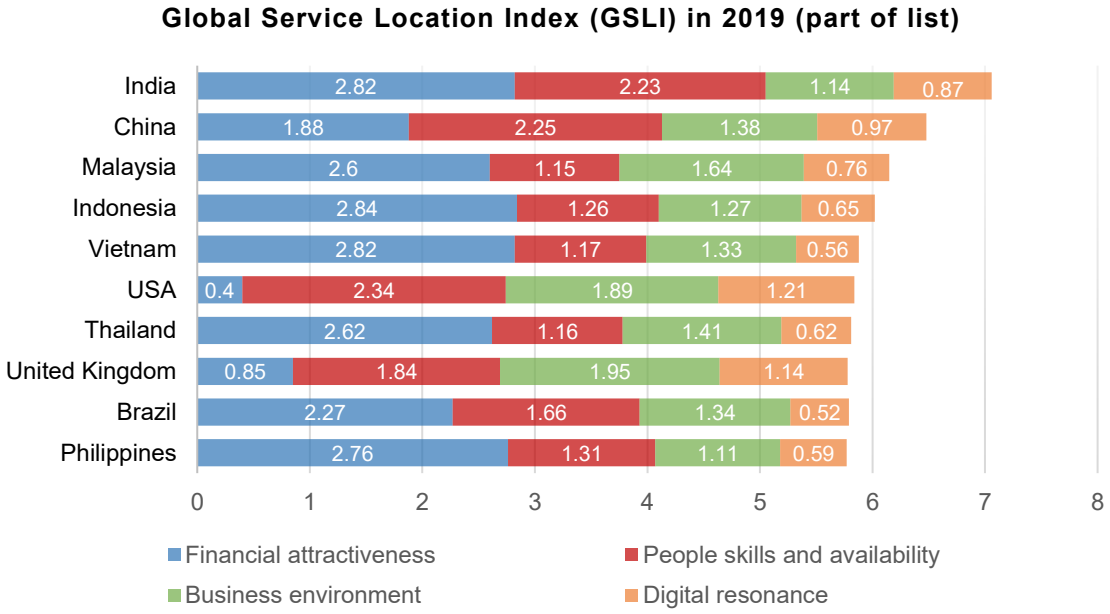

Figure 3: Leading countries in offshore business services worldwide in 2019 (Statista, 2019)

These criteria are not equally important, so Financial attractiveness carries 35% of the total value of the index, People skills and availability and Business environment participate with 25% each, and the remaining 15% carries the Digital resonance criterion (Statista, 2019).

Analysing the values of GSLI for 2019, it can be concluded that, overall, the most attractive countries are still India and China, despite the fact that the price of labour in these markets is rising, as it has been already mentioned. In general, it can be said that Asian countries have an advantage, mostly due to financial factors since the costs are lower in comparison with the countries on other continents. On the other hand, it can be noticed that the USA and United Kingdom are highly ranked as attractive, even though according to this criterion they are far behind the other best ranked countries, but they have distinct advantage in other criteria, which indicates that they are very suitable offshoring hosts for those organizations that are willing to accept a higher price, but can count on the exceptional availability of a skilled workforce, a stable and developed business environment and a highly developed digital infrastructure.

It should be said that the values of these indicators change rapidly from year to year, so the ranking of countries differs significantly. Thus, e.g. in 2019 The United States entered the top 10 countries for the first time. In Europe some countries that were members of the USSR (Russia, Lithuania, Latvia, Ukraine) made significant progress on the list during the last year, while, on the other hand, the Czech Republic, Poland and Hungary, which until recently were considered as some of the most attractive countries in the world, are no longer the most attractive at the European level either. South American countries such as Brazil, Chile and Colombia are also extremely attractive at the moment, while the African countries have experienced a decline in the list, and among them currently the best ranked are Morocco, Kenya and Ghana (Kearney, 2019).

4. CONCLUSION

The global sourcing is nowadays popular concept since the modern infrastructure provides the possibilities to use advantage of other organizations' resources or to approach markets and regions with better conditions regarding financial, economic or political aspects. Outsourcing and offshoring can be considered as very important strategic approaches in modern complex, dynamic and competitive global supply chains (Ishizaka, Bhattacharya, Gunasekaran, Dekkers, & Pereira, 2019) since these concepts can help organizations to gain 'efficiency' through cost minimisation, 'exploration' through an access to the right and technologically capable firm vendors/suppliers/players, and 'exploitation' from development of global markets (Kaur, Singh, & Majumdar, 2019).

Thanks to these concepts, many companies have survived the economic turbulences in the last couple of decades, and some of them have managed to use their potentials and become few of the strongest companies in the industries in which they operate. While outsourcing allows them to use the other organization's resources and thus reduce costs or increase the quality of products and services, offshoring provides opportunities to carry out activities globally with certain incentives related with concrete countries. Although organizations that use others' resources, and especially resources from other countries gain various benefits for themselves, they are very often criticized since they are considered to endanger the economy of their countries. On the other hand, many countries have experienced great industrialization precisely because they have hosted organizations from other parts of the world, which enabled them to become important players in the global world economy (Hikmet, 2020). While the market situation is difficult to predict, some current trends indicate that these strategies will also be significant in the future, and that organizations will continue to leave out parts of the business to others, or to move them to other countries. The selection of potential partners or markets is changing due to the changes in political, legal and economic factors both at the national and international level, but it is rational to expect that the benefits achieved through these approaches will continue to be a strong incentive for organizations to seek allies and/or areas that will help them to achieve their goals more efficiently.

In order to design and implement concepts of outsourcing and offshoring more efficiently many companies are increasingly using the help of modern IT solutions and artificial intelligence (AI). The impact of rapid development of technology on the way of doing business can be the basis for some further research on outsourcing and especially offshoring, because modern technological solutions enable efficient coordination of activities performed by physically separate operatives, which provides benefits for both companies and employees. While the companies can achieve significant financial savings, employees in remote locations are more satisfied and more dedicated to work when they are given the opportunity to independently manage and organize their jobs (Felstead & Henseke, 2017), as long as they deliver services and products on time and with satisfactory quality. This is especially important for the IT industry, where leaving jobs to the others, regardless of their location, is one of the key trends, since the employees become extremely flexible, satisfied and motivated because they have a strong sense of freedom when they are performing their activities (Kong, Schlagwein, & Cecez-Kecmanovic, 2019). AI, on the other hand, is relying on automation which enables faster and more efficient reaction, better control, lower costs and increased security, but it also leads to potential

changes in the workforce structure, especially for low-skilled jobs, because many workers will be replaced by robots (Nair & Pahurkar, 2019) and that fact will redefine the essence of these strategies. Having said that, it should be concluded that the leading national economies and their strongest companies will continue to have a key role, but the weaker ones can also look for their chances, especially due to greater market globalization and increased opportunities for easier connections with other participants.

ACKNOWLEDGEMENT

This research was supported by the Ministry of Education and Science of the Republic of Serbia through the Project No. 179081: Researching Contemporary Tendencies of Strategic Management Using Specialized Management Disciplines in Function of Competitiveness of Serbian Economy.

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ORGANIZATIONAL RESTRUCTURING THROUGH DOWNSIZING BASED ON THE ANALYSIS OF ERP SYSTEM DATA

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Abstract: *This paper covers the well-known and widespread topic of organizational restructuring through downsizing, putting an emphasis on new methods for its implementation based on contemporary information technology tools, such as Enterprise Resource Planning Systems (ERP) and Business Intelligence (BI). The aim of the paper is to contribute to development of more precise, efficient and more reliable models for calculation of optimal workforce number, which should be used as a mean of support to decision makers. In addition to theoretical knowledge, the case study of one Serbian production company will be presented, consisting of concrete model that was developed during a restructuring project performed by the consultant team from the Faculty of Organizational Science at the University of Belgrade in 2019. This document was founded on the thorough research including deep analysis of the company's business processes, interviews with employees and managers, analysis of numerous data sets and benchmark.*

Keywords*: organizational restructuring, downsizing, process mapping, data analysis, business intelligence*

1. INTRODUCTION

At present, it is nearly impossible to imagine performing any type of optimization, without neatly arranged data collected from some advanced information system. Senior consultants and managers had to have enormous knowledge and experience to be able to conduct such demanding and ungrateful task such as downsizing, without precisely prepared numbers in required context. They would carry out these tasks by doing analysis and calculations with collected raw data for days, even months, something that nowadays smart systems can give you in a second. Due to technical and technological progress and awareness on importance of information, now we have various software tools, data bases, machine learning, business intelligence, etc. – everything that we need for faster, more precise and efficient work. However, the key of successful organizational restructuring does not lie solely in technology, but rather in the new ways of thinking and handling information from information systems in a completely new manner.

2. MOTIVES BEHIND ORGANIZATIONAL RESTRUCTURING

The term restructuring has often been viewed with the negative connotation, especially at the domestic market, being associated mainly to privatization and breakdown of state-owned enterprises, layoffs, negative impact on the complete economy of certain cities, regions and state as a whole. However, the process of restructuring is much more than the above mentioned and represents the necessary tool for many companies which are competing in the market, whether it is the case of survival of the company or its further development. Therefore, restructuring can be defined as a set of discrete decisive measures taken in order to increase the competitiveness of the enterprise and thereby to enhance its value (Crum & Goldberg, 1998).

There are several types of restructuring, however, this paper will focus on organizational restructuring in line with the case study which will be presented below. Organizational restructuring involves different types of change, from changes in the organizational design and size of the organization to complete reengineering of business processes or building network and virtual organizations (Erić & Stošić, 2013). Organizational restructuring refers to planned changes in a firm's organizational structure that affects the use of people (Cascio, 2002). Organizational restructuring can be observed as a business requirement when the company has reached to the point where existing structure is no longer effective to give great outputs (Soni, 2016).

The motives behind the decision to start organizational restructuring process can be numerous. A survey conducted by the McKinsey & Company in 2014, shows that the most common reason for restructuring is the need to respond to company growth, followed by cost reductions as the second most common reason

(McKinsey&Company, 2014). Expectedly, companies indulge in the process of organizational restructuring believing that it will lead to the increase of productivity, efficiency and overall competitiveness of the company. Cameron and Green (2012) have made a very exhaustive and fully comprehensive list of reasons behind restructuring, as follows: *1) downsizing or rightsizing; 2) rationalization or cost-cutting; 3) efficiency or effectiveness; 4) decentralization or centralization; 5) flattening of the hierarchy; 6) change in strategy; 7) merger or acquisition; 8) new product or service; 9) cultural change; 10) internal market re-alignment; 11) change of senior manager; 12) internal or external crisis*.

Undoubtedly, with organizational restructuring companies seek to ensure the development of the company applying perhaps not so popular measures during that process. Organizational restructuring can be carried out only in a certain business units or in certain processes, but it can also involve the entire company (Alkhafaji, 2001). The first case can often be the consequence of higher costs or other gaps in performance in some organizational units and it is called departmental restructuring (Soni, 2016). In the second case, the scope of implemented measures is certainly larger and usually involves revision of the existing structure, management and delegation of responsibilities, the number of hierarchical levels, span of control, the number of employees, and many other aspects of business that will be directly or indirectly affected by these changes.

The results of already mentioned survey go in favor with afore mentioned, as most of the companies which have been analyzed state that organizational elements that improved meaningfully after organizational restructuring were: performance management, business processes, roles, governance, culture, management process, reporting lines, span of control, etc. (McKinsey&Company, 2014)

3. DOWNSIZING APPROACH IN ORGANIZATIONAL RESTRUCTURING

One of the forms of organizational restructuring is downsizing (Erić & Stošić, 2013). There are numerous definitions of downsizing, as well as numerous synonyms used by different authors. Gandolfi (2006) provided a summarized overview of more than 40 different terms associated with downsizing, with some of them being: de-hiring, delayering, declining, de-recruiting, rationalizing, redesigning, redundancies, resizing, reshaping, rightsizing, etc.

By some authors downsizing can be defined as planned elimination of positions and jobs (Cascio, 1993) (Child, 2015). Other define downsizing as a form of organizational restructuring which aims to improve organization's overall performance (Thornhill & Saunders, 1998). However, although downsizing can represent many different measures, its negative connotation often comes from its identification with layoffs. Layoffs can often follow the downsizing process, however, that is not the purpose itself of downsizing, rather its consequence. Layoffs are the same as employment downsizing, however, downsizing can include any number of combinations of reductions in a company's use of assets (financial, physical, human or information assets) (Cascio, 2002). In that sense authors state that downsizing can be observed as a broader concept, that is, a conceptual issue manifested through proactive or reactive strategies, where layoffs and other approaches refer to the operational mechanisms used to implement a downsizing strategy (Freeman & Cameron, 1993).

Therefore, the term downsizing shouldn't be identified by default as a reduction in the number of employees, even though it often leads to that. However, it should be noted that besides the size of the firm's work force, downsizing affects the work processes used (Freeman & Cameron, 1993). Determination of optimal number of employees, where possible, should be conducted with the aim to organize business processes in the best possible way, with the optimal use of resources. Following this approach, it is possible that in certain organizational units it is necessary to reduce the number of employees, whereas there can be other jobs or organizational units that may require engagement of additional workforce. For long-term, sustained improvements in efficiency, reductions in headcount need to be viewed as part of a process of continuous improvement that includes organization redesign, along with broad, systemic changes designed to eliminate redundancies, waste, and inefficiency (Cascio, 1993).

Reasons behind the decision on downsizing can be numerous, such as falling demand, the automation of work, decision to outsource some amount of work, etc. (Child, 2015). Those driving forces of downsizing can be viewed as macroeconomic, industry-specific and company specific (Gandolfi, 2006). Macroeconomic are international competition, globalization and political trade agreements. Industry-specific refer to decline in total industry sales, decline in profits, introduction to new technology, rising labor costs, need for greater responsiveness to customer needs, deregulation and privatization. Finally, company-specific driving forces of downsizing are poor financial results, change in strategy, change in management, change in ownership, improvement of innovation, improvement of entrepreneurship and poor productivity relative to competition. In a research conducted on the topic of downsizing strategies implemented in reputable examples of companies and states in the U.S. (AT&T, DuPont, General Motors, General Electric, IBM, Hewlett-Packard, Johnson & Johnson, and many others) most of the private companies stated that decision to downsize occurred as result

of restructuring activities intended to eliminate less profitable and unnecessary functions and/or make work processes more efficient, and therefore, the initial focus was on changing the future work of the company, not on reducing employment (United States General Accounting Office, 1995). However, downsizing in the public sector was typically conducted to cut costs by reducing the number of employees.

Taking into account all of the above-mentioned different reasons behind downsizing and considering the complexity of processes and activities in the company, various approaches and methods for the purpose of determination of required number of employees can be applied. They are mostly based on combination of process mapping, data analysis, benchmarking and personal expertise.

4. PROCESSES MAPPING AS THE STARTING POINT FOR WORKFORCE OPTIMIZATION

Mapping of business processes provides the basis for process management and finding the possibilities for their improvement (Jaško, Čudanov, Jevtić, & Krivokapić, 2017). It can be conducted with different motives, where one of them is certainly increase of productivity and creation of the basis for process standardization (Havey, 2005). Process mapping focuses on whether the processes add value, and, in comparison to, for example reengineering of business processes, it is relatively low cost, as it primarily involves eliminating steps rather than creating new ones (Vance, 2009).

An overview and detailed analysis of business processes certainly represent the starting point for the development of models and consequently, the calculation of optimal number of employees (Todorović, Komazec, Marič & Krivokapić, 2013). Business process can even in some cases unambiguously affect the required number of employees. They should provide the picture of the role of each employee, all the activities which are performed, the documentation involved, participation of other organizational units, and in some cases the time dimension of steps within the process.

In the above-mentioned research on downsizing strategies, around 65% participating private companies said that redesigning work processes to eliminate unnecessary and duplicative work was the primary objective of their restructuring efforts (United States General Accounting Office, 1995). One of the conclusions was as well that if organization simply reduces the number of employees without changing its work processes, staffing growth will return eventually. As some authors state, the implications of how downsizing is introduced are of wider consequence than simply the reduction of employment or assets (Child, 2015).

Nevertheless, consideration of business processes in determining the number of employees can lead to other structural and organizational changes in the company. Process mapping can highlight bottlenecks and redundancies, it could have a significant impact on performance (with elimination of certain process steps) (Vance, 2009) and it could even affect the distribution of responsibilities between organizational units and their mutual coordination. Namely, after the identified deficiencies in the implementation of business processes, and their correction and improvement, there may be a situation that entire processes or parts of the process can be moved to other organizational units or they could be outsourced. That inevitably leads to changes in the organizational structure, control span, the degree of centralization or decentralization, etc. Therefore, the process of determining the optimal number of employees should be seen as an incremental part of organizational restructuring, that is, its impact on the overall business system should not be neglected.

5. THE ROLE OF ERP SYSTEMS AND BI IN THE DECISION-MAKING PROCESS

Enterprise resource planning (ERP) systems are business systems that integrate and streamline data across the company into one complete system that supports the needs of the entire enterprise (Bradford, 2015). ERP is based on the well-structured database which can be used both for the purpose of everyday business operations and for decision-making process. ERP systems provide many benefits, however, from the managerial point of view, the most important ones are better resource management, improved decision making and planning and performance improvement (Shanks, Seddon, & Willcocks, 2003).

ERP systems are cross-functional and support processes through entire company. They provide integration across multiple locations and functional areas, which leads to improved decision-making capabilities that manifest in wide range of metrics, such as decreased inventory, personnel reductions, speeding up financial close processes, and others (Leon, 2011). However, it has different functionalities for different organizational functions, that is, separate modules. When it comes to human resources, ERP modules provide wide application, such as the usage for personnel management, payroll, benefits, time and attendance, learning management and recruitment management (Bradford, 2015). Data within that module is of utmost importance for building models for determination of required number of employees and making a decision on downsizing.

For the model that will be presented below, besides the data on achieved performance in the terms of outputs performed, the data on time and attendance will be of great importance. Time and attendance help companies

control costs, optimize the productivity of its workforce, provide key information for the payroll, and support the forecasting of labor requirements (Bradford, 2015). With this in mind, ERP models can provide relevant information on current employees' performance and needs for workforce, however, more importantly, it provides the basis for planning the future needs for workforce in relation to overall business features.

In that light, managers can achieve even greater level of support in the decision-making process through combination of ERP systems with Business Intelligence (BI) systems and tools. Business Intelligence is an umbrella term for applications, infrastructure, tools and best practices for accessing and analyzing data and information for decision-making and performance improvement to achieve market advantages (Gronwald, 2017). Today, many ERP systems offer broad functional coverage with extensive list of integrated software, such as BI software (Leon, 2011). Taking into account that BI is in that case used mainly for the analysis of the data gathered through company's ERP, then forecasting and reporting based on that data, it can be concluded that decisions could be made faster and with greater accuracy. Managers can predict the movement of business in the following business seasons based on the data from previous years, and consequently plan the resources needed, including human resources.

This paper will present an example of decision making on downsizing the administration units in one of the largest production companies from Serbia with more than 6,000 employees. The decisions were based on the analysis of the data set retrieved from the company's ERP system. The article will also provide an explanation of the developed model.

6. CASE STUDY

In the concrete example company had SAP ERP system which was in use through the past several years. Therefore, the system was able to retrieve the data in the necessary time frame, which was, in this case, two years. However, it is important to emphasize that the accuracy of calculations and predictions based on the data set is higher when the data from wider period is observed. Also, the reliability of this method is based on the fact that during the observed period there was no change in the organization that would affect the transfer of performance from one organizational unit to another.

One of the main advantages of this method refers to the availability of the data. It is easy to obtain the database with any important data from the system, as they are already collected and used for other purposes, as mentioned earlier. After receiving the database, data should be properly prepared, due to potential inconsistencies and missing data, which includes different aspects such as data extraction, data quality (parsing, standardization, matching and data cleansing), data transformation, etc. (Loshin, 2013). The use of various tools and software for analytics and business intelligence is recommended in this step also, as the further analysis and conclusions will be more accurate. For the purpose of this project, the consulting team used Microsoft Excel for data preparation, and afterwards for data analysis, taking into account that data obtained from SAP ERP system were already well structured and in necessary form.

The next step was to determine effective working hours of the organizational unit. There are two possible ways to determine effective working hours of organizational unit based on data from information system. One way would be to consider the data on accurate amount of time spent at work daily for each employee. The other way, which was used in this model, uses data on employee's presence at work, each working day, in a simple binary form 0-1 (present-not present). In the case of typical administration job, with an 8-hour shift, the starting assumption is that the employee spends all 8 hours at his/her workplace. The model disregards cases of leaving work early or working overtime with an assumption that these sporadic cases will even out at a certain sample size, that is, the difference between overtime hours and hours lost due to leaving workplace early is small and statistically insignificant with large enough sample size taken. The next assumption is that employee will not spend all 8 hours working effectively each working day. After subtracting the time spent on meal break and ad hoc activities which can be considered as work not specifically related to employee's everyday measurable aspect of work, but as one-time job directly given by his superior, or in indirect connection with his ongoing work, the time left for effective work is assumed to be 7 hours (daily, on average). For example, if on certain date there has been 5 employees present, multiplied with the constant value 7 (*Effective working Hours Constant),* the daily effective worktime of the organizational unit would in that case be 35 hours. This calculation was made for each day in the observed period.

The next step was to determine outputs of organizational unit and sort them by types. With administrative workplaces, such as invoicing job, which will be taken as an example for this matter, all data about the amount of outputs are mainly stored in company's ERP system, or in some less convenient cases, excel tables. As the specialization in an organization grows bigger this model becomes easier to use. The larger the level of specialization, the less diversity there is when it comes to outputs, therefore it is easier to determine relations between these outputs and to be more accurate when defining standard performance (output). There is also

a possibility that the organization's information system does not have data regarding all output types, so it is of great significance to find another method that would provide the exact number of outputs. Those methods would usually imply the estimates of managers or employees directly involved in the process, based on their experience or estimates based on corresponding benchmark.

For this model, it was crucial to define output types based on the difference in time needed for their complement. In given organization, ERP system registers the difference between documents for domestic and international market. Hence, the output quantity data has been collected and classified in the following way:

- *Domestic invoices;*
- *International invoices;*
- *Domestic credit notes;*
- *International credit notes;*
- *Domestic debit notes;*
- *International debit notes.*

The following step was to determine the ratio between duration of different output types. Firstly, it is necessary to determine the conditional unit, which could be either the output with largest quantity or the one for which it is easier to evaluate time needed for its processing. The chosen conditional unit has a weight 1. After that, each output should be compared with the conditional output and given a weight on the basis of time for processing, so that the time needed for each output could be brought down to the conditional unit.

By mapping operational process for each of these outputs, it was noted that variations in time needed to make a single invoice are based on following assumptions:

- Duration of invoice processing depends on whether the goods were marketed on a domestic or international market, as it is confirmed that due to additional export documentation, legal obligations and adjustments to foreign customers' demands, processing this type of invoice lasts on average 2 times longer than processing a domestic invoice;
- Duration of processing an invoice also depends on the type of shipping that follows a certain invoice. Company ships its products to all markets by road and railway transport. It was noted that processing of the invoice following railway shipping lasts 2 times longer than of the one following road shipping.
- Processing credit notes and debit notes lasts equally regardless of the shipping or the market – processing these lasts equally as processing a domestic invoice which follows road shipping.

The domestic invoice which follows road shipping (by trucks) is taken as a conditional unit and all weights for other output types are calculated based on this unit, in accordance with ratios between time needed for processing different types of invoices. By multiplying with an appropriate weight, duration of processing any other type of invoice is brought down to time needed to process a conditional unit – a domestic invoice which follows road shipping.

The company's ERP is set up in a way that it cannot distinguish road and railway shipping within domestic and international invoices, therefore, it was necessary to estimate each of their shares in a total number of invoices. It was done by experts' estimation, primarily by employees, and then their superiors, who gave their opinion and estimation of the frequency of specific invoices in a total number, based on many years of experience. It is estimated that out of total number of domestic invoices, 80% are invoices which follow road shipping and 20% are related to railway shipping. The results are similar when it comes to international invoices.

Table 1: Ratio and frequency between different types of outputs

Output type	Output Subtype	Weight	Frequency (%)
1 - Domestic Invoices	1.1 - Truck	1	80%
	1.2 - Railway	2	20%
2 - International Invoices	2.1 - Truck	2	80%
	2.2 - Railway	4	20%
3 - Credit Notes	3 - Credit Notes (domestic + international)	1	100%
4 - Debit Notes	4 - Debit Notes (domestic + international)	1	100%

Further on, it is necessary to determine the calculated daily output. On the basis of collected data for 494 days from the information system, work process records, interviews with employees and their estimates, a formula which returns the calculated daily output was created. Multiplying the total number of singular outputs for each of the output types by the corresponding weight, and then by the frequency in the total number of outputs, a calculated daily output is obtained in the form of a certain number of conditional units (domestic invoice which follows road shipment).

The formula for calculated daily output is:

$$CDA_i = P1_i \cdot W11 \cdot F11 + P1_i \cdot W12 \cdot F12 + P2_i \cdot W21 \cdot F21 + P2_i \cdot W22 \cdot F22 + P3_i \cdot W3 + P4_i \cdot W4 \quad (1)$$

CDA_i – calculated daily output performed in *i* day; *i* ϵ {1,…,494}
Pki – amount of k output in i day; i ϵ {1,…,494}
Wkj – Weight of kj output subtype; k ϵ {1, 2}, j ϵ {1, 2, 3}
Fkj – Frequency of kj output subtype; k ϵ {1, 2}, j ϵ {1, 2, 3}
i – day in which there had been available output data from ERP

Based on the previous step, the next step is to determine the standard performance (output). When the number of calculated daily outputs was determined for each day of the observed period, simply dividing that number with the effective working time of that particular day provides the performed daily output, which would be the number of calculated daily outputs per person per hour.

Table 2: Calculated performed daily output per date

Date	Calculated daily Output	Daily effective Worktime of Unit	Performed daily Output
03/07/2019	84	35	2.4
04/07/2019	130.2	35	3.72
30/07/2019	168	35	4.8

Some organizations determine standard performance by determining the average (arithmetic mean) of outputs achieved over a period. This approach has its obvious drawbacks, since it does not resolve the problem of extremely large sporadic cases, and on the other hand, it returns “mild” standard performance. The problem of outliers can be solved by removing values that deviate remarkably (extremely low frequency, extremely high / low number of outputs) from the analysis, if analysts deem it necessary.

However, in order to mitigate the mentioned drawbacks, this model uses slightly altered average. Assuming that the performance variable generated by the process is distributed according to normal distribution, the observed model for standard performance takes the average of performed daily outputs achieved over the period plus one standard deviation, considering that employees sometimes work faster, better, and that such behavior should be encouraged (it should also be noted that at the time when they had a high performance, this was not to the detriment of the quality of work). According to rules of normal distribution, the probability that the observed performance variable is at some point less than or equal to the standard performance is 84.1%, which means that in 15.9% of cases existing workers were able to achieve greater performance than the standard one. In the invoicing example, the standard output calculated in this way is 4.82 conditional output per person per hour, which means that one person produces 1 conditional output in 12.44 minutes on average.

The next step is to determine the optimal number of employees based on the previously calculated parameters. After calculating the value that was set for standard performance in the previous period, the further step for determination of number of employees required was to determine how many of them were necessary each working day in the previous period, if each of those employees would achieve standard performance, in order for the entire work to be fully completed, that is, the recorded quantity of output achieved that day. In this way, a review of days is conducted, with the corresponding outputs in observed period and required number of employees for each of them, so that the number of employees at that moment is optimal, neither too busy nor overloaded. The formula for this calculation is:

$$\text{Required Number of Employees per Date} = \frac{\frac{\text{Calculated daily output}}{\text{Daily effective worktime}}}{\text{Standard performance}} \quad (2)$$

The resulting numbers are rounded to the first larger integer (a more lenient approach that gives reserve) and those numbers are obtained for each analyzed day.

It was noted that during the observed period there were days when there was hardly any work at all and there was a need for only one employee to complete all work operating according to the standard performance, but there were also days when significantly more employees were needed to complete whole work on time. A table is given containing the required number of employees who would work according to the standard performance and the number of days in the previous period in which that number of employees was required to complete the entire work task on time. It is also cumulatively shown, in absolute and percentage terms, the number of days it took N or fewer employees to get the job done.

Table 3: Distribution of required Number of Employees per Day

Number of Employees (N)	Number of Days with N Employees	Number of Days with N or less Employees (Cumulative)	% of Days with N or less Employees
10	2	494	100.00%
9	2	492	99.60%
8	5	490	99.19%
7	8	485	98.18%
6	19	477	96.56%
5	45	458	92.71%
4	136	413	83.60%
3	195	277	56.07%
2	73	82	16.60%
1	9	9	1.82%

7. RESULTS AND DISCUSSION

The final step in the decision-making process would be to choose a certain percentage of days on which the organization could risk not having enough people to complete the job, if employees work with standard performance intensity. This shortage would have to be compensated either with faster work of the employees present during those days or the overtime hours. In this phase decision-makers will determine the number of required employees and having in mind the importance of such decision this is where particular attention should be placed. Hence, the decision will depend on the goals they want to achieve, including many aspects, such as existence and costs of overtime hours, workload of current employees, urgency of performing certain tasks, salary costs, and other employee related aspects, such as motivation, job satisfaction, etc. Therefore, it is very important to know what we want to achieve before we go on board with the decision on downsizing.

Current number of employees in the organizational unit from the presented example is 6. From the above table it can be concluded that in the observed period, working with standard intensity, at average, they managed to fully perform entire work task without overtime in 96.56% of days. Undisputedly, there had been many days when there was enough work for less than 6 employees. Only in 17 days it was necessary to work with an intensity higher that the standard, or standard intensity with overtime, because that amount of work required more than 6 employees. The optimal number of employees proposed by the consultant team was 4, which was even in 83.6% of days enough (but not necessary) to complete the whole job of the department. In the remaining days that were above the standard they would either work faster, or non-urgent and less relevant tasks would be left for the next day. For the application of this method experience and knowhow of the decision makers is of utmost importance. Nevertheless, in order to avoid subjective assessments, decision makers are advised to set clear goals and, if possible, measurable parameters that would reflect the difference if they select a certain number of employees. Although the department was proposed to be downsized by 2 employees, which is more than 30%, taking into account all above-mentioned, it can be concluded that the presented approach for determination of the required number of employees is relatively mild for several reasons. First of all, the standard performance is not determined by comparing process results performed by employees from another organizational unit or another company, but solely by comparing the performance of a particular organizational unit with itself in real time. Also, the standard performance is not determined by the results of the process achieved by the best worker, but by the cumulative performance of all employees directly involved in the process. Finally, the results of the research show that in the previous period, current employees in the existing conditions, set the standard of 4.82 invoices per man per hour, which was exceeded in 16.4% of the cases, on average two months a year.

8. CONCLUSION

"*Scientia potentia est*", Latin for “information is power” nowadays gains its full meaning throughout Industry 4.0 (The fourth industrial revolution). On the other hand, Einstein once said that information is not knowledge. The only source of knowledge is experience. This model aims to make knowledge from experience made from data which are stored somewhere in the system, while using traditional office tools, like Microsoft Excel, which can be used as some sort of BI tool. This model was originally designed to calculate the optimal number of employees in this organization. However, it should not be limited to one purpose, especially considering its various capabilities. It can be basis for identifying inefficient processes that should lead to process reengineering and costs cutting. If organization doesn’t have knowledge management established, that can be its first step. Another point of view is the value of this model to external consultants and their role in business. Data collected from various companies within this model provide indisputable argument in case of benchmarking and consistency while optimizing any other companies’ administration, regardless of the industry, as long as it is used within borders of administration. Main limitation of this research is the sample,

although the method was applied in several organizational units and the fact that the managers have accepted the results despite they often considered reduction of personnel. Future research should test this methodology in different companies. Another direction is to compare the results gained by this method with some other, in order to test its precision and efficiency.

ACKNOWLEDGEMENT

This research was supported by the Ministry of Education and Science of the Republic of Serbia through the Project No. 179081: Researching Contemporary Tendencies of Strategic Management Using Specialized Management Disciplines in Function of Competitiveness of Serbian Economy.

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ORGANIZATIONAL PRECONDITIONS FOR TURNING MAINTENANCE PLANNING INTO SMART AUTOMATED PROCESS

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Abstract: *Processes represent one of the key elements in every organization. Authors are focusing more and more on business processes as they see them as a mechanism for generating value for customers and building and maintaining competitive advantage. In each organization we can identify primary and supportive activities, but they all have important role in value chain. Operations represent all the actions that transform inputs into the final product form that has value for customers, and among other activities they include equipment maintenance. This paper tends to explain preconditions related to the organizational (re)design that represent the ground stone for the automatization of equipment maintenance planning. Certain tasks related to job allocation, definition of methods for organizing database of technical systems elements and to the procedures of organizing and reporting maintenance operations need to be executed before developing system that will turn maintenance planning into smart automated process.*

Keywords*: preventive maintenance plan, business process, organization, optimization, automatization*

1. INTRODUCTION

Every organization can be observed as a whole comprised of elements and relationships between those elements (Jaško, Čudanov, Jevtić & Krivokapić, 2017). Many authors have tried to perceive key elements of organizational systems and to present organization through models. In almost every model, processes figure as one of the key elements of every organization. Authors Waterman, Peters and Phillips (1980) in their model 7S under the element called system consider all formal and informal procedures that allow organizations to realize their activities. In the STAR model, processes are perceived as an element of organization precisely under this name (Kates & Galbraith, 2007). Even in the most contemporary concepts that try to explain the ways of performing business, the authors recognize the processes, that is, key activities, as one of the most important building blocks of the business model (Osterwalder & Pigneur, 2010).

Although little attention was paid to business processes until the 1990s, today they are placed in the center of interest, where in the scientific and professional literature more attention is placed to concepts such as process orientation or business process management (Sharp & McDermott, 2009). A process can be defined as a set of activities that use one or more types of inputs to produce an output that represents value to customers (Hammer, 2007). Harington (1991) describes a business process as an activity or group of activities that take input, increase its value and thus produce output for the internal or external user. Each organization transforms inputs into outputs in a certain way through a series of related activities that constitute business processes, thus creating a product or service (Komazec, Todorović, & Jevtić, 2012), and providing a competitive advantage and long-term sustainability (Carmeli & Tishler, 2004). Many authors see constant analysis and improvement of business processes as a potential source of sustainable competitive advantage (Powell, 1995), while some even say that process management is the best practice management principle to help companies sustain competitiveness (Hung, 2006). The process can also be seen as a structured series of activities designed to produce a specific output for a particular customer in the market (Davenport, 2005).

Observing the complete value chain within an organization, the key processes that exist in each system can be identified. Porter (1998) divides them into primary activities and support activities, as shown on Figure 1. Operational systems represent the guiding principle for the creation of value in every organization, since they refer exactly to the activities that transform inputs into outputs. Among others activities, they include the maintenance of the equipment that is used to create products or provide services.

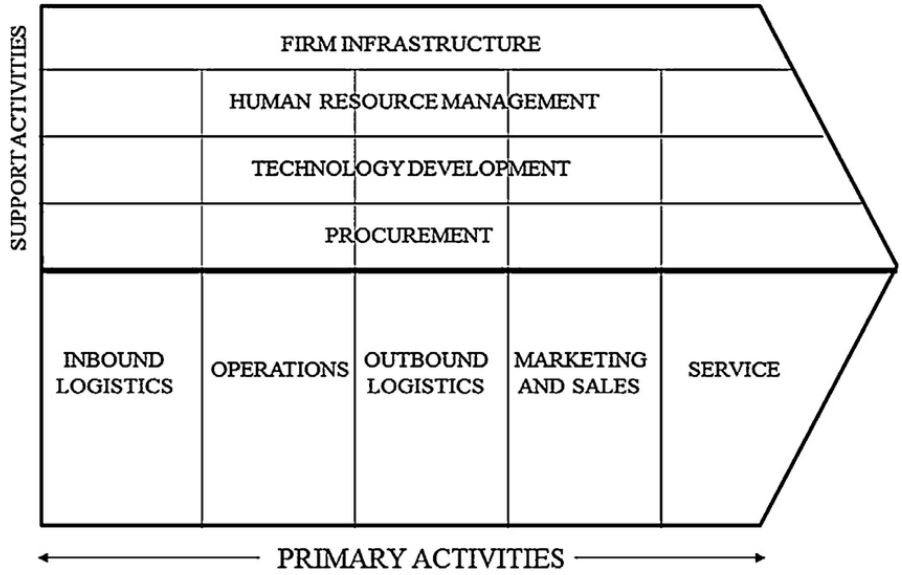

Figure 1: Primary and supportive activities in value chain (Porter, 1998)

2. MAINTENANCE PROCESS AND PREVENTIVE MAINTENANCE PLANNING

Equipment maintenance represents one of the most important functions within any system. Ensuring the correctness, functionality and development of technical systems is one of the prerequisites for continuity of production or provision of services, but also for building and maintaining a competitive advantage, both in terms of continuity and portfolio expansion, and in terms of creating flexibility of pricing policy by increasing productivity, that is, reducing costs. The importance of this process is reflected in the fact that the management of maintenance activities is often a very important part of business strategy (Barberá, Crespo, Viveros & Stegmaier, 2012). Maintenance jobs can generally be divided to preventive and corrective (Bahrick & Hall, 1991). Preventive maintenance tends to prevent malfunctioning and failures from happening, while corrective is focused on solving the problems when they happen. Corrective maintenance is stochastic and main goal is to eliminate the malfunctioning with minimal costs and in shortest time. On the other hand, preventive maintenance is predictive and can be planned (Lao, Ellis, & Christofides, 2014). Preventive maintenance consists of activities aimed at improving the condition of equipment and machinery before a malfunction occurs (Komazec, Todorović & Jaško), so it can be seen as an investment into preventing issues that may stop the operations, reduce the productivity and increase operational costs or cause opportunity costs (Stenström, Norrbin, Parida & Kumar, 2016). Preventive maintenance should be regarded as an investment opportunity to be optimized, and not as a cost to be minimized (Van Horenbeek, Pintelon, & Muchiri, 2010).

One of the most important activities in the process of maintaining technical systems is preventive maintenance planning (Kłos & Patalas-Maliszewska, 2013). Development of preventive maintenance plans is among key components in maintenance management framework (Barberá, Crespo, Viveros, & Stegmaier, 2012). The challenge for maintenance planning is to identify appropriate objects and tasks for preventive maintenance and ensure that there are adequate resources for the repair actions (Rosqvist, Laakso, & Reunanen, 2009). Therefore, organizations strive to find ways to define the most effective maintenance plans (Schutz, Rezg, & Léger, 2013). Information technology (IT) could be an important tool for reaching efficiency and effectiveness within maintenance, provided that correct and relevant IT is applied (Kans, 2008). Process intelligence can be used to have a positive impact across all aspects of operations (O'Donovan, Leahy, Bruton & O'Sullivan, 2015). However, as in any other use case scenario, certain organizational preconditions are demanded before implementing automatization and advanced software solutions (Pantsar-Syvaniemi, Ovaska, Ferrari, Cinotti, Zamagni, Roffia, & Nannini, 2011).

3. ORGANIZATIONAL PRECONDITION FOR AUTOMATIZED MAINTENANCE PLANNING

One of the main preconditions for the automatization of maintenance planning process is to define all possible operations of preventive maintenance for every element type that exist in organization's technical systems. The illustration is shown in Table 1.

Table 1: List of preventive maintenance operations per type of element

Technical system type	Element type	Maintenance operation	Maintenance period	System stop demanded	Time (min)	Labor force	Operation type
TS1	E1	O1	daily	No	30	1	electrics
TS1	E1	O2	daily	No	5	1	automatics
TS1	E1	O3	weekly	No	120	1	mechanics
TS1	E1	O4	weekly	No	150	2	mechanics
TS1	E1	O6	two weeks	Yes	600	6	electrics
TS1	E1	O7	two weeks	No	900	2	mechanics
TS1	E1	O8	monthly	Yes	300	5	automatics
TS1	E1	O9	monthly	Yes	240	2	mechanics
TS1	E1	O10	annually	Yes	900	3	mechanics
TS1	E2	O1	daily	No	10	1	automatics
TS1	E2	O2	daily	No	30	1	automatics
TS1	E2	O3	daily	No	15	1	mechanics
TS1	E2	O4	weekly	No	120	1	electrics
TS1	E2	O6	monthly	Yes	300	4	mechanics
TS1	E2	O7	annually	Yes	1200	5	mechanics

Additional levels of decomposition for all fields can be added if necessary. Besides parameters such as operation, element, system (or more if additional decomposition is needed), it is also necessary to define maintenance period for each operation, as well as predicted duration. It is also important to know whether the operation can be executed without stopping the technical system. Such stop can refer to power supply shutdown, production stop, IT network stop, app functionality stop or any other planned system stop according to the specifics of business process. For the purpose of allocating optimal set of human resources it is also required to define the type of operation, so each activity can be allocated to the adequate unit in organizational structure, or to specific outsourcing partner. Finally, in order to optimize utilization of labor capacity, it is important to determine the duration of each operation, as well as minimal number of executors (labor force field). Certain maintenance operations simply demand participation of more than one person. Of course, this model can be widened with any additional set of data or selection options, according to the needs of specific organization and its maintenance planning system.

What is extremely important is to have centralized database of elements and technical systems, and not distributed to various organizational units or legal entities in cases of complex organizations. If one technical system is implemented multiple times, for example in different units or on various locations, it needs to be recorded in the database, as illustrated in Table 2.

Table 2: Categorization of technical systems within organization in the centralized database

Technical system code	Technical system name	Technical system type	Location	Entity
CTS1	NTS1	TS1	Location 1	Entity 1
CTS2	NTS2	TS1	Location 1	Entity 1
CTS3	NTS3	TS2	Location 1	Entity 1
CTS4	NTS4	TS3	Location 1	Entity 1
CTS5	NTS5	TS1	Location 1	Entity 1
CTS6	NTS6	TS1	Location 1	Entity 2
CTS7	NTS7	TS1	Location 1	Entity 2
CTS8	NTS8	TS2	Location 1	Entity 2
CTS9	NTS9	TS3	Location 1	Entity 2
CTS10	NTS10	TS1	Location 1	Entity 2
CTS11	NTS11	TS4	Location 2	Entity 2
CTS12	NTS12	TS5	Location 2	Entity 2
CTS13	NTS13	TS5	Location 3	Entity 2
CTS14	NTS14	TS2	Location 3	Entity 2
CTS15	NTS15	TS6	Location 3	Entity 2

Furthermore, if single element type is present on in different technical systems, it has to be recognized as the same element type within whole maintenance planning system, as shown in Table 3.

Only after the introduction of such a database and the organization of equipment maintenance work partial or complete automatization of preventive maintenance planning process can be considered.

Table 3: Distribution of elements to technical systems in the centralized database

Element code	Element type	Technical system code	Manufacturer	Installation year
CE1	E1	CTS1	M1	2016
CE2	E2	CTS1	M2	2016
CE3	E3	CTS1	M3	2017
CE4	E4	CTS1	M1	2019
CE5	E5	CTS1	M1	2016
CE6	E6	CTS2	M3	2016
CE7	E7	CTS2	M4	2020
CE8	E2	CTS2	M2	2016
CE9	E8	CTS2	M1	2017
CE10	E9	CTS3	M5	2019
CE11	E10	CTS3	M5	2016
CE12	E3	CTS3	M1	2017
CE13	E11	CTS3	M3	2016
CE14	E12	CTS4	M3	2020
CE15	E2	CTS4	M4	2018
CE16	E5	CTS4	M6	2018
CE17	E13	CTS4	M4	2016
CE18	E14	CTS4	M2	2016
CE19	E15	CTS5	M2	2019
CE20	E7	CTS5	M6	2020

4. SMART GENERATION OF MAINTENANCE PLANS AND WORK ORDERS

If the appropriate organizational allocation of maintenance operations is carried out, by units in the organizational structure or specific workplaces, and if all data are entered into the database in previously described manner, it is possible to create an initial maintenance plan, based on all operations related to technical systems and the associated elements, that is, their periodicity of realization.

Described maintenance planning model allows the annual maintenance plan, in the form shown in Table 4, to be generated automatically, based on the maintenance periodicity.

Table 4: Illustration of automatically generated annual preventive maintenance plan

Technical system code	Technical system name	Element code	Element type	Operation	System stop	Time (min)	Labor force	Period	Note	Week	Date
CTS1	NTS1	CE1	E1	O1	No	30	1	daily	365x in plan		
CTS1	NTS1	CE1	E1	O2	No	5	1	daily	365x in plan		
CTS1	NTS1	CE1	E1	O3	No	120	1	weekly	52x in plan		
CTS1	NTS1	CE1	E1	O4	No	150	2	weekly	52x in plan		
CTS1	NTS1	CE1	E1	O5	Yes	210	4	weekly	52x in plan		
CTS1	NTS1	CE1	E1	O6	Yes	600	6	2 weeks	26x in plan		
CTS1	NTS1	CE1	E1	O7	No	900	2	2 weeks	26x in plan		
CTS1	NTS1	CE1	E1	O8	Yes	300	5	monthly	12x in plan		
CTS1	NTS1	CE1	E1	O9	Yes	240	2	monthly	12x in plan		
CTS1	NTS1	CE1	E1	O10	Yes	900	3	annually	1x in plan		

As for the further course of the process of drafting the annual maintenance plan, it is necessary to determine the planned week for the implementation of activities that do not take place on a daily or weekly basis (those whose periodicity is longer than a week). If the annual maintenance plan is prepared in the described manner and the planned weeks are allocated, the monthly and weekly maintenance plans are also generated automatically from it, based on the assigned week of implementation. The allocation of a planned week can theoretically also be automated, if appropriate limitations are predefined within the system, or if it is done on the basis of historical data, i.e. previous plans. However, the planned week can be influenced by a number of external factors depending on the specifics of the organization, which are simply not possible, or very difficult to predict. This primarily refers to production plans that often depend on demand or sales, then weather conditions if technical systems are outdoors, then from partner companies if technical systems depend on them, as well as the availability of human resources, which is affected by the planned and unplanned employee absences. Taking into account all aforementioned, it is even more difficult at the very beginning of the year to assign a specific date for the implementation of activities in an adequate manner. Practice shows that the optimal solution is to automatically generate an annual plan and predict the weeks of realization of certain tasks, and that specific dates of realization of activities are assigned within monthly or even weekly plans.

After assigning the planned week to each operation from the annual maintenance plan, monthly and weekly plans are automatically generated, and after determining the specific dates of operations within the monthly or weekly plan, an overview of daily activities by dates is obtained, from which work orders are further created. The work order should, on the one hand, provide a sufficient number of employees for the implementation of the most demanding operation in terms of the required number of people, and on the other hand, to ensure the utilization of all engaged workers. Specifically, if, for example, there are 4 employees on a work order due to certain operation, the total estimated duration of all activities on that work order must be around 30 hours (4 employees with 7.5 hours of effective working time during the day, if there are 8 working hours and one break of 0.5 hours). Otherwise, there will be unused staff capacity at the end of the order execution. The work order should contain the following fields:

- the date to which it refers (or the period);
- a list of activities that need to be implemented (and the elements to which they relate);
- list of employees in charge of realization of activities.

When allocating employees to work tasks, it is necessary to take into account the following:

- the required number of employees for the implementation of activities on the work order should be greater than or equal to the required number of employees for the activities that require the most employees;
- the total duration of activities on the work order should ensure that sufficient work is assigned so that all workers are effectively engaged throughout the day, i.e. for as many days as the order lasts.

If the described planning system is connected to a personnel database that is being regularly updated, a work order in the format shown in Figure 2 can also be generated automatically.

WORK ORDER

Number: 123 **Start date:** 10.06.2020. **End date:** 10.06.2020.

TASKS: **EXECUTORS:**

Technical system code	Technical system name	Element code	Element type	Maintenance operation
CTS1	NTS1	CE1	E1	O1
CTS1	NTS1	CE1	E1	O2
CTS1	NTS1	CE1	E1	O3
CTS1	NTS1	CE1	E1	O4

Petar Petrović
Marko Marković
Stefan Stefanović
Miloš Milošević

Figure 2: Illustration of automatically generated work order

With the aim to fully automate the maintenance planning process, and be able to generate not only the initial plan automatically but also each subsequent one, it is necessary to standardize the way of reporting on the implementation of each work order, and thus the maintenance plan. In order to automatically monitor the implementation and update of the plan, but also to create potential for future improvements of the planning system, the implementation report, whose illustration is shown in Figure 3, must contain the following items:

- list of realized operations, so that they could be recorded in the plan;
- a list of unrealized activities, so that the plan can be updated and that they can be moved to another day and later added again to a work order;
- the reasons for not carrying out any such operation, for later analysis;
- identified additional necessary maintenance activities, in order for them to be added to the plan and assigned to a future work order, but also to monitor the condition and performance of technical systems and elements;
- time of beginning and end of works, and if possible, of each maintenance operation, in order to control and revise the estimated duration of operations, but also for evaluation of workers;
- verification of all workers from the work order, but also the users of technical systems that the works have been performed.

WORK ORDER REPORT

Number: 123 **Start date:** 10.06.2020. **End date:** 10.06.2020.

TASKS

Technical system code	Technical system name	Element code	Element type	Maintenance operation	Completed	Note
CTS1	NTS1	CE1	E1	O1	YES	/
CTS1	NTS1	CE1	E1	O2	YES	Revise tomorrow
CTS1	NTS1	CE1	E1	O3	YES	/
CTS1	NTS1	CE1	E1	O4	NO	Not enough time
ADDITIONAL WORKS						
CTS1	NTS1	CE1	E1	O7		Replacement
CTS1	NTS1	CE2	E2	Description 1		Malfunctioning noted

EXECUTORS:		**USER(S):**				**ADDITIONAL NOTES**
Petar Petrović	Stefan Stefanović			Start date & time:	10.06. 7:30h	
Miloš Milošević	Marko Marković			End date & time:	10.06. 14:30h	

Figure 3: Illustration of standardized work order report

This standardized way of reporting enables automatic recording of works, but also update of weekly, monthly and annual maintenance plans. There are several basic reasons for amending or supplementing a plan:

- if all planned activities are not realized in full, so some of them are left for the next few days, due to the lack of time or if certain problems in the work occur (fourth row on Figure 3);
- if during the work the needs for additional maintenance activities arise (second row on Figure 3);
- if during the realization of the work order some activity which was not in it and which is planned for some later date is realized regardless, in that case it should be recorded and removed from the plan (fifth row on Figure 3);
- if, in addition to standard maintenance operations based on condition or system performance analysis, it is determined that some other maintenance activities are required (last row on Figure 3).

In situations when it is necessary to supplement the plan with additional activities that are determined to be implemented during the year, based on the analysis of technical system performance and equipment condition, it is also necessary to assess the duration and minimum required number of employees, define whether to stop the technical system and predict the week (and later the exact date of realization), as shown in Table 5.

In this specific example:

- planned activities (from the work order) that were implemented were recorded (rows 1, 2 and 3);
- activities from the order that have not been realized are marked (row 4) - they need to be assigned a new date in the maintenance plan, and they should be in certain work order again;
- activities from the plan that were not in a specific work order but were nevertheless implemented (row 7) were marked, in order to be recorded, and not to be placed again in some future work order;
- new activities were added to the maintenance plan based on the notes from the report on the implementation of the work order (rows 11 and 12), the duration and required number of employees were estimated, and they were assigned a planned week and implementation date in order to be placed in some future work order.

In the described manner, based on the execution report, the works are recorded and the implementation of the maintenance plan is monitored, and at the same time the maintenance plan is being dynamically updated. In order for the plan to be automatically updated, it is necessary that the reporting on the realization of work orders is done with the help of certain software solution that will automatically record the data in the database. Otherwise, additional works can be entered manually in the annual plan, and they will be assigned a planned week and date (which will probably be done manually for previously explained reasons), after which further development of monthly and weekly plans, as well as work orders, will continue to be performed automatically.

Table 5: Illustration of automatic maintenance plan update

Technical system code	Technical system name	Element code	Element type	Operation	System stop	Time (min)	Labor force	Week (plan)	Date (plan)	Realization date
CTS1	NTS1	CE1	E1	O1	No	30	1	22	10.june	10.june
CTS1	NTS1	CE1	E1	O2	No	5	1	22	10.june	10.june
CTS1	NTS1	CE1	E1	O3	No	120	1	22	10.june	10.june
CTS1	NTS1	CE1	E1	O4	No	150	2	22	11.june	
CTS1	NTS1	CE1	E1	O5	Yes	210	4	23	11.june	
CTS1	NTS1	CE1	E1	O6	Yes	600	6	23	11.june	
CTS1	NTS1	CE1	E1	O7	No	900	2	23	12.june	10.june
CTS1	NTS1	CE1	E1	O8	Yes	300	5	23	13.june	
CTS1	NTS1	CE1	E1	O9	Yes	240	2	22	10.june	
CTS1	NTS1	CE1	E1	O10	Yes	900	3	23	13.june	
CTS1	NTS1	CE1	E1	Revision	No	30	1	22	11.june	
CTS1	NTS1	CE2	E2	Description 1	Yes	360	5	24	21.june	

5. CONCLUSION

In this way, dynamic planning of maintenance work at the level of the entire organization is provided, as well as standardized monitoring of the implementation of the maintenance plan in real time. At any time, it is possible to see the percentage of implementation of the annual maintenance plan and determine the possibility of performing the remaining operations. This opens the possibility for flexibility and timely response, as additional capacity can be engaged in a timely manner if it is determined that there is a danger that the maintenance plan will not be fully implemented for any reason.

Furthermore, a basis for analytics in the domain of performance of technical systems and individual elements was generated. It is possible to determine the total maintenance time by element and technical system, and therefore maintenance costs. In addition, different equipment manufacturers or suppliers can be compared and the performance of their products analyzed. Also, different entities to which the equipment belongs or the locations where it is located can be analyzed, in order to determine possible additional factors that affect the dynamics of failures and the results of preventive maintenance operations.

Finally, it is possible to monitor the performance of the executors of maintenance operations, regardless of whether they are employees or externally engaged parties through outsourcing. Comparison of defined time norms with realistically realized operation times creates a basis for simulative rewarding of employees. It can also be important for the evaluation of outsourced executors.

Although the model is designed to be very practical, this paper describes the potential for its application from a theoretical point of view, therefore the basic limitation of the paper is implementation and application in practice. On the other hand, we have already successfully applied the model in several different organizations and we plan to present the achieved effects in some future article. The potential for further research lies in the further development of the described concept, primarily in the domain of full automation of the planning process. This refers to the automatic scheduling of maintenance operations by weeks, possibly even days, which requires the development of algorithms related to personnel databases in which it is possible to identify available human resources, then spare parts and equipment warehouses, as well as other support activities necessary for implementation of maintenance process. Planned weeks and days for operations included in the annual plan can be determined on the basis of historical data, with the application of artificial intelligence systems, or on the basis of multi-criteria analysis and optimization models that will take into account any anticipated limitations that may affect their implementation.

ACKNOWLEDGEMENT

This research was supported by the Ministry of Education and Science of the Republic of Serbia through the Project No. 179081: Researching Contemporary Tendencies of Strategic Management Using Specialized Management Disciplines in Function of Competitiveness of Serbian Economy.

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TYPOLOGIES OF SERVICES REVISITED: MAISTER'S AND SCHEMENNER'S FRAMEWORKS IN THE DIGITAL AGE

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Abstract: *This paper is aimed at adjusting existing frameworks of service classification to the environment of digital age. As well known frameworks both in theory and practice, we have chosen Maister's classification and Schemenner's classification. We have described both classifications and provided examples, as well as new examples of services in the digital age using Maister's graphical representation. Since the frameworks are similar, Schemenner's classification is described without the graphical representations. Future research can be focused on the elaboration of Schemenner's description, which was shortened in this article due to text size limitations. Specific aspect of business are given for each of the four quadrants, along with a rudimentary description of the possible business model.*

Keywords*: Service framework, Maister's classification, Schemenner's classification, Service typology*

1. INTRODUCTION

This paper is aimed at extending the famous classification of services proposed by the Maister (1993, 2004), as well as Schemenner (1986). Maister has proposed a two-dimensional framework of service classification, which can be extended on various industries and examples. The first dimension of this framework is the level of client interaction. Maister (2004) divides this to two distinctive categories according to the process, which can be standardised - the same for each client and customised- specific to each of the client's needs and requirements. His second dimension is the level of client interaction, which he categorises as high and low. According to that, he presents 2 by 2 framework. The first combination is the standardised service with a high level of client interaction, which he illustrates by the nurse example. Service value is directly related to the interaction with the client, and this service is hard to automate or outsource.

The second combination Maister proposes in his classification of services has a low level of client interaction, and is standardised. Mass service approach, which is in this case illustrated by Maister's example of the pharmacist, is easy to automate and can benefit a lot from the application of artificial intelligence (AI). The third combination is the customised service and high level of interaction with the client, which is illustrated by the psychotherapist services. It is even harder to automate this class of services because finesse needed to provide it with the competitive edge is related to the soft skills and human interaction. The fourth and final class also has a low level of client interaction. However, the service itself is not standardised but customised. It can benefit from the AI in the diagnosis, which is a significant portion of the created value, and it can be automated with more ease due to the lower level of human interaction.

Schemenner (1986) provided a very similar framework earlier. His proposed axes are level of interaction and customisation, which integrates two of the Maister's dimensions, and on the second axis, he provides labour intensity. This leaves us again with a framework of four separate service types. The first group in his framework has low interaction and customisation but high labour intensity. Dubbed mass service, it relies on the benefits of Taylorism to improve efficiency (Jaško, Čudanov, Jevtić, & Krivokapić, 2014). Using the economy of scales, with minimal interaction a standardised service is provided to the customer, corresponding to its namesake in Maister's classification. Second class, with low interaction and customisation, along with the low labour intensity results in what he calls service factory. Basically, clients are left to self-service most of the time, and the resources owned by the service company provide the rest of value without significant work engagement, usually by self-service or the automated process. Schemenner illustrates this by the example of airlines, resorts, hotels, recreational facilities. The third option he proposes has a high degree of interaction and customisation, along with the high level of labour intensity. It results in the services he illustrates as professional services, where most of the interaction is aimed at knowing the client and estimating client's tacit needs and preferences, which Maister illustrates with the examples of doctors, lawyers, accountants and architects.

Fourth and the last class of services in his framework has high interaction and customisation; however labour intensity is low. The efficiency of service here relies on the economy of scale, owned competitive resources, or both, as in his given example of hospitals and repair services. By using their framework, we will try to provide examples of services which fit in their framework in the context of industry 4.0 and discuss possible applications of IT and automation.

2. SERVICE FRAMEWORKS FOR INDUSTRY 4.0

To analyse how do modern, industry 4.0 services fit in these decade-old frameworks, we will rely on Maister's classification and use his framework, populated with new serviced with digitally transformed business models.

2.1. Hybrid services

The first example of our services has a standardised process, as well as a high level of client interaction. Most of these services are based on the digital transformation of industries. Examples of these industries can be given in the transformation of taxi services by companies such as Uber (Cramer & Krueger, 2016; Cherry, 2016), Hailo (Brenner & Herrmann, 2018) or Lyft (Rogers, 2016). A similar example is the transformation of lodging, tourism industry by the companies such as Airbnb (Skog, Wimelius & Sandberg, 2018; Geissinger, Laurell & Sandström 2020) or Booking.com (Kohle, 2017; Boukherouk, Ed-dali, & Dbibirha, 2019). Examples can also be found in the digitalisation of banking services (Tornjanski, Marinković, Săvoiu, & Čudanov, 2015). Further on, similar platforms are transforming the industries which rely on offline sales/customer relationship channels or go online using particular applications, specific to the business entity.

Companies such as listed above aim at the global offer. They work as architects, operators and caretakers (Snow, Miles, & Coleman, 2000) of the global network which is providing the services instead of divided, separate business entities. First benefit of the Hybrid services is a combination of economy of scope and economy of scale (Dombrowski & Wagner, 2014), as one channel is used to distribute service to a significantly larger client base. Therefore, a wider array of services can be provided. At the end, it is more about the customer than about the technology, as it was noted by Furr and Shipilow (2019). Technology, AI and automation are here only the tool and channel for providing the old service to the digitally literate customers. The basic idea remains the same, while the value is delivered to the clients by other means. Automation and AI can find implementation to increase efficiency and effectiveness of the distribution and customer relationships process. A border case between these hybrid services and mass service platforms which are described in the next paragraph are distant learning and MOOC platforms, such as Coursera, EdX, Udemy or Udacity.

2.2. Social networks and .com platforms

The second type of services in the Maister's typology can be illustrated by the social networks and .com platforms which are fully automated and provide the whole package of value without any, or at least without significant physical interaction. We can find examples in LinkedIn in providing the service of professional social networking (Gerard, 2012; Chang, Liu, & Shen, 2017). Another example is mobile phone photo-sharing, video-sharing, and social network service Instagram (Sheldon & Bryant, 2016), or its owner Facebook. Further, Amazon can be seen as an example of e-commerce platform giant. However, this company provides a wide portfolio of services which go beyond this type, due to the constant innovation of the corporate business (Arnett, Goldfinch & Chinta, 2018). A common denominator for this and similar examples is that services do not have a high level of client interaction and that the service is standardised. Although clients customise their experience and need satisfaction with the different approaches to the usage of tools, basically the tools providing the service are standardised.

There are numerous examples of the application of automation and AI for the service that these companies provide. Getting to know their users, and trying to create the customised experience using available standardised tools are essential goals for companies in this quadrant, and analysis of aggregated user data can be used to influence purchase intentions (Valentini, Romenti, Murtarelli, & Pizzetti, 2018), to provide a competitive advantage to online marketers (Agung & Darma, 2019). Applications can extend beyond this quadrant, and be deeply questionable, such as scandal with Cambridge Analytica harvesting user data to sell insights to political campaigns (Berghel). Also, this type of services can be extended to very creative purposes, such as university branding (Desai & Han, 2019) or event monitoring (Giridhar, Wang, Abdelzaher, Al Amin, & Kaplan, 2017).

2.3. Data mining and AI based consulting

Next type of services in the new economic environment uses the benefits of data mining and AI to provide customised, highly client adjusted solutions. Contrary to the first example of services, these services use

intensive contact with the client to mutually create and harmonise various aspects of the custom solution, which is provided as a service. While the previous examples can be illustrated as the mass service, gaining from the economy of scope and searching for the as low marginal costs as possible, this type of services is more resembling handcrafted production. Each service can be aligned to a single customer and specifically fit its needs and requirements.

Such service can be found in the application of AI in business decision making (Duan, Edwards, & Dwivedi 2019). This large and growing field can be satisfied internally, but companies that are not major players would probably be directed to find external services. Example of such AI and data mining based consulting can be provided by the Accenture (Morvan, 2016), and AI is becoming more and more interesting in providing the consulting services (Nissen, 2017). Another interesting example is FinBrain (Zheng, Zhu, Li, Chen, & Tan 2019), using AI to predict finance trends stock prediction, which can be used to provide customised investment portfolio.

2.4. AI analytics and resource management services

In order to provide a service with the low level of client interaction, but with the highly customised process, a company will have to automate analytics and provide a customised solution but avoid to manually gather data, information and knowledge about the client's needs and requirements using the direct contact and interaction. This type of services can use IoT to monitor and manage resources, gathering a large amount of data and automatically providing customised service. Applications can be found in predicting failures based on big data analysis, or in the optimisation of maintenance and usage.

Example of such services can be Larsen and Toubro Ntx digital infrastructure management (Lamba, 2019). Also, container monitoring service Sysdig, which applies this approach to improve performance management (Degioanni, 2019) and provide container security monitoring (Gantikow, Reich, Knahl, & Clarke, 2019). Since these services are emerging, there is a wide scope of possible business model innovations and improvement in the application of these services.

2.5. Maister's matrix of service typology adjusted for digital services

In the following figure we present advanced matrix as described in the previous portion of text, which is conceptually developed by Maister. It is adjusted for digital services, based on AI, mass customisation, automation and other concepts inherent to Industry 4.0. Examples given can be extended to all companies which fit given description provided in the four quadrants.

Due to the limited writing space, Schemenner's framework is not presented separately. By integrating dimensions of interaction and customisation Schemenner provides a new dimension of labour intensity. Without automation, this dimension is loosely similar to the level of client interaction on Maister's framework, and in that cases frameworks would also be very similar. In the case services are automated, high labour intensity quadrant services are slowly disappearing from the business environment. However, flamboyant examples can be found, such as the case of Amazon's Mechanical Turk (Buhrmester, Kwang, & Gosling, 2011) and similar crowdsourcing projects.

3. CONCLUSIONS

Analysis of the presented patterns in Maister's framework points us toward the conclusion that frameworks provided more than three decades ago can still be an interesting tool for analysis of services in the digital age. Schemenner's framework was given in brief description due to the limited space, and future research can be focused its elaboration. These typologies can help entrepreneurs in the digital services business to analyse their business strategies. Since all four quadrants provide a different concept of doing business, we can expect that different value propositions, channels, customer relations are necessary in order to provide value to client segments. Also, different revenue streams are expected for different classes in the framework. Future research can be aimed at identifying business models appropriate for each of the presented classes, as well as further describing organisations of companies, fit to provide different types of services for each of the four quadrants.

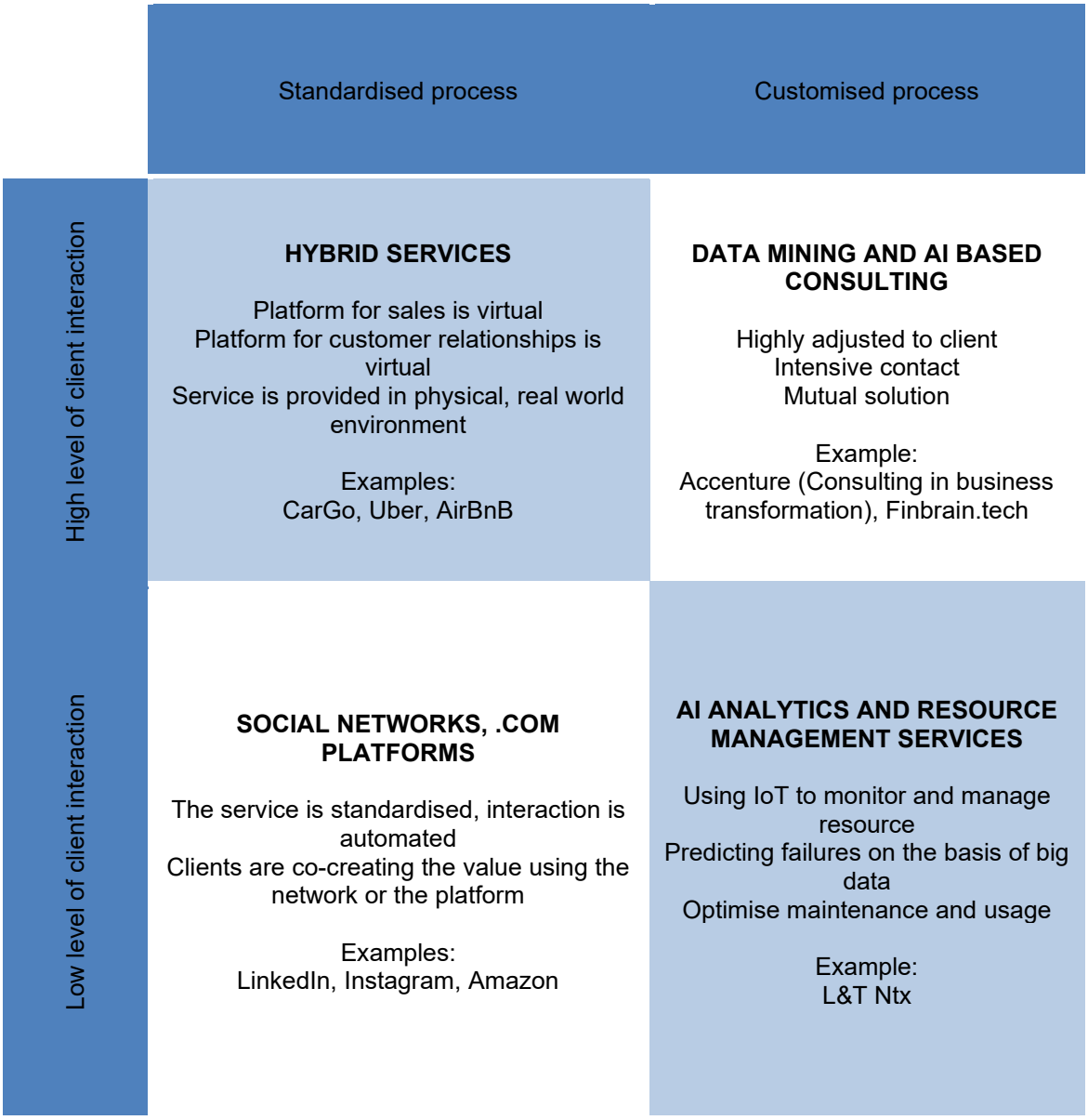

Figure 1: Maister's matrix adjusted to digital services (based on Maister, 1993)

ACKNOWLEDGEMENTS

This research study has been supported by the Republic of Serbia's Ministry of Science and Technological Development, Program of Basic Research 2011-2014 project III47003, "Infrastructure for Technology-Enhanced Learning in Serbia".

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IMPROVING FLEXIBILITY OF PROCESS PERFORMANCE MEASUREMENT

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Abstract: *This paper seeks to improve flexibility of process performance measurement (PPM), since the existing literature research regarding PPM models suggests the lack of flexibility. In order to address this issue, a new process performance measurement model is proposed. Then the case study research was conducted, and based on the results, the proposed model is extended, with a list of process performance indicators aligned with strategic goals. The model can be used in a wide range of different companies, which, among the other, increase its flexibility.*

Keywords*: Flexibility, goals, process, performance indicators*

1. INTRODUCTION

In modern business conditions, in order to achieve sustainable performance of business systems, it is crucial for companies to manage their processes. Process management introduces a systemic and integrated view of work and it shows the interdependence between suppliers and clients (Nara et al., 2014). Companies that align their business processes with the changing environmental requirements will not only gain a competitive advantage, but they will also be able to manipulate this alignment better and faster than their competitors (Tupa, 2010). In order to measure progress towards business goals, it is important for companies to evaluate the performance of their business processes by means of the so–called Process Performance Indicators (PPIs) and their target values (del-RíO-Ortega et al., 2012).

In literature and in practice there is number of performance measurement (PM) models and frameworks (Budd, 2010; EFQM, 2009; Fitzgerald et al., 1991; Franceschini et al., 2019; Kanji, 2002; Kaplan & Norton, 1998; Kueng, 2000; Ljungberg, 2002; Lynch & Cross, 1991; Neely et al., 2007; Sikavica & Hernaus, 2011; Sinclair & Zairi, 1995) that provide guidelines for the PM system design, with each of them developing and reviewing PM problems from different perspectives (Simeunovic et al, 2016). These different PM models have clear academic foundations, but they are of little help in the practical implementation of concrete measures at the operational level. Many organizations still define their PM systems without understanding the dynamic interdependences between the goals, processes and performance indicators (Glavan, 2011; Hernaus et al., 2012; Kueng et al., 2001; Wieland et al., 2015).

According to authors' knowledge, none of PM models link organizational goals and PPIs directly, which would allow model flexibility (for this research purposes, flexibility is defined as the applicability of model in a wide range of companies, without significant changes in the model itself). This is important because the environment is dynamically evolving, and goals, as well as the organization's strategy should be changed, and when they change, some of PPIs also have to be changed.

So, the crucial question is: How to enable flexibility in measuring process performance i.e. is it possible to design a process performance measurement (PPM) model that is applicable in a wide range of companies, without significant changes to the model itself?

The paper is organized as follows: after a brief literature review about process performance indicators and the existing PM models, the initial PPM model is proposed. After that, the research methodology is described. This is followed by the results section and the discussion section, which examines the research question and the new PPM model. The paper closes with practical implications of research, research limitations and suggestions for further research.

2. LITERATURE REVIEW

The PPM system expresses the company's strategies and goals in process-oriented performance measures and provides the necessary information and tools for their validation (Grosswiele et al, 2013; Wieland et al, 2015).

Process measurement involves setting the PPIs, determining the desired value of the indicators and measuring the achieved values (Sujova et al, 2014). PPIs are metrics capturing the performance of a business process (Kohlbacher & Gruenwald, 2011). These are indicators that measure the performance of the whole organization through the process and determine the extent to which the organizational goals are achieved (Sikavica & Hernaus, 2011).

PPIs must provide a clear information about process effectiveness and efficiency (Del-RíO-Ortega et al., 2013; Franceschini et al., 2019). In most processes, measurements (obtaining performance indicators) are performed in order to obtain a large amount of information which allows quality control, yield evaluation, operation optimization, among other tasks (Maciel et al., 2017).

According to Heckl and Moormann (2010) companies need to select PPIs that are directly related to their strategy, and they need to link those indicators with their business goals and resources. This will then result in strategic performance information that supports senior management in targeting the desired strategic direction.

Although most authors agree that PPIs must be linked to the goals and strategies of the organization, there is no consensus in the existing PPI literature on what types or dimensions of PPI should be measured (Simeunovic et al, 2020).

Numerous models of defining and developing PM systems have been proposed in academic research. These different PM models have clear academic foundations - they provide guidance on how companies should project their unique performance measurement system, but they are of little help in the practical implementation of concrete measures at the operational level (Striteska & Spickova, 2012). Many organizations still define their PM systems without understanding the dynamic interdependences between the goals, processes and performance indicators (Hernaus et al. 2012; Kueng et al. 2001; Glavan 2011; Wieland et al. 2015). Moreover, although the process of developing a PM models is well researched, only a small number of papers explicitly address PPM systems (Van Looy & Shafagatova, 2016).

By researching and analyzing the literature on the most common PM models (Tableau de Board (de Guerny et al., 1990), Activity based costing method (Budd, 2010), Data Envelopment Analysis (Savić, 2012), Balanced Scorecard (Kaplan & Norton, 1998), EFQM model (EFQM, 2009), Supply Chain Operations Reference model (Supply-Chain Council, 2010), etc), the lack of flexibility in these models was identified. According to (Simeunovic, 2015) model flexibility is defined as the ability to use model in a wide and varying range of companies, i.e. model applicability in a number of companies, with no significant changes in the model.

3. INITIAL PM MODEL

Based from this literature research, and some practical experiences of the authors, an initial model for PPM, called GPI model, was developed. The prerequisite for applying PPM model is that the company is process-oriented. This model is designed in order to help process-oriented companies to define PPIs which are related to the strategic goals of the company.

The GPI model starts from the goals at the highest level of the business system, which have to be defined based on stakeholders' requirements and aligned with mission and vision of the company. When strategic goals are defined, it is necessary to determine what company needs to do in order to achieve those goals, i.e. to decompose them into lower level goals (business units' goals). The goals of business units are considered as second level goals. The next step is to determine which processes in the organization should be performed in order to achieve these second level goals. Those are key processes and performance of these processes should be measured, since they contribute to defined goals realization.

Then, for each of these processes, performance indicators, which should be measured, have to be defined. In this way, PPIs are directly linked with bussines units' goals, but also, indirectly, with the highest level (strategic) goals of a company. The degree to which goals are met is determined by measuring and comparing process performance with a defined goal.

4. RESEARCH METHODOLOGY

4.1. Research Design

It was decided to conduct a case study research in order to: 1) test the applicability of the proposed model; and 2) examine the interdependencies of strategic goals and PPIs and to generate the universal list of PPIs, which can be measured and monitored in each process-oriented company.

In order to determine the quality of the research design we used four criteria (Yin, 2009): Construct validity (has been met by grounding the concept of flexibility of PPM models in the literature, and by multiple sources of data); Internal validity (has been met through within-case analysis and cross-case pattern matching); External validity (has been met through analytical generalization and selection of multiple cases from different industrial sectors); Reliability (has been assured through the case study protocol that we developed).

The unit of analysis was business system, i.e. company. The criteria for selection of the cases were: 1) companies are process-oriented; 2) at least one of the authors was involved as consultant in previous projects of process model design in the company; and 3) company data is available for research (companies want to cooperate). The case study research was conducted from October 2015 until February 2017.

During research planning, the intention was to test the initial GPI model in process-oriented organizations, and then, to analyze the decomposition of strategic goals of organizations into the business units' goals, as well as their connection with key process performance indicators

4.2. Data Sources

Data collection was conducted in two phases. Phase 1 involved the selection of companies. Among 36 companies that we selected, three were dropped out because they recently implement GPI model, so it wasn't possible to identify the model's success, while two companies refused to participate in the research for their own reasons. So, thirty-one companies participated in the research. For confidentiality purposes, the names of the companies have been obscured. A description of the selected organizations is summarized in Table 1.

Table 1: Research sample

Case	Description of Business Activity	No of employees	Founded Year
A	Production of wood and wood products	4	2002
B	Production of metal and metal products	7	1993
C	Consulting and engineering services	185	1989
D	Production of textile products	18	1996
E	Production of milk and dairy products	53	2003
F	Financial and insurance services	684	2007
G	Production and distribution of wine	20	1996
H	Wholesale Trading	3	1992
I	Financial and insurance services	561	1992
J	Production of processing equipment	42	1998
K	Catering services	130	2004
L	Production of milk and dairy products	174	1992
M	Production of heating devices	1500	1948
N	Land transport services	18356	2005
O	Production of cardboard packaging	118	1982
P	Engineering, consulting, training and support services	40	1992
Q	Security and investigation services	27	2005
R	Production of uncommon radionuclide	8	1991
S	Transport and storage services	16	2010
T	Land Transport services	5944	1892
U	Production of metal and metal products	74	1992
V	Wholesale Trading	4600	1992
W	Production of confectionery products	1500	1952
X	Production of furniture	33	2001
Y	Production of building materials and aggregates	334	2002
Z	Production of flexible packaging	76	2003
AA	Retail trading	11	2008
BB	Travel and tourism related services	4	2011
CC	Production of food and beverages	35	1996
DD	Education services	36	2005
EE	Sports, amusement and recreation	72	1912

Table 1 shows that the research sample varied regarding size (3 to 18,356 employees), founded year (3 to 122 years) and business industry (13 service-oriented companies, 14 production companies and 4 companies operating in service and manufacturing industry). This phase also included sending an appropriate form for conversion of business system's goals into PPIs.

Phase 2 included usage of various data sources. Firstly, all the companies were visited several times, in order to better understand the companies' processes. In addition, workers/officials in each organization were interviewed. They were chosen on the basis of their earlier involvement in process design projects and their knowledge of the company's business process. Interviews were conducted in order to evaluate the significance of the defined indicators, and whether they are truly valid for monitoring the achievement of goals. Interviews were conducted according to recommendations of Yin (2009). Also, the existing documentation and different archival records were examined in order to gain profound understanding of the procedures in the studied cases.

This work was done in order to identify the unequivocal dependence between the strategic goals of the company and the PPIs monitored in each company. This dependence was recorded in the template for translating the business system's goals in PPIs, as well as through formulas in each company. Templates and formulas were verified and they represent the result of the data collection phase.

5. RESULTS

The initial GPI model was applied in each case (company). Furthermore, in every company, the units of measurement, reference values and the method of measuring these goals were defined. The management of each company was thus able to measure PPIs, and to use the information gathered in order to manage their business.

Regarding this research, the results of case study within each company were: (1) a fulfilled form for translating the business system's goals in process performance indicators, and (2) for each strategic goal, a set of PPIs to be monitored were derived and represented by the formula. In this way, the following information for each company was obtained (Simeunović, 2015):

- strategic goals, defined according to the company stakeholders' requirements;
- company's bussines units goals;
- company's key processes, i.e. processes that contribute to the accomplishment of the company's strategic goals;
- performance indicators of these key processes, which the company should measure in order to obtain timely information on process performance, and therefore also the business performance; and
- the link between PPIs and strategic goals.

The collected data were then coded and cross-verified in order to facilitate data categorization and enable their generalization (Simeunovic et al, 2020).

A universal list of strategic goals was than created. Due to generalization of strategic goals in the coding phase, quantification part of the goal definition was omitted. Among the total of 37 different goals that are defined (in the same or similar way), twelve goals were defined in almost every company. These strategic goals were, as mentioned earlier, decomposed into the business units' goals in each company. Furthermore, the key processes were recognized in each company, and categorized, resulting in the list of ten key processes. The names of those processes are generalized, and for operational usage, we recommend to adapt their names to the specific company.

Then, for each process, the PPIs (one or more), which should be measured and monitored, were defined. Total of 172 different PPIs were defined, but twenty of them are identified as indicators that should be measured in order to monitor achievement of the most common defined strategic goals. Strategic goals, key processes in which these indicators should be measured and PPIs linked with those, strategic goals are shown in Figure 1.

Regarding the second result from this case study, in each company from the case study research, for each strategic goal, a set of PPIs has been identified, which is recommended to measure in order to monitor the progress in achieving that goal. This doesn't mean that a company has to measure all PPIs from the set. Rather, company should choose those PPIs which are most cost-effective for measuring and which will provide accurate data regarding the accomplishment of a strategic goal.

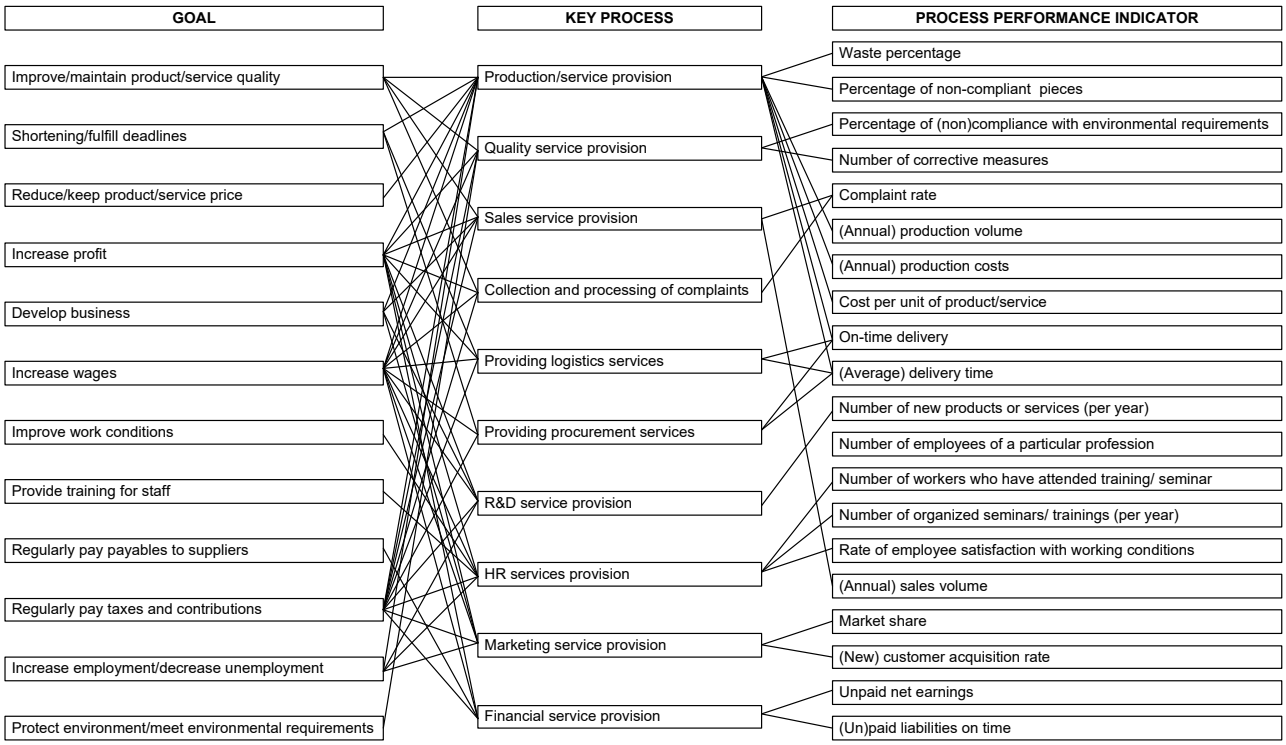

Figure 1: List of strategic goals, key processes and PPIs

6. DISCUSSION

The reviewed literature indicated that it is important for companies to evaluate the performance of their business process by means PPIs in order to measure progress towards business goals and gain a competitive advantage (Cleven, 2011; del-RíO-Ortega et al., 2012; Harmon, 2019; Kueng, 2000; Tupa, 2010;…). Still, many organizations still define their process performance systems without understanding the dynamic interdependences between the goals, processes and performance indicators (Glavan, 2011; Hernaus et al., 2012; Kueng et al., 2001; Wieland et al., 2015).

In order to overcome this gap, it was decided to investigate the possibility of developing flexible PPM model. The initial GPI PPM model was derived based on literature research, and practical experiences of the authors. The model was applied in 31 companies through case study research. During the model implementation there were no significant problems, i.e. the final result - links between the strategic goals and the PPIs were successfully identified in all companies and verified by the employers in charge.

Based on the case study results, the initial GPI mod-el has been expanded, and as such it can be apply just as it is, without any changes. The GPI model contains twelve different strategic goals and twenty PPIs, as well as their linkages (Figure 1). Model can be used in any business system, regardless of its activity, size and form of ownership, which means that it is extremely flexible.

So, the flexibility in measuring process performance is possible to achieve by specifying links between strategic goals and appropriate PPIs, since each company can adapt the model to its strategic goals, and according to them, measure the performance of its processes, including business performance.

7. CONCLUSIONS

The research presented in this paper describes the development of a new GPI model, which aims to fill a gap in the literature regarding the flexibility of process performance measurement practice. Using evidence from the literature about process performance measurement, and experience of authors in the field of business process management, an initial GPI process performance measurement model, based on process management, was proposed. The model was then extended based on case study evidence collected in thirty-one company that operate in different industries. The model presented above is the current version of the GPI model after modifications that have been incorporated.

The intended purpose of GPI model is to aid companies to measure performance of processes which influence the success of the business, by selecting the PPIs on the basis of company's strategic goals. The results of the case study verified that the model could achieve this aim.

GPI model has the potential to become a useful tool for managers in the following ways:

- the initial GPI model can be used as a guidance for establishing PPM system that is aligned with strategic goals of company - if managers want to define company-specific PPIs;
- GPI model can be used as it is, with a slight model customization (regarding the quantification of goals, detailed names of process, etc).

However, there are a few limitations regarding this model that need to be taken into account. Firstly, although the multiple case study research was conducted, the number of companies that applied this model is not sufficient enough for a solid validation of the PPM model. Secondly, due to the restricted number of companies, the research generalization has to be reconsidered. Although some international companies participated in case study research, it is difficult to conclude from a single-country study whether the GPI model is valid in different countries and other research contexts. However, there is no specific reason that nationality might affect the results, but conducting this kind of research in other countries would increase the possibility of GPI model generalization.

Given the limitation mentioned above, the future re-search would include the implementation of the GPI model in a larger number of companies, preferably in other countries, the investigation of the possibility to quantify the identified interdependencies between the strategic goals and PPIs as well as the operationalization of the defined PPIs.

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INTEGRATION OF BPM AND LEAN IN VOCATIONAL EDUCATION

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Abstract: *The purpose of the paper is to point out the importance and possibilities of integration of Business process management and Lean approach. Many educational institutions lag behind in developing and implementing process methodologies and Lean approach. The research is based on the use of Business process management for critical process selection and the application of Lean approach for process improvement. For that purpose, the research was conducted in vocational education by identifying the value chain and defining goals of the organization, so as the KPIs for their monitoring. The practical teaching was identified as the critical process, because it has the highest influence on the fulfillment of goals. Furthermore, for analyzing the process of practical teaching from the aspect of adding value, the critical process has been improved. The proposed solution includes suggestions for eliminating waste in critical process, which would improve the quality of teaching in vocational education.*

Keywords*: Lean approach, Business process management, vocational education, waste.*

1. INTRODUCTION

As a management principle, Business process management (BPM) combines tools and methods for increasing the efficiency and effectiveness of organization processes (Beimborn & Joachim, 2011). The importance BPM in practice is growing over the years, but the main challenge remains how to implement process principles into an organization's operation (Skrinjar & Trkman, 2013). Many research studies in field of business processes have shown that organization can benefit from BPM through better financial and nonfinancial performance (Stojanović et al, 2017). Also the implementation of BPM can be very compound process which requires effort, resources and time (Buh et al., 2015). Madison (2005) states that 85% of companies' problems can be attributed to business processes, and that solving those problems can lead to quality improvements, customer satisfaction improvements, cost and time reductions, etc. There are many approaches that deal with process improvement and some of them are: continuous improvement, Lean approach, Total Quality Management (TQM), Six sigma, etc. (Stojanović, 2016). The most commonly used improvement methodologies are Lean and Business Process Management. Lean approach have been incorporated in many organizations in private and public sector (Balzer, 2016). Although Lean has been present as a useful business strategy for process improvement for more than ten years, its application in education institutions is still in its infancy. In education sector, organizations are increasingly using concepts such as BPR, total quality management (TQM), and in the last few years, Lean (Thirkell & Ashman, 2014). In addition, by understanding the education organizations processes, organizations can define and develop actions for quality improvement of services, increasing customer satisfaction and productivity, so as reducing costs, waste, and cycle time.

The systematic review of the literature on Business Process Management and Lean approach in education showed that these two approaches can be used for improvement of teaching methods and processes in education institutions (Balzer, 2016). Searching the Scopus database with the keywords "Lean" or "Business Process Management", and " vocational education", only 14 papers were published about this topic in journals and conferences. Papers explain the advantages of applying the Lean approach, but none of the papers show a set of Lean tools that would be successful for implementation in vocational education. This indicates the gap between the importance of Lean tools in theory in education and their actual implementation in practice. On the other hand, searching the by combining this two methodologies, the education organizations will be able to optimize processes and establish process-oriented organization, through the identification and elimination of non-value-added activities. Also, this will build a framework for education organizations to standardize the business processes. The outcome of this research is investigating in more detail and analyzing the possibilities of implementing both methodologies in the special areas of vocational education.

This research was conducted in two steps. The first section will be based on theoretical background of business process management and Lean approach and also their integration for process improvement in education.

The second section consisted on BPM combined with Lean approach, which will be presented in the case study in vocational school.

2. THEORETICAL BACKGROUND

According to Van der Aalst et al. (2003), BPM is defined as “supporting business processes using different techniques, methods and software to design, enact, control and analyze operational processes, which will involve organizations, humans, applications, documents and other sources of information”. According to Jeston and Nelis (2006) BPM implies achieving organizational goals by improving, managing and controlling core business processes, and which is extremely important for adoption of continuous process improvement within the concept. BPM represents all of company's efforts to level its processes with strategic goals (Stojanović et al., 2012). On the other hand, Lean approach has been receiving attention lately from lots of organizations. More and more companies are now combining Lean with other improvement principles (Jovanović, 2018). The Lean concept has its origins in Japanese car plants (Liker 2004). The Lean concept came from Japan, when Japanese manufacturers realized that they could not afford the huge investment in rebuilding their facilities (Bhamu & Sangwan, 2014). Many authors have documented various quantitative and qualitative benefits of Lean implementation, such as improvement in reducing lead time, increasing job satisfaction, standardization, etc. The five Lean principles can (Womack & Jones, 1996; Balzer, 2016): identify the value of the process, identify the process flow, eliminate many types of waste, make the process flow smoothly, and pursue perfection through continuous improvement of the processes. Beside that, Lean focuses on removing wastes from processes (Dicken & Walker, 2012). By eliminating wastes in the process flow, it creates processes which will reduce human effort, reduce space, resources and time to make products and services with lower costs, compared with traditional organizations (Balzer, 2016). As a basis for defining waste, it is necessary to classify the activities of the company as (Hines &Taylor, 2000): value adding activities, non-value adding activities and necessary non-value adding activity.

2.1. Integration of BPM and Lean approach

Business processes are an essential part of every institution, and their managing is considered as one of the key priorities in many organizations (Hribar & Mendling, 2014). BPM presents a combination of different performance improvement approaches which result is an integrated business management system (Hammer, 2010). It also gives companies the competitive advantages that is needed to support more agile and flexible business processes (Dicken & Walker, 2012). Organizations from different sectors are constantly facing the challenge of “doing more with less” (Fryer, 2007). Many education organizations are dedicated to process improvement, whether the improvement includes a small change of processes or whether it includes big and radical improvement (Balzer, 2016). Therefore, within the application of the Lean, in order to see the results, it is important to measure the performance of the process, as well as to document the process that enables the identification of opportunities for improvement (Stojanović, 2016). BPM and Lean have much in common as they (Dicken & Walker, 2012):

- Believe that the work of an organization is contained in the process;
- Promote the standard process documentation in order to measure and improve;
- Respect people’s knowledge about their work;
- Are process driven with the main goal of continuous improvement;
- Involve management support for sustainable improvement and transformation.

Many researches presents various methodologies for process improvement, which can result in a long list of processes that needs to be improved. When choosing the right processes to improve, it is necessary to determine which methodologies are alternatives, what are the selection criteria and how the evaluation and final selection is performed (Stojanović, 2016). Although many of the educational organizations started to adopt process-oriented organizational structures, most of them are still keeping traditional, function-based organization model (Seethamraju, 2012). This research presents the whole methodology for integration of BPM and Lean in education and proposes a conceptual framework for implementation in education, from the analysis of value chain, identification of critical processes, defining the goals, elimination of waste and creating the indicator for measuring the effects for proposed solution. By combining BPM methodology and Lean, and process monitoring, the organizations will have the ability to optimize processes and continuously improve their life cycle (Dicken & Walker, 2012).

2.2. The application of BPM and Lean approach in education

Although Lean principles are increasingly used in education institutions for process improvements, there is still a misunderstanding about Lean as a manufacturing tool (Antony et al., 2012; Emiliani, 2004; Kazancoglu et al., 2019). Many education organizations that had the Lean initiative for business processes improvement, were focused on systematically waste elimination, through eliminating the non-value added activities (Antony, 2014). As a widely accepted approach by a many education institutions, many researches have shown that

only few of these institutions are integrating BPM with Lean for achieving the better efficiency and effectiveness of education processes (Antony, 2014). Problems may appear in misunderstanding the need of Lean, as employees in general are unwilling accept the changes in organization (Balzer, 2016). Studies that implement Lean in education typically present small teams of employees who are willing to participate in few-day workshops in order to improve some unproductive or unsatisfying processes from local through institution-wide area (Balzer, 2016). Emiliani (2004) was one of the first researches to apply Lean approach in education sector. Typical areas of implementing Lean for process improvement are usually providing administrative services for students, creating new or remodeling an existing research lab, purchase of school supplies, creating new courses for students, students counseling, approval of donations, communicating with school donors and contributors, etc. (Balzer, 2016).

Lean methodology is a useful and rigorous approach to improving processes, but the main issues are (Jeston & Nelis, 2008):

- The alignment with organization strategy;
- Necessarily changing or reengineering the business process, specifically in the case of a change in business strategy;
- The essentials of a BPM project, explicitly people change management, leadership and project management;
- End-to-end focus of processes, in organization and even across organizational boundaries.

According to the Kazancoglu et al. (2019) the Lean approach can be viewed as a beneficial methodology for eliminating waste, improving satisfaction and continuous improvements of organization processes. Although Lean has been broadly approved by many service and manufacturing organizations, its applications in education institutions have been a challenge for participants involved in the Lean implementation. A successful strategy for a successful application of Lean requires collaboration and shared responsibility between participants (Cudney, 2018). Some of the fundamental challenges of BPM and Lean in the education environment are (Antony, 2012; Seethamraju, 2012):

1. The strategy of accomplishing is not clear to many managers, because of the limited understanding and lack of skills in process management;
2. These concepts don't have agreed theoretical conceptual framework for implementation in education;
3. Terminologies taken from manufacturing industry can been a problem for employees in education institutions;
4. The process is viewed in isolation from the cause of the problem;
5. Quite often a process is improving when problems occur, but the processes must be considered from a systems perspective;
6. It is crucial to have commitment and support of management, because the lack of commitment and support makes it difficult to achieve continuous improvement in organization;
7. Implementation should not be viewed as something short-term solution, because sometimes the influence of process improvement on certain aspects could not be seen instantly;
8. Absence of process ownership and process thinking.

Together they indicate a number of common concerns in the education sector. One of the common concern is that documentation can be deficient for many processes, with no standardized instructions for employees or training programs that will help them to know each of the steps and activities of every process related to their work in organization (Balzer, 2016). So in the following chapter is proposed a model for establishing a process-oriented education organization. This model, as the combination of BPM and Lean, will be based on overcoming the mentioned problems of education.

3. METHODOLOGY

The research will be performed as follows: a BPM approach will be used for identifying the critical processes and their influence on achieving of goals, as well as defining the key performance indicators. Lean approach will be used for improvement of identified critical process of vocational education. Eventually BPM will be used for measuring the effects of improvement. This research was conducted in the secondary vocational education institution. For this research was chosen one of the methodologies for business processes improvement and establishing a process-oriented organization - Universal process approach technology (Radović, 2012). The application of this methodology provides all the necessary solutions for arranging the business system, as well as the effective and efficient operation of the company. The proposed model in this paper is based on Universal process approach technology, integrated with Lean principles and Lean tools, which can be useful for improving the processes. At the beginning of this research, the basic data about the school were analyzed, so as their activities and organizational structure of the organization. The value chain is also defined, with the subsystems in organization. Business processes were identified, in order to recognize the school's priority, critical, and key processes. The goals of the school have been set for the next two years. The translation of

goals into KPIs of process success was done and a model for monitoring two indicators was given. After that, one process was chosen - the realization of practical classes, which has the greatest impact on business and which is analyzed in more detail in the rest of the work. Suggestions for improving the process of realization of practical classes are given and a new solution is designed with the possible effects of implementing of proposed improvements. Using 5 Why 1 How method, waste elimination and Ishikawa diagram the cause of the problem can be found. This Lean tool are one of the most useful tools that can be applied in the field of secondary education, as they provide good results in the short term. In this paper will be presented only few of the used tools for process improvement.

3.1. Implementation of BPM and Lean approach in vocational education

The first step in Universal process approach technology is the identification of business processes. For that purpose, a value chain was constructed, where each value chain activity can be further divided into specific sub-activities (sub-processes) and it includes the core and support processes in organization. The core processes of the school are shown in the figure 1, and they include processes of Marketing, Research and development (R&D) and core process - providing education service to a customer. Providing education service to a customer includes six sub-processes. As the most complex process, teaching can be singled out, which includes theoretical and practical teaching for many students in different school programs. Also, the correlation is shown between core processes inside and between the sectors. Based on that, it can be concluded that there is a connection between all sectors and that they effect each other, so as on the customer.

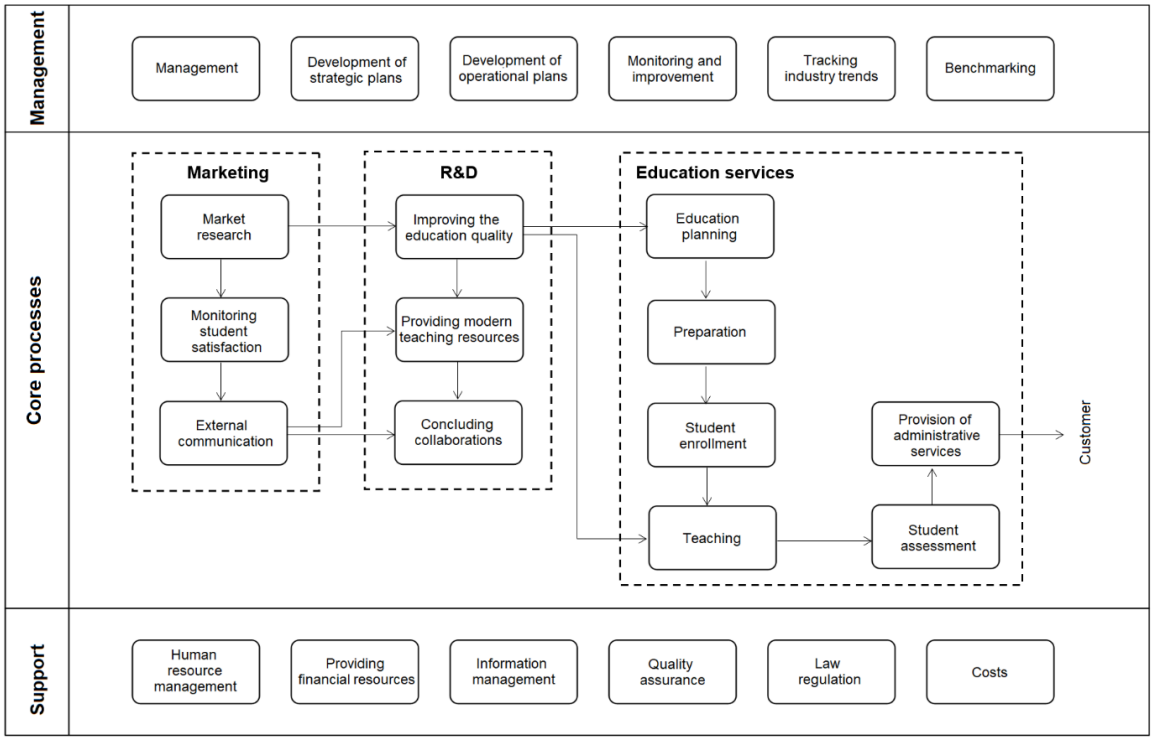

Figure 1: The value chain in secondary vocational school

This value chain is the base for creating a catalog of process objects, as one of the steps of process approach and necessary step for further steps: creating a process model. This model is based on the process catalogs of all primary and support processes, and the identification and selection of process priority, critical and key processes were identified. Based on the list of priority, critical and key processes, a narrower set of processes for review, improvement and/or reengineering has been identified. In the next step, five goals of the organization are defined, so as the KPIs for their monitoring. The goals of the school are defined in order to achieve the vision and planned annual results of school. The next table shows seven critical processes from the process catalog and the influence of critical processes on the fulfillment of goals (Table 1).

Scores 2, 1 and 0 are based on the direct impact on the goal, indirect impact (the output from the observed process is the input into the process that directly affects the goal) and no impact on the goal. By ranking the processes in organization, it has been selected the one of the critical processes that will be improved, which have the largest score 6 in previous table. Analyzing the value stream of organization, the critical processes also can be identified. For improvement was chosen the process of realization of practical teaching, which is priority, critical and key process in organization. For that purpose, the analysis of the current situation has been

done in order to see the current state of the critical process. Since it is a medical school, it is very important to provide a quality practical teaching for students.

Table 1: Influence of critical processes on the fulfillment of goals

		Goals						
		Increase the internships for students	Increasing student satisfaction	Increasing the quality of practical teaching	Reduce the use of medical supplies	Increase the number of donations	Score	KPIs
Processes	Development of the annual plan of the institution	1		1		1	3	Percentage of plan realization
	Student enrollment					1	1	Increase of enrolled students Enrollment rate
	Realization of practical teaching		2	2	2		6	Percentage of correctly performed exercises Average number of repetitions of exercises per student Medical material stock level
	Realization of exams		1	1			2	Passing rate
	Provision of administrative services		1			1	2	Average students waiting for documentation
	Concluding new business collaborations	2	1			2	5	Percentage of new practices
	Providing modern teaching resources		1	1	1	2	5	Number of new laboratories

* 2 - direct impact on the goal, 1 - indirectly affects the goal, 0 - no impact on the goal

For identification of potential causes of problems in practical teaching, Lean tools were used, such as: 5 Why 1 How, Ishikawa diagram, A3 report, waste elimination, etc. Ishikawa diagram was used to discover the cause of a problem by asking the question why errors occur in practical classes. In addition to the main cause, the sub-causes of the problem were identified within 4 categories: material, machine, men and method. It was discovered that students are not completely clear about all the steps of the exercises in practical classes, which leads to the cause that the students doesn't have an instruction for exercises and the fact that exercises are difficult to perform independently. Using A3 report, potential causes are also considered. Report includes analyses of the critical process, specific proposals for improvement, plan for their implementation and the indicator that can be monitored and measured for increasing the percentage of correctly performed exercises. The analysis of the current situation includes an analysis of value-adding activities, non-value-adding activities and necessary activities. The following columns indicate for every activity of practical class whether it is a value-added activity (VA), a necessary activity (NVA) or a non-value-added activity (NVAU) (Table 2).

Table 2: Analysis of activities from the aspect of adding value

			Category		
	Activity	**Duration [minutes]**	***VA***	***NVA***	***NVAU***
1.	Students preparing for class	3			*
2.	Teaching records	3			*
3.	Introduction to theory	30	*		
4.	Exercise simulation	25	*		
5.	Division of students into groups	2		*	
6.	Preparing for exercise	10			*
7.	Performing the exercise in a group	80	*		
8.	Student assessment	35			*
9.	Disposal of medical waste	20			*
10.	Recapitulation of materials and standard errors	15		*	
11.	Completion of class	2			*

For each activity of this process is stated the duration in minutes, and since the students have a block lesson of 5 classes a day, the duration of all practical teaching activities is 225 minutes without a break. The process of realization of practical classes includes 11 activities, of which 3 add value, 2 does not add value and the other 6 activities are necessary and their elimination requires significant changes. Certain actions can be taken to reduce wastes and to eliminate the non-value-added activities. The necessary activities cannot be

eliminated, but suggestions can be given for their improvement, which has been done in further research. It is necessary to identify potential causes of problems, using the method "5 Why" - repeat the question "why" five times until the most probable cause of the specific problem is reached. Based on the analysis of the existing state of practical classes, it is possible to define what causes the problem in practical teaching. Also as part of the analysis of the current situation, an analysis was done using the A3 report, which allows users to more easily understand the problem.

It has been noticed that students repeat the exercises several times, and it affects the resources they spent: gloves, alcohol, cotton wool, test tubes, needles, etc. This appears as a problem, because resources for the practical teaching are limited. Through the analysis of the causes of the problem and the application of the tool 5 Why and A3 report, the main cause of the problem was identified - the student does not have a pre-prepared instruction based on which he will know all the steps of exercise. Also, the student repeats the exercise 3 times on average before doing it correctly. Two key reasons have been singled out: the student doesn't know all the steps of the exercises and the student cannot perform the exercise independently. The fact that the student doesn't know all the steps of the exercise is the biggest problem, because it causes mistakes, reduces the quality of practical teaching and affects student's safety.

3.2. Results and discussion

Improvements were suggested and the effects of proposed solution will be presented. It is possible to eliminate three activities: preparing students for classes, dividing students into groups and recapitulation of materials and standard errors, which reduce the number of activities from 11 to 8. The activities of introducing the theory, simulating exercises, performing exercises in a group and disposal of medical waste should be simplified. Reducing the number of activities will affect the time for activities. Time for non-value adding activities will be reduced for 20 minutes, which can be used for other activities that adds value to students. In this way, by reducing the duration of certain activities, students will be able to devote more time to performing exercises - activities that add value. Job Breakdown Sheet be used as a way to improve process and eliminate waste. Job Breakdown Sheet includes all important steps and key points for each exercise, which would allow students to perform the exercise independently under the supervision of a teacher. The instruction would enable students to have all the steps of the exercises they perform in one sheet, which is expected to significantly increase the quality of practical teaching.

The proposed solution was measured through indicators of practical teaching. Practical teaching have good parameters because school prepare students to have a craft and that they can get a job immediately after school. The KPI that is defined and monitored in this research is the percentage of correctly performed exercises from the first time. Every week, as part of practical classes, students perform certain exercises. The indicator of the first during the first 4 weeks of practical classes was previously analyzed in the school and the value of the indicator is on average 45% (Figure 2). This figure shows that half of the exercises in classes were not performed correctly in the first four weeks.

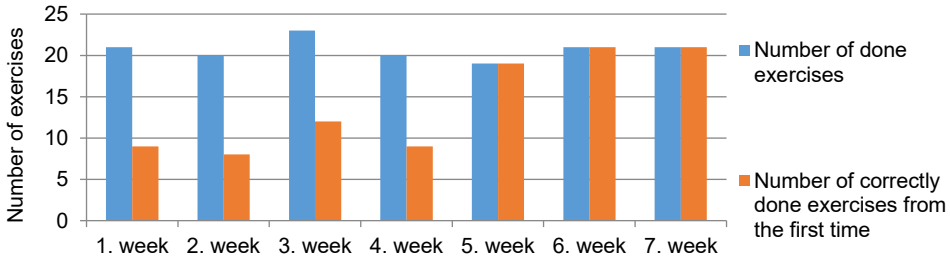

Figure 2: Number of performed exercises

However, by applying the proposed improvements from six to seventh week, the indicator is expected to increase from 45% to 100% (Figure 3). This would increase not only this indicator, but also expect a decrease in the number of repetitions of exercises from the first time. Previously, students needed to do 4 exercises before doing one correctly. This is expected to reduce the number of repetitions to 1 per exercise. By implementing the improvement – reducing the number of activities, reducing the time for activities that doesn't add value and creating the Job Instruction Sheet for each student exercise, the application of universal process approach technology would almost be completed.

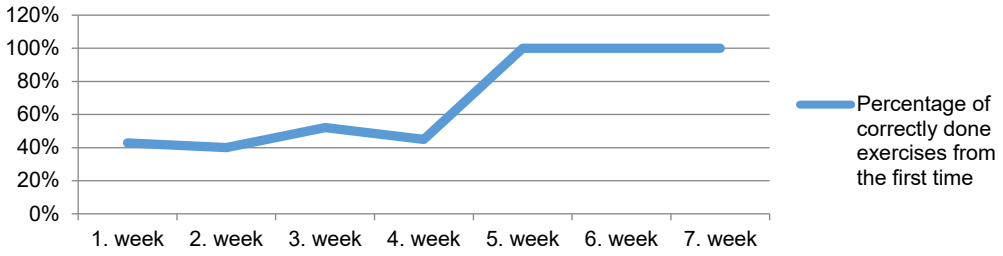

Figure 3: Percentage of correctly performed exercises from the first time

The latest step of this methodology says the organization needs to establish a system for continuous improvement, monitoring and process management. So it is necessary to continue monitoring the indicators and look for new ideas for improvement. Also, improving the process of realization of practical teaching would achieve good results in a relatively short time, but it is expected that the application will be extended to other aspects of the organization.

4. CONCLUSION

The implementation of proposed integration of BPM and Lean approach has major benefits, for increasing the student and employees satisfaction, and also for increasing the effectiveness and efficiency of practical teaching in secondary school. This research were based on improvement of processes in secondary vocational school by applying the Universal process methodology and Lean approach. In this paper were presented how Lean tools would be suitable for education sector. Also, this paper presents the whole methodology for integration and proposes a conceptual framework for implementation of integration of BPM and Lean in education. The five goals of school were defined and for them were created indicators that can monitor achievement of goals. The KPI that is defined and monitored in this research is the percentage of correctly done exercises from the first time. This indicator present the base for establishing a system for continuous improvement in education sector. Reducing the number of activities and the time for activities that doesn't add value, the integration of Universal process approach technology and Lean tools would be completed for that critical process. This can be implemented on other critical processes, not only teaching, but this represents one way and the first steps for achieving the process-oriented organization system. The contribution of this paper is reflected in overcoming the problems in the field of secondary vocational education:

- It propose conceptual framework for implementation of BPM and Lean integration in education;
- Implementation strategy is presented through clear and achievable effects of improvement in the educational institution;
- Terminologies transferred from other industries to education sector are easier to understand;
- The processes are observed from a system perspective from the analysis of all processes and the causes;
- Awareness of managers and employees in the implementation of Lean tools and process improvement are higher, so as their role in achieving the vision of the educational institution;
- Process improvement initiative is viewed through continuous improvement, not just as a one-off project;
- The awareness of the process orientation in educational institution is increased;
- Proposed solutions requires the investment of minimal resources for implementation, which is important for the educational institution because it has limited resources.

The future direction of this research will be making instructions for other school processes, but what is also important, to spread the research area to administrative and financial sectors of the institution. Paper presents one of the possibilities of application of integration of BPM and Lean in education, so the future research will be to investigate the other methodologies and their integration for process improvement. Also, the direction of the research is to apply this integration in other education institutions, not only vocational education, including higher education and different educational sectors.

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SMART E-BUSINESS

CONTENT

APPLICATION OF BLOCKCHAIN TECHNOLOGY IN ECOMMERCE

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Abstract: *Blockchain technology will have an impact on the ecommerce revolution. It offers transparency, security, and efficiency. Ecommerce participants if want to prosper and make their own progress should accept this shift in technology and reconsider the way they function. In addition to being faster and at a significantly lower cost, some of the competitive advantages that this technology offers are complete supply chain control for upgrade efficiency and profits. Soon, advantages of blockchain should enforce more participants to consolidate the technology within their operations.*

Keywords*: blockchain, ecommerce, supply chain, consumer, data.*

1. INTRODUCTION

Blockchain has power to change the way society functions as a whole. It has almost unlimited implementation in ecommerce, as well as, supply chain management, a particularly sensitive area is the supply chain of pharmaceutical products; money transfers; sectors like food security; data sharing, data warehousing, digital IDs, and also taxation, digital voting, real estate management, etc. According to FDA DSCSA Blockchain Interoperability Pilot Report (2020, p. 4) “in March 2019, industry leaders Merck and Walmart collaborated with IBM and KPMG to participate in the Pilot Project Program under the Drug Supply Chain Security Act (DSCSA) to shape and define interoperability between trading partners and demonstrate how a novel technology, such as blockchain, can be used to solve for DSCSA interoperability requirements”. The goal of the blockchain is to secure integrity and anonymity of transactions. This paper considers advantages of blockchain implementation in ecommerce, and makes recommendations and possibilities for further application.

Technologies that are expected to change retail sector, offering unprecedented opportunities, which will be adopted at different rates, but each will redefine the basic retail operations, are (World Economic Forum, 2017, p. 10): Internet of Things (IoT), autonomous vehicles (AV)/drones, artificial intelligence (AI)/ machine learning, robotics, digital traceability, 3D printing, augmented reality (AR)/ virtual reality (VR) and finally blockchain. In this paper, we try to analyze the main trends in the application of blockchain technology and discover its advantages in application, in assumption of the future growth of application because of the growth of ecommerce, as a suitable way of buying due to the global pandemic crisis. One of the main negative factors in the growth of ecommerce was mistrust, which will be significantly reduced by the application of blockchain technology, so the main research question in this paper is:

- *How could the application of blockchain technology affect the reduction of negative perceptions about ecommerce that is formed due to problems such as unsecure payment, shipment and inventory uncontrol, false product reviews and data insecurity?*

By analyzing the current literature in this field, comprehending how blockchain technology functions, with insight in the characteristics of application in ecommerce, an impact on increasing transaction security, the paper provides a conceptual framework for further research on the application of blockchain technology in ecommerce.

2. THE CORE AND BASIC CHARACTERISTICS OF BLOCKCHAIN TEHNOLOGY

Blockchain technology is considered as one of the significant technological achievements in contemporary history and is established combining economic game theory, law of large numbers, software engineering and programming, cryptology, and disruptive computing. A blockchain can be explained as a “chain” of transactions, which are typically performed in cryptocurrencies, and stored in “blocks” on a countless computers on the Internet. The basis of the blockchain is described as distributed or digital “ledger" in many

researches (Saberi, et al., 2019; Sanger & Maharishi, 2020; Nofer, et al., 2017, Ismanto, et al, 2019). This technology records transaction data and stores it on multiple different computers. Integrated transactions follow in a "block". Each block is connected to the block before and block after, consequently designing a "chain". Since blockchain data is kept on numerous computers on the Internet, the data is not centrally controlled, which gives the blockchain the advantage of being reliable, trusted, and largely immutable.

Zheng, et al. (2018, p. 371) emphasized that “blockchain has shown its potential for transforming the traditional industry with its key characteristics: decentralization, persistency, anonymity and audibility”. One of the main reasons why cryptocurrencies are preferable is due to the decentralized character of blockchain technology. Reason for decentralization explains Tian (2017, p. 1) as “centralized system is vulnerable to collapse, since single point of breakdown will lead the whole system to be crashed”. Using blockchain there is no centralized control, which indicates that only the person concerned in the operation can manage the transaction. As Gromber, et al. (2017, p. 186) claim “many functions might become obsolete if people started to organize and protect the society using decentralized platforms”. A blockchain stores data in blocks that are attached to a chain of similar blocks of information. Each block demands verification over the network before it can be attached to the chain, which makes it very difficult to change.

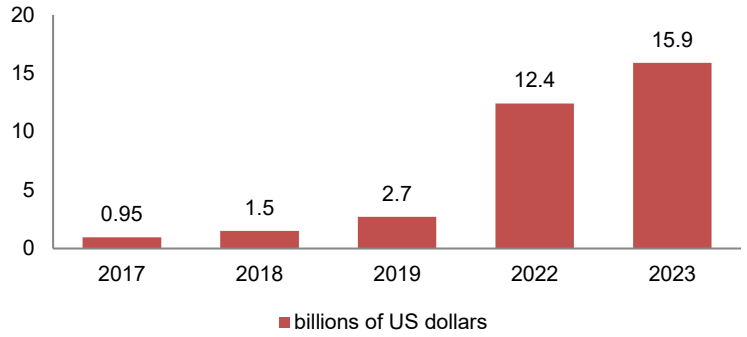

Figure 1: Worldwide spending on blockchain solutions from 2017 to 2023 in billion US dollars (Lui, 2019).

Global spending on blockchain solutions is expected to increase from 1.5 billion in 2018 to an estimated 15.9 billion by 2023. By the end of 2019, global spending on blockchain solutions reached $ 2.7 billion per year. Annual spending has almost tripled since 2017. Forecasts suggest that spending on blockchain solutions will continue to grow in the coming years, reaching nearly $ 16 billion a year by 2023. Finally, authors Adams, et al. define brockchain as “blockchain for good” B4G, as it could help deliver socially and environmentally beneficial outcomes, framed in terms of sustainable development through challenging existing business models and providing new opportunities for value creation (2018, p. 127).

3. POTENTIAL OF BLOCKCHAIN IN ECOMMERCE

Blockchain technology provides a lot of possibilities for ecommerce business, from payments, supply chain management, to decentralized markets, etc. According to Končar, et al. (2020, p. 119) “the emergence of the electronic market, based on the Web, has changed the trading process and the structure of the supply chain", which has given space for the development of new technologies, including blockchain. Security and risk reduction is critical in the ecommerce industry. Application of blockchain in ecommerce payments offers extensive security, data safety and wallet preservation. Sanger and Maharishi (2020, p. 1732) point out that “much of the world’s total population is actually moving towards ecommerce for its effectiveness and easiness, but ever since, security has been the most crucial concern which actually breaks through the development of progressing business”.

This technology is tracking more and more money transactions on the Internet. Blockchain development is evolution in expanding transaction security to provide a better consumer experience during transactions online. As Lovreta, et al. (2019, p. 324) predicted “the development of communications and technology allows customers to actively participate in the creation of the value they want”. Technology has changed the global market, and the ecommerce business will especially profit from the growth of blockchain. Bulsara and Vaghela came to conclusion that the cost of transactions in blockchain based platform is lower than normal ecommerce transactions, transactions are faster than traditional payment mechanisms in ecommerce, which leads to the possibility of rapid micropayment (2020, p. 3794).

Furthermore, blockchain based currencies are considerable convenient and secure to use. Blockchain eliminate the need for an intermediary in the form of a regulatory administration, because everything can be done from home via the Internet. In addition, there is no account opening because the virtual wallet is

completely free. Data security is exceptionally required because individual companies maintain consumer data such as name, address, phone number, account number and so on. Thanks to blockchain technology, its decentralized character prevents hacking and intrusion into consumers' personal data.

The supply chain management is one of the most condemning points of ecommerce operation. According to Hackius and Petersen's findings participants of supply chain are fairly positive about this new technology and the benefits it offers; factors like the hierarchical level, blockchain experiences, and the industry sector have a significant impact on the participants' evaluation (2017, p. 3). Those who engage in ecommerce regularly have trouble to monitor products, manage inventory, and yet centralize the database. Blockchain technology facilitates these tasks. When looking at the supply chain, one of the general matters is hacking or deception and fraud. Nevertheless, by skipping intermediaries in the supply chain, blockchain technology relieves these threats. Saberi, et al. (2019, p. 2130) came to conclusion that "the evolution of blockchain-based supply chain management enables the creation of shared, secure, decentralized ledgers, autonomous digital contracts (smart contracts), and trustworthy and secure networks, it supports transaction between partners (peer-to-peer) by reducing the role of middlemen/intermediaries in the network".

Product tracking becomes easier because product information can be accessed via radio frequency identification tags and built-in sensors. Tracking the product from its origin to the place where it is now can be tracked with blockchain technology. Removing intermediaries also leads to a reduction in total costs. Blockchain enables ecommerce companies to manage their inventories more effective and efficient. This technology eliminates the need to invest in other inventory tracking and monitoring resources.

False product recomendations and comments are widespread in a large number of online product sales. Many consumers are often deceived by these false recommendations end up disappointed with the purchase. Nevertheless, this is not the situation with blockchain. This technology helps verify reviews and prevents ecommerce sellers from deleting comments without notifying customers.

Organizations all over the world remain to carry on blockchain solutions that have a variety of applications, such as customer loyalty programs, commercials, contracts, charity, and commercial lending. All trends indicate that the benefits of adopting a blockchain have all participants, both online and offline.

4. PRACTICAL APPLICATION OF BLOCKCHAIN IN ECOMMERCE TRANSACTION

Blocks, as a part of blockchain, store information about transactions such as the date, time and value of the transaction that consumers spend in ecommerce. The blocks also store information about all who participates in the transactions. The complete purchase block for ecommerce records also the name of the seller. As a substitute of using the real identity of the consumer, the transaction is recorded without discovering any information using a distinctive digital signature, for the purpose of name.

Blocks in a blockchain keep information that differentiates them from other blocks. Each consumer has a name that will differentiate each from each other, each block keeps a unique code called a "hash" that allows consumers to be separated from each other block. Hash cryptographic codes are created by unique algorithms. The consumer makes purchases on the ecommerce website, but what happens if consumer decides to continue shopping? Although the details of the new transaction will look almost identical to the previous purchase, they will still separate from the previous block due to their different codes.

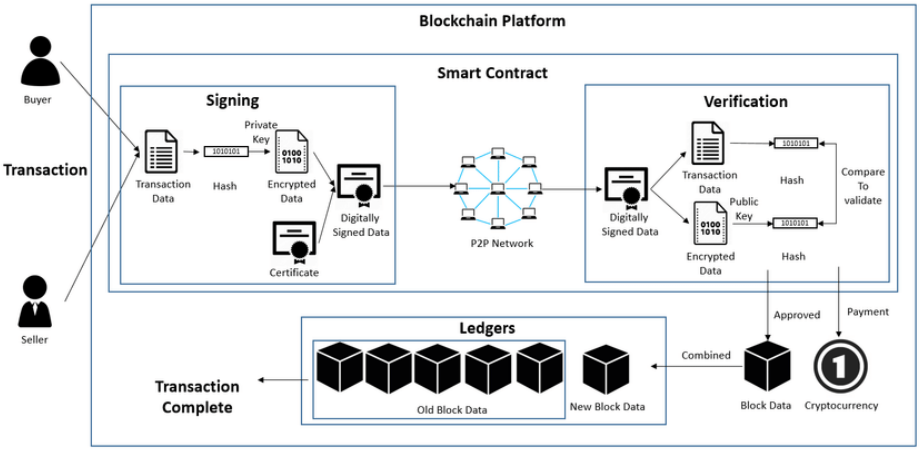

Figure 2: Blockchain as ecommerce platform architecture (Ismanto, et al., 2019, p.4)

When a transaction is realized a blockchain is created. The consumer completes the purchase and receives a purchase confirmation. In many cases, the block will group likely numerous transactions, so the purchase will be packaged and stored in a block alongside with information about other users' transactions.

After the purchase, the transaction must be confirmed by both the consumer and the seller. Normally, the data should be checked by a third party. However, with blockchain, that is left to the computer network. When consumer buys from an electronic retailer, the computer network runs to confirm if the transaction realized the way it was done. In other words, blockchain confirm the details of the purchase, such as the time of the transaction, the value and the contributors.

Every transaction is kept in a block. After the transaction is confirmed as correct, it is realized. The transaction amount, digital signature of consumer and digital signature of the seller are also stored in a single block. Then transaction joins hundreds or thousands of similar ones in a block.

The final block of the realized transaction receives a hash. Once all block transactions have been confirmed, it must be assigned a unique identifier as a hash. The block is also given a hash of the last block attached to the blockchain. After that, the final block can be added to the blockchain, and blockchain of whole transaction is created. Examples of blockchain technology with application in ecommerce and specific areas of application are (Daley, 2020):

1. ECoinmerce - an ecommerce platform based on blockchain tokens;
2. EVERY* - the first blockchain-based, brand-direct ecommerce retailer;
3. Fluz Fluz - uses blockchain to curate a social ecommerce platform;
4. Shopin - uses blockchain to help retailers gain better customer insight;
5. Spl.yt - catalogs inventory from different sellers and displays it in one centralized location;
6. OPSkins - a blockchain-based ecommerce platform for selling rare digital items, including video game skins, gift cards and unique gaming weapons;
7. Portion - a blockchain ecommerce site and marketplace for purchasing digital and physical art; and
8. Buying.com - the first ecommerce platform that allows both consumers and online stores to buy directly from manufacturers, distributors and wholesalers.

Thanks to the blockchain, the consumer is provided with an original product that will be delivered for the paid amount. The monetary part of the transaction is performed in a secure manner. Blockchain allows the consumer to pay for the product to the seller in cirtocurrency. As Sheikh, et al. (2019, p.778) explain that “payment via criptocurrency process is faster and safer as it does not store customer’s payment information, which are called as “push” transaction in blockchain”. The consumer can use discount vouchers that belong exclusively to him and no other participant in the network can use the voucher. Nevertheless, the customer can straightly switch vouchers with another customer. Also, consumer can transfer loyalty points to other customers. All this can be done immediately, without verification of seller. This improves the customer experience because transactions are quick, secure and agreeable. On the other hand, there is certainty for sellers that they will receive money for the delivered product.

5. CONCLUSION

Despite all the complexity, the potential of blockchain as a decentralized form of online data storage is almost limitless. Taking into account advantages like privacy of data, security, lowering costs and fees, blockchain technology can considerately have a wider application. Blockchain preserves the authenticity of the data. Thousands of computers on the blockchain have role to confirm the details of the purchase. After confirming the transaction, it is stored to the blockchain. Each block carries its own distinctive hash code. When block information is changed, the hash code of that block changes. Nevertheless, the hash code on the block does not. This divergence makes it difficult to change blockchain information without confirmation. This leads to data integrity in the overall blockchain. Blockchain will affect changing business processes in many industries in the future, but this will also take time and effort. Nonetheless, in the near future, we will expect participants on the market to finally embrace the benefits of the blockchain and begin to use it for safer storing data, and overall consumer protection. Blockchain will encourage participants to acquire new skills, while doing business in traditional way will be completely reconsidered. All this observed it could be expected that greater application of blockchain in ecommerce will come in next period of time and affect greatly on system reliance.

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MODELING A DEEP LEARNING SYSTEM FOR PREDICTING USER BEHAVIOR ON WEBSTORES

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Abstract: *This paper presents an approach to developing a system for analysis of user behavior on webstores. A system is based on a deep learning network with multiple inputs and output layers. The system is intended to be used for predicting the next user actions on an e-commerce website and a prediction will the user make a purchase. The prediction is based on collected user actions from the server log. The main goal of the paper is to improve the level of conversion on e-commerce websites and total sales. Based on the user's behavior data we identify activity patterns of users that lead to a purchase. In the paper, we tried to connect user behavior with their online purchasing habits. We use deep learning for generating a prediction, as it creates models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction. Further, we describe steps in modeling a deep learning system and propose a system architecture for it.*

Keywords*: Deep learning, prediction system, user behaviour, e-commerce*

1. INTRODUCTION

Machine learning technology is used on all modern online services. When you are searching through a web or using a social network or navigating through an e-commerce store, machine learning is always behind the scene, personalizing data especially for you. Machine learning is used to identify images, select search results, and recommend pages that you would be interested in based on other user's data or on your data that is collected. Machine learning is a technology that gives computer systems a chance to learn with data, without being programmed.

Machine learning has been investigated as a technique for making the selection, using historical records and their outcome as training data. Machine learning has been investigated as a way of ascertaining which factors should be taken into account by the system. Machine learning is using patterns in data to make some predictions/ recommendations (Witten et al., 2017).

E-commerce websites are constantly improving their recommendation systems to increase revenue. The main goal of every recommendation system is to guess which products will a user be interested in and to show that product to the user. The sooner the user gets a good suggestion, the chance that a user will make a purchase is higher. When you think of this problem through the perspective of making a purchase, if users do not find what they are looking for in relatively quick time, they will leave the site and they will not make a purchase. If users receive something that they like from the system, the chance that they will make a purchase is a few times higher. This paper main goal is to model a system for predicting user behavior on e-commerce websites using deep learning techniques.

Deep learning is narrower concept than machine learning. It can be considered a subset of machine learning. The concept of deep learning is thought as a deep neural network, meaning that it has many layers involved. A neural network is using only a single layer of data and a deep neural network has two or more layers of data. Deep learning networks require a large amount of data to be trained. It learns from exposing millions of data points. Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction. These methods have dramatically improved the state-of-the-art in speech recognition, visual object recognition, object detection and many other domains such as drug discovery and genomics. Deep learning discovers intricate structure in large datasets by using the backpropagation algorithm to indicate how a machine should change its internal parameters that are used to compute the representation in each layer from the representation in the previous layer (LeCun et al., 2015).

Deep-learning methods are representation-learning methods with multiple levels of representation, obtained by composing simple but non-linear modules that each transform the representation at one level (starting with the raw input) into a representation at a higher, slightly more abstract level. With the composition of enough such transformations, complex functions can be learned (LeCun et al., 2015).

2. LITERATURE REVIEW

Predicting online user behavior has been in the focus of several research papers. Few researchers tried to connect user behavior with their online purchasing habits. In paper (Vieira et al., 2015) researchers did a comparison of traditional machine learning techniques with the most advanced deep learning approaches. Researchers tried to identify activity patterns of certain users that lead to a purchase and then extrapolate as templates to predict a high probability of purchase on websites. They used an unbalanced dataset with about 1 million sessions containing the click data of users which had 3% of the training data with buy sessions. The conclusion was that detailed information about which products the user visited does not carry much gain to the logistic regression accuracy (in some cases it even decreases due to the increase of dimensionality), while in using random forest they have got higher accuracies. For deep learning networks pre-trained with Stacked denoising auto-encoders reach the highest accuracy for predicting user behavior (which can be due to the sparse data set).

Data collected using mobile phones are used in paper (Alsheikh et al., 2016). Researchers were using the Actitracker dataset, which included accelerometer samples of 6 conventional activities (walking, jogging, climbing stairs, sitting, standing, and lying down) from 563 crowdsourcing users (Lockhart et al., 2011). They presented an overview and brief tutorial on deep learning in mobile big data analytics and discuss a scalable learning framework over Apache Spark. In their research distributed deep learning is executed as an iterative MapReduce computing on many Spark workers. Each Spark worker learns a partial deep model on a partition of the overall mobile, and a master deep model is then built by averaging the parameters of all partial models. Their Spark-based framework speeds up the learning of deep models consisting of many hidden layers and millions of parameters. Researchers validated their framework with a real-world dataset.

In paper [27] researchers used mobile search behavior to predict purchase intentions for users. They tested a proposed prediction model on Alibaba dataset. They based their research on consumers that often search for products and services that are closely relevant to the current context such as location and time. They proposed a probabilistic generative model to discover underlying search patterns, i.e., when to search, where to search, and in what category. Their paper illustrated the effectiveness of integrating contextual factors into modeling consumers' search patterns.

The deep learning system has been modeled in (Tang et al., 2014). The modeled system is used for Twitter sentiment classification. Researchers built a system in a supervised learning framework by concatenating the sentiment-specific word features hand-crafted features. They have trained their system using 10 million Twitter messages with positive and negative emotions. The system has been verified towards these messages for predicting Twitter messages sentiments.

As a popular solution for deep learning researchers often use TensorFlow. TensorFlow is a machine learning system that operates on a large scale and in heterogeneous environments. TensorFlow supports a variety of applications, with a focus on training and inference on deep neural networks (Abadi et al., 2016). In (Cheng et al., 2016) researchers create distributed representations from cross-product transformations on categorical features, and the implementation on TensorFlow is used to power the Google Play app store recommender system.

This paper's focus is to model a system that will be able to predict will user make a purchase, leave a site or go to some other page, based on previous user actions that are analyzed using deep learning.

3. MODELING A DEEP LEARNING SYSTEM FOR PREDICTING USER BEHAVIOR ON E-COMMERCE WEBSITES

The goal of a deep learning system that is being modeled in this paper is to predict how a user will behave on the e-commerce website. The main goal of every e-commerce website is to navigate the user to make a purchase that will increase owner revenue. Modeling a deep learning system for predicting user behavior consists of the following steps:

1. Gathering user data
2. Preparing user data

3. Choosing model
4. Training model
5. Evaluating model
6. Adjusting model
7. Modeling system architecture

UML activity diagram below explains the process of modeling a deep learning system.

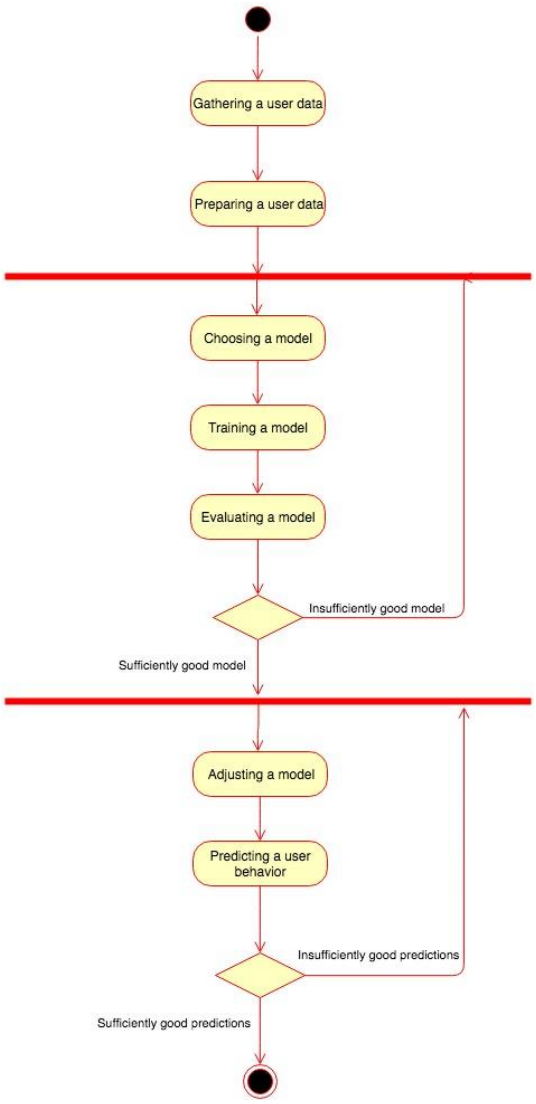

Figure 1: UML activity diagram that explains the process of modeling a deep learning system

3.1. Gathering user data

Gathering user data is the most important step in modeling a deep learning system. Without a lot of data, our system would not be able to predict anything. Data quality and quantity determines how precise your predicting model can be. If you collected data that is not relevant to the real case scenario the predicting model would not be able to do any valuable predictions. Some researchers are considering a problem with not properly balanced training data. In (Batista et al., 2004) researchers are investigating a problem where examples in training data belong to one class which heavily outnumber the examples in other classes. This can influence the performance achieved by a learning system. In that situation, the learning system may have difficulties learning the concept related to the minority class. With the hourly increasing amount of data, bad data is going to become an even bigger problem.

We used the data from the server logs from an e-commerce website that is selling handyman tools (URL of the website is *verktøy.no*). The fixed set of actions is selected based on the data from apache server logs in period from *2018-01-11* to *2018-01-25* for logged in and not-logged in users.

3.2. Preparing user data

Data preparation is a step in modeling a system for predicting user behavior where data is loaded and prepared for training. In this step, it is important to investigate any relationships between different variables. Also, in this step, we would need to make sure there are no imbalanced data. If there is an imbalanced data, the model would be more inclined towards the action that is mentioned more times, since it would be right most of the time.

In this step, data is separated into training data and testing data. Training data is usually taken to be 75% and 25% for testing data. Testing data is used to evaluate trained model performance (Witten et al., 2017).

Data preparation also includes converting any data to the expected format, removing unlikely values, fixing missing values, removing irrelevant values, and all other kinds of data manipulation before data is used in the model (Kotsiantis et al., 2007).

The apache logs that were used were in the following format:

IP address | Timestamp | Relative URL | Request type | Response code

The list of the most used actions is extracted from server logs. The list consists of 18574 user action events. User actions in table 1. are extracted from the server logs. They are grouped into specific categories based on their URLs. In table 1. we are showing how these categories are selected based on URLs.

Table 1: Mapping URL paths from server log to user actions

Action	URL paths from server logs	Server request type
Visit home page	/	GET
Visit category page - level 1	all first level category paths	GET
Visit category page - level 2	all second level category paths	GET
Visit category page - level 3	all third level category paths	GET
Search for product	/search/?q=	GET
Visit product page	all product URLs	GET
Add product to cart	/checkout/cart/add/	POST
Go to cart page	/checkout/cart/	GET

Data collected this way is very scattered, so it is necessary to adjust it by grouping data for specific periods to make data less scattered. Data for actions that user can do is highly unbalanced since only in some cases users will make a purchase. Most of the time users are spending just looking for the products. That problem is not considered in this paper. For this research, we are using python library Keras (which is using TensorFlow and Theano in the background). For mapping user actions into numbers (for easier processing by deep learning network), we are using a LabelEncoder preprocessing tool (within ScikitLearn). This will give certain numeric labels to all user actions from a dataset (from 0 to 8). Since these numbers are ordered just by random assignment by LabelEncoder library, we need to create a dummy variable for user actions (which is used to represent a categorical variable into dichotomous variables) (Wikiversity, 2020) using OneHotEncoder from ScikitLearn package. All variables that are used in our model have to be standardized before we use them for us to have their value within the same scale. We are using a StandardScaler method from ScikitLearn package. After this is done the data is fully prepared for the usage.

3.3. Choosing model

Choosing a model for deep learning system is selecting one of the four fundamental neural network architectures (Gibson & Patterson, 2017):

- Unsupervised Pre-trained
- Networks Convolutional Neural Networks
- Recurrent Neural Networks
- Recursive Neural Networks

For this scenario, we selected recurrent neural network (RNN) architecture. These types of networks are particularly well suited for modeling problems in which temporal relations are relevant and the time gaps between the events are of unknown size. User behavior histories are inherently sequential, making RNNs a

natural model choice. In e-commerce, available data sources and prediction scenarios often change, making the generality of RNNs appealing as no problem-specific feature engineering has to take place. RNNs can be applied to predict future consumer behavior in regression and classification settings, for example, to predict interest in fashion brands or consumer lifetime value (Almeida & Azkune, 2008).

The main goal of our model is to model the dependency on previous user behaviors into the user behavior prediction process through the recurrent structure in RNN. We used an RNN model the user behavior history directly.

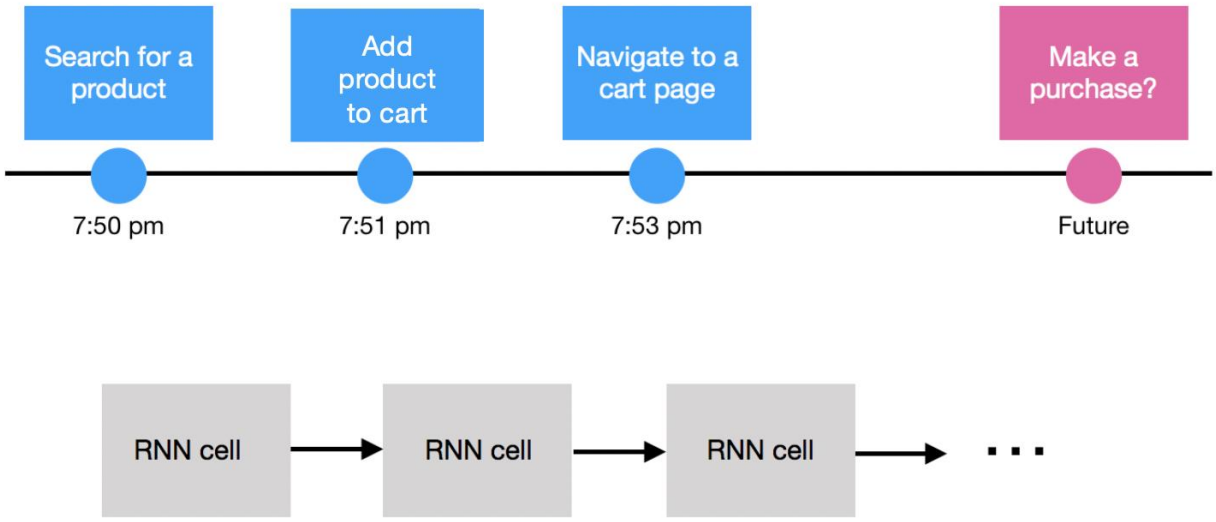

Figure 2: RNN model for user behaviour history (sample scenario)

To create a deep neural network, we are using a Sequential module for initializing NN and dense module to add hidden layers from Keras library. There are 8 input parameters (all events except *Make a purchase* event). We are assigning weights to each of this factor using a uniform function.

3.4. Training model

Training a model consists of running training for previously prepared data within the selected model. During training, the RNN is learning to detect relevant action patterns in user behavior events. For example, it can learn that the sequence of searching for a product around noon and adding a product to the cart a few minutes after will lead to purchasing a product. Or it can learn that searching for a product in the morning and adding the product to the cart the next day will have a higher probability that product will be purchased than in the first example. In our case, it will be more explained in the next section.

In any machine learning process, during training, data has to be divided into training and test data. We will use ScikitLearn's method *train_test_split* for dividing data between training and test datasets in ratio 80:20. Our model training dataset has 14859 entries. Training data is run compared to a deep learning model with two hidden layers (our deep learning model consists of an input layer, two hidden layers, and the output layer). Before training of the model can be done, a model has to be compiled with a specific algorithm (to find an optimal set of weights for each input parameter). We have used Adam algorithm from SGD (Bottou, 2010). Now, this model can be trained using classifier with a modified batch size (after how many observations when a weight should be updated) and epoc (number of iterations). Now, the prediction can be made, which action the user will do next.

3.5. Evaluating model

After the training data and getting a prediction, which action the user will do next, the model should be evaluated. We are building a confusion matrix to check the model accuracy based on the results that we have collected from our test data. The confusion matrix is built from test data and our model predictions. For our model we have used 3714 records for testing the model accuracy.

We used SdA (Stacked Denoising Autoencoders) as a learning technique. An autoencoder is a neural network with a single hidden layer and where the output layer and the input layer have the same size. We have selected 80% of a dataset as a training set and 20% as a test set. We used Spearming to organize meta parameters using Bayesian optimization (Snoek et al., 2012). We are running network models on Apache MXNet deep learning framework.

The achieved accuracy with SdA technique of our implemented model was 76.17%. So, as a conclusion, our deep learning model can guess what will be the next user action based on a user's previous action with probability higher then 76%.

In table 2. we are showing what is the chance that user will *Make a purchase* action if they previously did each of the extracted actions from table 1.

Table 2: User actions as input and *Make a purchase* action expectation as output (from 0 to 1)

Action	User will make a purchase within next 5 steps	User will make a purchase within next 10 steps
Visit home page	0.015	56
Visit category page - level 1	0.041	45
Visit category page - level 2	0.064	40
Visit category page - level 3	0.070	0.081
Search for product	0.068	0.089
Visit product page	0.119	0.119
Add product to cart	0.212	0.212
Go to cart page	0.798	0.798

As we can see in the table 2., if the user comes to a product page, there is an 11% chance that the user will make a purchase. We can also see that the lowest chance for the user to make a purchase is if it lands on a home page. What we can also see is that if the user visits some of the categories, the chance for making a purchase is around 4-6%, and this increases to 8% as the user clicks on a deeper level of category. After searching for a product by name, 8% of users will end up making a purchase. When a user adds a product to a cart, 21% of those actions are ending with the user making a purchase. Around 20% of users drop on a cart page and they never finish a purchase.

3.6. Adjusting model

After evaluating a model and determining its results it is important to check if results are satisfactory. In deep learning models, there is always a space for tweaking model, so it is important to mention that this step is very important. As can be seen in Figure 1. if predictions are not good enough a system modeler should be returned to choosing a model and choosing its parameters. In this paper, we will not focus on tweaking a model.

3.6. Modeling system architecture

As it is mentioned in evaluating a model, this deep learning model can predict the next user action, based on previous user actions. For example, if a user went to a product page, we could predict if that user will leave the website or add a product to the cart. If a user adds a product to the cart, we can guess will user make a purchase. The model can be accurate and predict what the user will do next.

To make this prediction model scalable and accessible for users in the production environment, a methodology of system architecture on the Digital Ocean is proposed. This architecture is shown in the figure below.

In the figure 3 a suggested architecture methodology is shown for the implemented prediction system. It shows information flow in a prediction engine. From the data that is generated on the application level (application, devices, and web) the data goes to Apache Kafka. Apache Kafka is used for real-time processing of events. It is attractive for its ability to scale to millions of events per second. After that, data is sent to Apache Kudu. Apache Kudu is a storage layer that enables fast analytics on fast data. IT is used as storage that allows incremental inserts of the events. After that, data is sent to Apache Spark. Apache Spark streaming is used for presenting complex event processing workflows. On the figure below it is shown how Apache Spark streaming works.

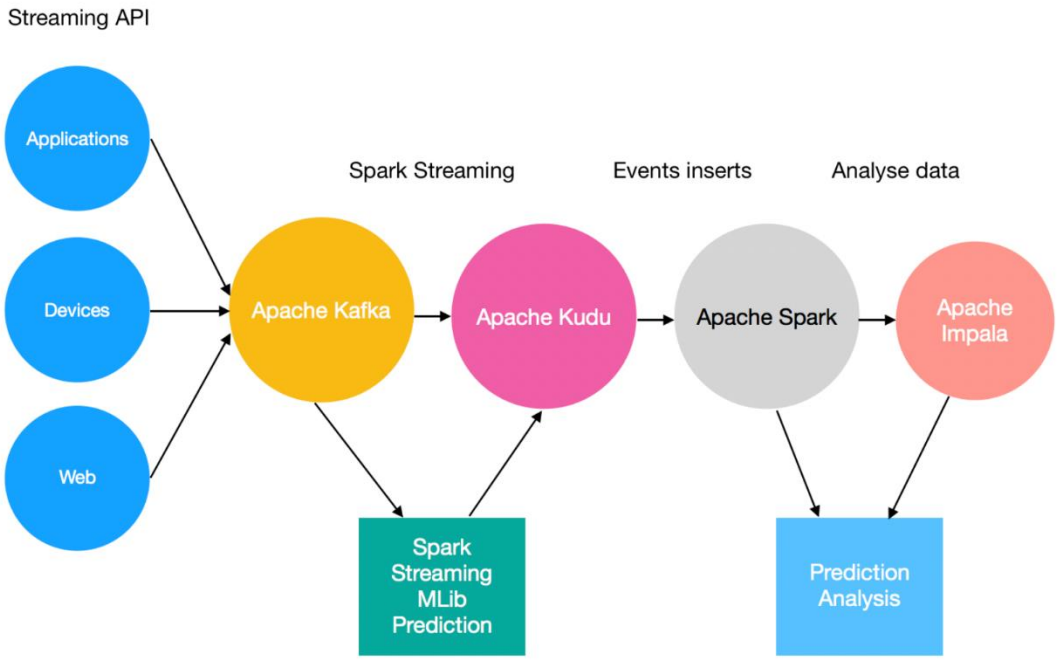

Figure 3: Suggested system architecture methodology

As shown on the figure 4, Apache Spark streaming converts input data stream into batches of input data, which is processed by Spark Engine and outputs batches of processed data. Apache Impala is used as a presentation layer, to show and analyze results.

Figure 4: Apache Spark streaming workflow (Apache Spark streaming, 2020)

4. DISCUSSION

In this paper, the main focus was on predicting user behavior on an e-commerce website using a deep learning system. User behavior is predicted based on the hidden patterns that the deep learning system recognized in another user's behavior. Based on that, the system can predict what will be the next user action based on a user's previous actions. Also, the system can predict will the user make a purchase or not. Traditional approaches in e-commerce are based on vector-based methods like logistic regression with feature engineering (Chapelle et al., 2014). Using deep learning to predict consumer behavior has been used in several papers, but researchers didn't use the sequential behavior model explicitly. Deep learning has been applied to predict customer churn in mobile communications. Researchers converted sequential consumer data like phone calls into image-like representations (Wangperawonga et al., 2016). The deep neural network architecture is also used in (Bracher et al., 2016). Researchers presented a method to determine Fashion DNA, coordinate vectors locating fashion items in an abstract space. They merged content and sales data for recommendation and article mapping. They based their research on a deep neural network architecture that ingests article information such as tags and images and is trained to predict sales for a large set of frequent customers.

Deep neural networks are also used for YouTube recommendations (Covington et al., 2016). Researchers described the system at a high level and focus on the dramatic performance improvements brought on by deep learning.

Recurrent neural networks have been investigated in the recommender system and e-commerce before but in order to predict click rates for ads (Zhang et al., 2012). It has been applied to the stream of ad impressions that are shown to an individual user. RNN has not been used to model user behavior in terms of different

actions. In (Ferreira et al., 2015), researchers tried to predict demand on an e-commerce website. Researchers used regression trees as a machine learning algorithm for doing prediction.

Deep learning systems are also used in image analysis. In (Karpathy & Fei-Fei, 2017), researchers presented a model that generates descriptions of image regions after scanning an image. They use datasets of images and their sentence descriptions to learn about the inter-modal correspondences between language and visual data. They also used Recurrent Neural Networks (RNN) over sentences and a structured objective that aligns the two modalities through a multimodal embedding. Also, in (Chan et al., 2015) and (Cireşan et al. 2012), researchers created a deep learning network for image classification. They have tested classification on different image datasets. In (He et al., 2016), researchers used deep learning networks for image recognition. They have been investigating the possibility of reformulating the layers as learning residual functions with reference to the layer inputs, instead of learning unreferenced functions.

5. CONSLUSION

At the time of writing, there is not much investigation on how a deep learning system can be used for predicting user behavior on an e-commerce system. Also, there are no other papers that are analyzing previous user actions to determine further user actions.

This scenario can be really useful in investigating where e-commerce website owners are losing most of the potential buyers. Since conversion on e-commerce websites are usually below 3%, the information where they are losing most of the potential buyers can be very beneficial to store owners (Statista, 2019).. It is important to mention that using this technique and similar analysis, store owners can reveal potential drop points for users that they were not aware of before.

In the future, this research can be used as a base for determining a probability for a user to leave the website, and based on that website can offer those users some special discount or some other recommended products, so users might decide to stay on the website. This could work in real-time, and if the system predicts that the user will leave the website soon, the website can be prepared to take some actions to keep users going further in making a purchase on a website.

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THE ROLE OF SPARK AND KAFKA IN THE PROCESSING OF FAST DATA IN TELECOMMUNICATIONS

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Abstract: *Data has been recognized as an important asset in many industries. Nowadays, the focus is moving from big data to the data that requires instant gathering and processing, so-called 'fast data'. The goal of this paper is to address the nature of such data in modern telecommunications networks and the challenges and benefits of its handling in real-time. The paper further portrays the capabilities of Apache Spark and Apache Kafka, which can be useful for the ingestion and processing of the 'fast data' in the telco context.*

Keywords*: fast data, streaming data, telecommunications, Spark, Kafka*

1. INTRODUCTION

Different enterprises and different industries are nowadays gathering a huge amount of data. The intention they have is to identify the information useful for their business needs (Miloslavskaya & Tolstoy, 2016) and to turn this enormous data potential into tangible value for the organization. This includes a large and complex data sets that cannot be handled by the traditional data applications and data processing tools. Therefore, the data science and the different platforms enabling large-scale data processing and matching the different requirements related to flexibility, scalability, and control are becoming critical assets to achieve the goal.

In telecommunications, more than in any other industry, service providers have access to numerous data sources that can generate insights meaningful for their business (MapR Technologies, 2017; Newman, 2019). Many of those data sources are generating the data which should be gathered and acted upon right away to satisfy customer's expectations, ensure network automation or prevent service outages. Such kind of big data that needs instant processing as it arrives in the system is usually referenced as "data in motion" or "fast data" (Byrne, 2017).

The processing of fast data implies specific technological requirements. To satisfy them, numerous solutions have been developed during the last years. This paper focuses on two open-source projects belonging to the Apache Software Foundation, Apache Spark and Apache Kafka and their applications in telecommunications. Spark is one of the fastest and most efficient general engines for large-scale data processing (Apache Spark, n.d.), while Kafka is a distributed, fault-tolerant, publish-subscribe messaging platform (Apache Kafka, n.d.).

This paper is organized as follows. Section two presents the concept of fast data and explains the sources, nature and increasing significance of fast data in telecommunications in everything connected world. Section three outlines specific challenges in the fast data processing and discusses two architectures used by enterprises in integrating real-time and batch data analytics. It provides a brief overview of Apache Spark and Apache Kafka and then further explores the functionalities developed within these projects that could be used efficiently in the data processing infrastructure of the telecom operator, including references from the real implementations. Section four concludes the paper with practical contributions and suggestions for future work.

2. FAST DATA IN TELECOMMUNICATIONS – CONCEPT, IMPORTANCE, AND CHALLENGES

Telecom operators have already recognized the data as an important asset, and a vital part of their digital transformation. Besides the data about subscribers' behavior and preferences, data generated by the end devices and by network infrastructure elements, data about every event in their network, they can access to the different external information (e.g. whether info, social networks, etc.) and correlate it with the proprietary information (MapR Technologies, 2017; Brdar, Novovic et al, 2019). In the academic papers and industry publications, different classifications of these data can be found. This article leverages on the differentiation described by TM Forum (TM Forum, 2019) which identifies the following groups:

- Customer & Stakeholder Data – Data about the customer and his/her usage of product and services, bills, complaints, etc. coming from Billing, CRM and call center, data about the interaction with the customers using both the digital and traditional channels, data about the partners and other stakeholders.
- Data Center & Network Data – This includes streaming events, alarm data, configuration data, performance data, system logs, resource utilization, trouble ticket data, knowledge repository data, message logs, performance reports, etc. related to the different telecom network elements (RAN, CS core, PS core, VAS network elements), as well as to the compute, storage and network infrastructure (TM Forum, 2019).
- Service Data – Services related logs, events, incidents, trouble tickets, all kinds of orchestration activities and relevant data, transactions, and purchases.
- Operational Data – Information around both business and technical processes (e.g. fulfillment, assurance, device, and equipment maintenance, etc.) (TM Forum, 2019)
- Enterprise Data – Financial, inventory, workforce, and similar enterprise-wide relevant data
- External Data – Weather or location information, information about external events (e.g major sports events) that could have an impact on the usage of telecommunication networks (TM Forum, 2019). Additionally, important external data are coming from different social networks where subscribers share their positive or negative opinion about the operator's network, services, tariffs, staff, etc.

During the last years, the focus of the operators worldwide started to focus on particular data, called "data in motion" or "fast data". The change was mainly caused by an enormous increase in real-time data related to usage and subscribers' behavior, and by the deployment of cloud-based systems and network technologies (Newman, 2019). Such a change requires a different type of infrastructure and different analytic capabilities.

The concept of Fast Data emerged from the differentiation in terms of time sensitivity in big data processing (Miloslavskaya & Tolstoy, 2016; Shalom, 2014; Shahrivari, 2014). Initially, big data processing was only a batch processing of a vast amount of raw data in its native format. The first wave of Big Data management platforms and frameworks have been developed in response to demand for scale in volume, velocity, and variety of data. While this fulfills most of the requirements related to the handling of historical data, there are events and corresponding data that should be analyzed quickly, if possible, in real-time (Shalom, 2014; Shahrivari, 2014). Typical examples are related to the processing of social media feeds or online orders, although in many other cases processing the most recent data is necessary to make the right decision or conclusion (Craig, Potter & Berglund, 2020).

Fast Data is described as "a relentless stream of events generated by humans and machines that must be analyzed and acted upon in real-time" (Byrne, 2017), or as a time-sensitive structured and unstructured "in-flight" data which requires low latency and processing of big data streams at speed (Miloslavskaya & Tolstoy, 2016). Furthermore, in the case of data streams, there is no defined beginning or end of the dataset, data is arriving sporadically, and the size of a dataset can vary significantly (Craig, Potter & Berglund, 2020).

Processing fast data in the context of telecommunications means managing numerous live events related to subscribers, connected devices, networks or services and aggregated measurements (TM Forum, 2019). Fast data platforms in such a case need first to capture streaming data, enrich this data with the relevant context (e.g. personalization), analyze it in real-time, decide the next course of action and act before the data comes to rest (Byrne, 2017). The benefits of real-time data can be applied to many aspects of a telco operator's business (Newman, 2019; McEligott, 2020; Byrne, 2017). Three main areas of application are further explained in the subchapters below.

2.1. Improving Customer Experience

One of the strategic goals of the majority of the telecom operators is to become a customer-centric organization and to bring the experience of telco customers as closely as possible to the level set by the most popular providers of digital services (e.g. Netflix, Amazon). To achieve this, they have to manage and improve different touchpoints and interactions in the customer journey (Newman, 2019; TM Forum, 2019; MapR Technologies, 2017; Byrne, 2017). Processing of fast data is crucial for both the understanding of customer's preferences, usage and spending patterns and the understanding of customer's perception. In the first case, this awareness enables operators to personalize their offering, proactively anticipate the subscriber's needs and make intelligent marketing and sales (Newman, 2019; TM Forum, 2019). The second case makes possible for the operator to bridge the gap that sometimes exists between the overall technical performances of the network and the perception of the individual subscriber using a particular service at the moment. Even if the problem happens, if the operator reacts promptly and accordingly (e.g. sending an immediate apology and offering some voice or data traffic for free) this could improve overall customer satisfaction and loyalty and reduce churn.

2.2. Improving Operational Efficiency

This is a broad area that includes collecting and processing real-time data to efficiently manage and optimize all the aspects of network planning and operations (Newman, 2019). There are many use cases in modern telecommunications where the real-time decisions are needed: least-cost routing, subscriber management, policy management, and enforcement, real-time charging, authentication and authorization, fraud detection, are just some of them (Byrne, 2017). Evolution of telco networks based on Network functions virtualization (NFV) and Software-defined networking (SDN) makes the real-time data even more important, and at the same time increase the volume of the "data in motion" that should be taken into consideration. The data and knowledge coming out of them are supposed to be used for proactive capacity planning, network resource allocation, configuration, orchestration, preventive and corrective maintenance, etc., of the virtualized infrastructure, without or with the minimum human intervention (Fersman, 2019; Byrne, 2017; Newman, 2019; McEligott, 2020). At the same time, telecommunications networks, like the fifth generation of mobile networks (5G), are expected to become the crucial contributor in the digital transformation of other industries and to enable remote control of heavy machinery, autonomous vehicles or remote surgery. Those new applications impose strict demands on the quality of service and security. If tomorrow's networks are expected to be "zero-touch" networks, i.e. self-operating, self-optimizing and self-healing, and at the same time be a part of the critical infrastructure, then it is of uttermost importance to have the powerful intelligence and analytics tools to manage them and to feed them with the right data (Fersman, 2019).

2.3. Participating in New Ecosystems

Looking for new revenue streams, telecom operators are becoming part of new ecosystems. Providing critical connectivity, as outlined above, is their main role, but not the only one. The capability of collecting and processing fast data opens up the other possibilities for monetization. In the case of IoT deployments, operators can include in their offering handling of data coming from connected devices and sensors (TM Forum, 2019). Another possibility is to sell to third parties the data and insights operators have about their subscribers, including the patterns of their activities, interactions, and mobility during the day, assuming that all regulatory and privacy-related prerequisites for such a scenario are fulfilled (Brdar, Novovic et al, 2019).

Table 1: Fast Data in Telecommunications

Area of application	Examples of possible applications
Customer Experience	Understanding of customer's preferences, usage and spending patterns
	Understanding of customer's perception
Operational Efficiency	Least-cost routing
	Policy management and enforcement
	Fraud detection and prevention
	Proactive capacity planning
	Network resources allocation
	Preventive and corrective maintenance of the virtualized infrastructure
New Ecosystems	Generation and monetization of insights from the IoT data
	Generation and monetization of insights from the subscribers' data

3. PROCESSING OF FAST DATA

In a nutshell, processing of fast data imposes two main technological requirements: a streaming system that can ingest the various data related to events as fast as they occur and a data store capable of handling and analyzing each item coming in those massive, continuous data streams, in a near-real or real-time (Miloslavskaya & Tolstoy, 2016).

3.1. Lambda and Kappa architectures

The increasing importance of real-time analytics for insight generation does not exclude the need for analyzing large volumes of historic data. Thus, the big data infrastructure should be capable of dealing with a huge amount of data efficiently and enabling both real-time and batch data analytics. Two architectures providing the potential answer on this challenge are named after the Greek letters, Lambda and Kappa (Samizadeh, 2018; Lin, 2017; Dominguez, 2019).

The objective of Lambda architecture is to have a robust, fault-tolerant system, that is linearly scalable and enables writing and reading with low latency (Dominguez, 2019). This architecture comprises three distinct layers: Batch Layer, Speed Layer (also known as Stream layer) and Serving Layer (Samizadeh, 2018).

In brief, Lambda architecture is characterized by using separate layers for batch processing and streaming, plus a merging layer on top (Samizadeh, 2018; Lin, 2017; Dominguez, 2019). The new data captured by the system is sent both to the Batch Layer and the Speed (Stream) Layer simultaneously. Any new data stream that comes to the Batch Layer is added to the existing Data Lake and after that treated trough the batch process resulting in different batch views. The Speed Layer is helping in reducing latency by handling the new data only, but using the models updated by a previous batch process. The output of the Speed Layer processing is a near-real-time view. Serving Layer is combining both batch views and near-real-time views to generate the answers on the ad-hoc queries (Samizadeh, 2018; Dominguez, 2019). Such an approach ensures both the reliability in updating the data lake and increased throughput, reduced latency and negligible errors in the processing of real-time data, but at the cost of increased complexity (Samizadeh, 2018; Lin, 2017; Dominguez, 2019).

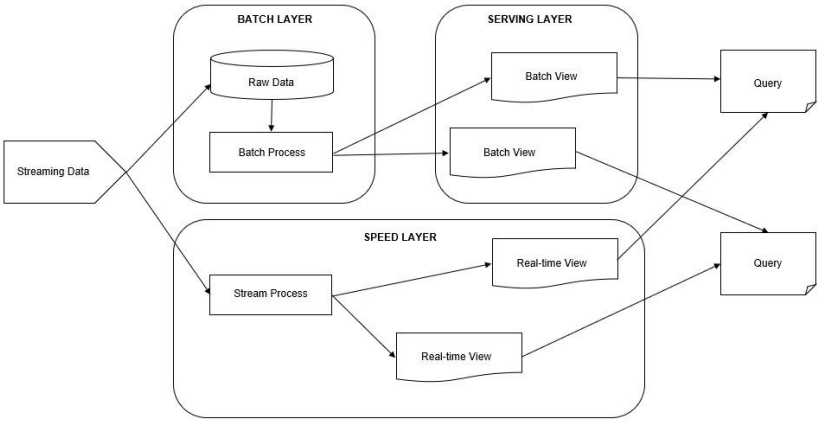

Figure 1: Lambda Architecture Simplified Overview (Verrilli, 2017)

In the Kappa architecture, batch processing is replaced by streaming through historic data. In this option, everything is considered as a stream and consequently, the focus is on the stream processing engine. This scenario does not provide the same capabilities as in the case of Lambda architecture, but it enables deployment with fewer hardware resources. If the batch layer functionalities are not crucial, and the main requirements are related to the real-time processing, then the Kappa architecture can be the right alternative (Samizadeh, 2018; Lin, 2017; Dominguez, 2019).

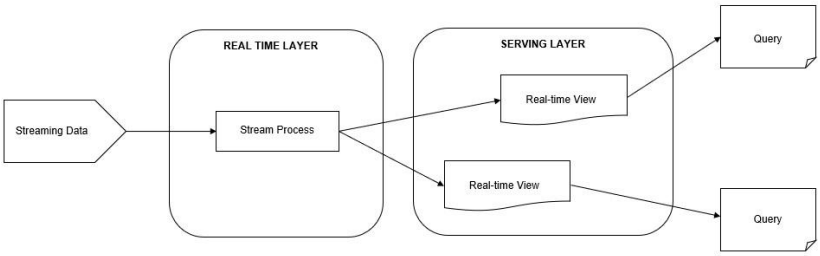

Figure 2: Kappa Architecture Simplified Overview (Verrilli, 2017)

The choice of architecture is always a tradeoff and depends on the priorities that in particular business context and circumstances are associated with features like low latency, high throughput, low cost, code simplicity, easy maintenance, etc. (Lin, 2017).

3.2. Apache Spark and Apache Kafka

Apache Spark is a unified analytics engine for large-scale data processing (Apache Spark, n.d.). It is one of the most active projects in open source, and it has been built on the idea of resilient distributed datasets, or RDDs. The concept of RDDs is a fault-tolerant abstraction for sharing data in cluster applications. It has been introduced to overcome the limitations of the previously developed frameworks for large-scale data analytics (e.g. MapReduce), in the case of iterative algorithms and interactive data mining tools (Zaharia, Chowdhury et al., 2012). Spark achieves high performance for both batch and streaming data (Apache Spark, n.d.).

Spark is widely applicable as it provides high-level APIs in Java, Scala, Python and R, and an optimized engine that supports general execution graphs. Additionally, it supports a rich set of higher-level tools including Spark SQL for SQL and structured data processing, MLlib for machine learning, GraphX for graph processing, and Spark Streaming (Apache Spark, n.d.; Zaharia, Das et al., 2012).

Apache Kafka is a distributed streaming platform. It is used for building real-time data pipelines (providing a reliable transfer between the different systems and applications) and for streaming applications (expected to react to events in real-time) (Apache Kafka, n.d.), (Craig, Potter and Berglund, 2020). Kafka is handling streams of records, each of them having a key, a value and a timestamp. Records are grouped per "topics", where the topic presents a category or feed name to which multiple producers can publish the records, and to which multiple consumers can subscribe (Apache Kafka, n.d.). For each topic, Kafka maintains a partitioned commit log, where the offset (a sequential id number) uniquely identifies each record within the partition. Furthermore, Kafka runs as a cluster and partitions are distributed over the servers in this cluster (Kafka brokers). Each Kafka broker is handling data and requests for a share of the partitions and at the same time, each partition is replicated across a configurable number of servers for fault tolerance (Apache Kafka, n.d.).

Kafka has four core APIs (Apache Kafka, n.d.):

- Producer API enables an application to publish a stream to one or more topics (Apache Kafka, n.d.).
- Consumer API makes it possible for an application to subscribe to one or more topics and process the corresponding stream of records produced to them (Apache Kafka, n.d.).
- Streams API allows an application to act as a stream processor, by transforming the input streams from one or more topics to output streams to one or more output topics (Apache Kafka, n.d.).
- Connector API allows reusing of the producer or consumer APIs that can link Kafka topics to existing applications or data systems (Apache Kafka, n.d.)

Kafka reads and writes streams of data like a messaging system, enables scalable stream processing applications and storage of the data streams in a distributed, replicated and fault-tolerant cluster (Apache Kafka, n.d.; Craig, Potter & Berglund, 2020).

Spark and Kafka can be combined differently with other platforms in the deployment of the relevant big data architecture. For example, Kafka's publish-subscribe messaging system can be used for real-time data ingestion in both Lambda and Kappa architectures. Spark Streaming, together with other low latency technologies can be used for the implementation of the Speed layer in the Lambda or the Stream processing layer in the Kappa architecture. Another alternative is to use Apache Spark as a common platform to develop the Batch and Speed layers in the Lambda architecture, thus share much of the code between those two layers (Forgeat, 2015.).

3.3. Application of Apache Spark and Apache Kafka in Telecommunications

The rising importance of fast data in telecommunications forces the operators to apply best practices in building a real-time data architecture (Forgeat, 2015.). Besides the generic fast data requirements, those solutions must comply with telco's specific requirements on volume, latency, scale, cost, data consistency, etc. (Byrne, 2017). More and more, operators, but also traditional suppliers of telco equipment, are leveraging on open source solutions to meet these demands. Due to their features and functionalities, outlined earlier in this chapter, Apache Spark and Apache Kafka can be a good choice to be combined with other open-source components to create a highly scalable, fault-tolerant and cost-effective data pipeline for a real-time telco data stream. Furthermore, they have the capabilities that could be particularly useful in the telco context.

Being in its essence, a distributed log (Lin, 2017), Kafka is satisfying many important logging requirements specific to the telco world. In other cases, where a single event doesn't need to be saved but has to initiate relevant actions, Kafka enables pattern detection to be applied with a subscription to triggering events (TM Forum, 2019).

Due to the specific business processes, regulations and/or interoperability standards, data streams generated by telecommunication networks or subscribers are often subject to normalizations, cleansing, consolidation or other transformations. Spark enables those transformations to be performed at the requested speed. Furthermore, Spark Streaming with its performances is very valuable and efficient in cases where the processing of streaming data requires some consolidation or any other operation with historic data to be included (Kumar & Kumar, 2019).

Another important advantage of using Spark and Kafka in telco context is that operators can find this competence in the market, and in synergy with telco specific subject matter experts, design and implement tailor-made solutions. Below are listed some examples of real-world implementations.

- Airtel Sri Lanka used Kafka and Spark together with other open source solutions (Cassandra, Presto, Yarn, Zeppelin) to develop its lightweight business intelligence (BI) platform (Mehta ,2019).
- SK Telecom is using Spark and Shark to analyse the mobile usage patterns of their subscribers (Apache Spark, n.d.).
- Spark Streaming is used as the processing engine and Kafka as the broker in the fast data platform developed by Telefonica which is leveraging on several open-source projects from Apache Software Foundations (Elastic Search, Kibana, NiFi) (Chappell, 2020). The architecture of this platform is based on TM Forum's Open Digital Architecture reference architecture (TM Forum, n.d.) and detailed microservices-based API implementations, created by Telefonica.

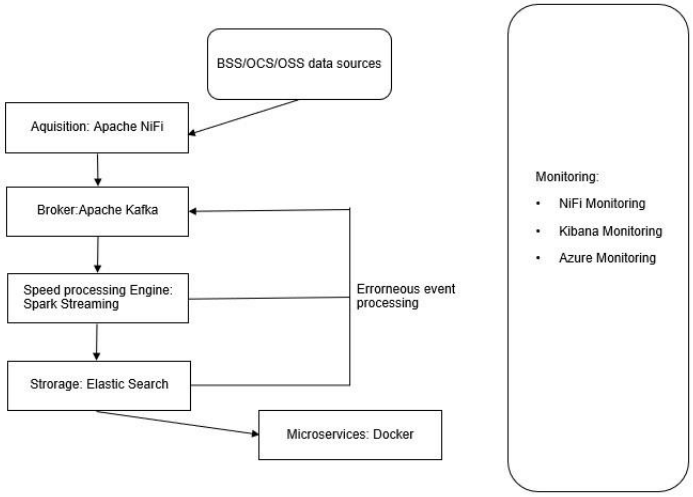

Figure 3: Fast data platform based on ASF components (Chappell, Analysis Mason, Telefonica, 2020)

This implementation provides a good illustration of the characteristics of the Kafka and Spark and the potential benefits that the mobile operator could have of implementing them. The main requirement of the operator was to provide a solution capable to integrate to existing and new domains in their network, to ingest and process hundreds of millions of events, and to present results immediately in the right context for customers and channel partners (Chappell, 2020). As solution is based on the popular open source tool, the operator leveraged on the internal competence and resources for development. First domain integrated to the platform is BSS (Business Support Systems), while in the next phase the integration to OSS (Operational Support Systems) domain is foreseen. (Chappell, 2020). Key business benefits are (Chappell, 2020):

- Improvement of operational efficiency (more extensive queries available and better performances achieved, lower middleware cost in comparison with the legacy SOA based solution)
- Development of capability that supports operator's strategic ambitions and enables future growth (exposing customized data to third parties in a short time)

There are predictions that open-source based event streaming platforms might become a core infrastructure for the integrations and new applications in the telco networks, replacing legacy middleware solutions. Additionally, integration with external partners implemented today via APIs, in the future might become Kafka-native (Waehner, 2020).

In a short term, one of the potential areas for further usage of Spark and Kafka in telecommunications could be the security related real-time analytics. As mentioned above, operators are looking for their role in the new ecosystems, exposing their own data or capabilities to different third parties. In such a scenario a potential security breach could have much worse consequences than reputation damage or operational disturbance. The processing of fast data, in this case, will be crucial for detecting and preventing threats or vulnerabilities.

4. CONCLUSION

This paper presents a conceptual overview of the fast data and summarizes the characteristics of architectures supporting its ingestion and processing. It further focuses on the nature and importance of these data in modern telecommunications. A massive increase in the volume of streaming data that operators need to process, and the need to act on that data at very low latency make the adoption of fast data applications and frameworks to be an integral part of the digital transformation of telco operators (Byrne, 2017; Newman, 2019). This paper outlines the capabilities of Apache Spark and Apache Kafka as the potential components in the

fast data platforms and emphasizes the possibilities of using them in telecommunications. In addition to examples of real implementations, it provides a suggestion for future work in the area of security-related analytic.

It can be considered as a sort of starting point for the telco operators aiming to build a solution for the processing of streaming data, to derive new data insights from it, enable the making of accurate decisions and further business growth.

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EMPLOYING CHATBOTS IN DIGITAL MARKETING

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Abstract: *Future development of digital marketing is strongly impacted by advanced technologies and concepts that include AI and machine learning. The evolution of online shopping has changed how companies meet customer service expectations and needs. The aim of this paper is to enhance both customer experience and conversion rate within e-commerce by employing AI technologies, especially chatbots. The contribution of this paper is in helping e-commerce websites to identify opportunities of chatbots, boost sales and increase the number of satisfied customers by implementing personal assistants with chatbot building platforms. The main goal of chatbot implemented in this paper is to reduce the number of FAQs, understand customer preferences and guide them in purchase. A chatbot was developed using Virtual Spirits platform. In addition, the chatbot was integrated into an online clothing store.*

Keywords*: digital marketing, artificial intelligence, chatbots*

1. INTRODUCTION

Artificial intelligence is the intelligence demonstrated by machines, as opposed to the intelligence that people have. AI is not human intelligence, but it can think like a human and may exceed human intelligence. Machine learning is a branch of artificial intelligence and is based on the idea that systems can learn from data, identify patterns and make decisions with minimal human assistance. This paper deals with the role and effects of AI and machine learning in digital marketing, especially chatbots. Alan Turing, computer pioneer, has proposed the question 'Can machines think?' in his paper 'Computing Machinery and Intelligence' (Turing, 1950). The Turing test checks whether a machine can stand side by side with human intelligence. No machine has passed the famous Turing test (Warwick & Shah, 2016). Ray Kurzweil, Director of Engineering at Google, has predicted that machines like chatbots will have human level intelligence and pass the Turing test by 2029 (Kurzweil, 1999).

Paper is structured as follows. In Section 2 there is an overview of current trends in AI in digital marketing. in areas such as personalized product recommendation, ppc ad optimization, SEO, predictive customer behaviour and chatbots. In Section 3 you can find chatbot history, usage of chatbots in various industries and approaches to chatbot development. Implementation of e-commerce chatbot for online clothing store is in Section 4, as well as terms of reference and implemented features. In this paper, the main challenge in creating a chatbot was to take full advantage of the chatbot building platform VirtualSpirits in creating a functional personal shopping assistant for an online clothing store. Chatbot building platforms do not have the power of customization as code-based chatbots, but they have great advantages in terms of maintenance, simplicity and immediately available reports and analytics on the behavior of website visitors. In order to take full advantage of the platform, a conversation flow was created for all product categories available on the previously created e-commerce website. At the end of the paper, in Section 5, you can find conclusion with key point summary.

If business wants to remain competitive in the market, keeping up with digital marketing trends is a must. Over the past few years, digital marketers were hesitant to apply artificial intelligence. Today, many successful companies have adopted and integrated AI and machine learning in their marketing strategies.

2. OVERVIEW OF CURRENT TRENDS OF AI IN DIGITAL MARKETING INDUSTRY

Digital marketing trends are incorporated with every industry that is present on the Internet. Not so long ago, companies needed only a website for online presence. Today, digital transformation market is growing daily. In 2020, AI technology in digital marketing will be among the most prominent trends. Digital marketers can no longer hope that the same old methods they used will work forever.

The words of Milan Kundera "Business has only two functions - marketing and innovation." are best describing today's market. Innovation is a never-ending process, but companies that succeed in it will develop strong corporate reputation and will outgrow competitors. AI offers an improvement to current marketing tactics, as well as entirely new ways of creating and distributing value to customers (Cannella, 2018). Cannella highlights innovations in digital marketing through integrations with AI like programmatic advertising, retargeting ads, chatbots, interactive marketing through biometrics image recognition and computer vision in social media marketing. (Cannella, 2018).

Current trends regarding AI technology in digital marketing industry are most common in areas of digital advertising, product recommendation, SEO, customer behaviour and virtual assistants (How Artificial Intelligence Is Transforming Digital Marketing | Forbes Agency Council, 2019). Most famous **digital advertising** platforms like Google, Facebook and Linkedin are using AI to find customers and make them do desired actions. These platforms use AI technologies to analyze customers information, so they can show them the most relevant ads. Companies that use these platforms, with the impact of AI technology, can improve the performance of the ads and generate more sales.

Many retail and e-commerce companies use AI technology to track their customers' preferences, habits and buying behavior based on their interests and previous purchasing history. This data helps them make suggestions and promote products and services that their customers may be interested in buying. **Personalized product recommendations** after online purchases are invented by Amazon. They use algorithm they call "item-based collaborative filtering" that makes their web pages unique for each customer.

For **SEO**, digital marketing trends are moving into the voice search. SEO experts use AI technologies to optimize and improve their content and links produced by search optimizers. Marketers can also use AI to optimize their content for voice search, as we move increasingly into a voice-operated digital world. On the other hand, Google SERP has also taken great efforts to individualize its search results. If users search for the same phrase, they are going to get different results that are based on their previous search results. Google has "Rank Brain", a machine-learning algorithm, that helps them fight against black hat SEO. This algorithm gives understanding of every query each person is making.

AI is changing how e-commerce companies interact with customers. **Predictions of customer behaviour** are made in the direction of better understanding their purchasing habits. Importance of individual customer service experience is rising. By using AI, companies can personalize each user's experience and can approach customers as individuals.

Most people are familiar with **chatbots** (virtual assistants) like Alexa and Siri, or even Rea, banking chatbot of Raiffeisen bank created for Serbian market. E-commerce chatbot works as a digital assistant and completes tasks such as: providing customer support, answering FAQs and completing customer purchases. This paper provides guidelines for creating virtual shopping assistant that can service multiple users at the same time and can offer 24/7 customer support. Consumers' allegiance will shift from trusted brands to a trusted AI assistant. (Dawar, Niraj & Bendle, 2018). More about chatbots is covered in following sections.

Even though AI is advanced technology in the digital marketing field, it is going to bring out more improvements in future years both for companies as well for customers.

3. HISTORY AND USAGE OF CHATBOTS

Eliza is considered to be the first chatbot that was invented in 1966. by professor at Massachusetts Institute of Technology Joseph Weizenbaum. Eliza is a program operating within the MAC time-sharing system at MIT which makes certain kinds of natural language conversation between man and computer possible. (Weizenbaum, 1966). This program was designed to imitate psychological therapist when the user types statements in natural language. It analyzes the user's statement and generated some response often as an open-ended question. Eliza wan one of the first programs with the possibility of passing the Turing test. The term "ChatterBot" was first used by Michael Mauldin in 1994 to describe these conversational programs that were originally implemented as simple IF-THEN-ELSE rules, based on pattern matching with variable assignment (Mauldin, 1994). Eventhough chatbots have been in existence for almost sixty years, they have gained widespread use over the past few years.

Chatbot is a computer program based on artificial intelligence and human language processing that simulates a conversation between a user and a computer. The conversation can be done either by text or voice and their job is to recognize user input, access the database and give a predefined response. Bot represents personal virtual assistant. Developers are in charge of making chatbots intelligent.

Usage of chatbots in various industries

Chatbots can perform various tasks such as: giving certain informations to users, making calls, encouraging online sales and booking tickets for restaurants, hotels and transport. They are widely used in banking sector, restaurant and tourism industry, healthcare industry and e-commerce. Banking chatbots are financial assistants that are used to give answers to any questions asked by client. AI-based virtual assistants can provide the user with suggestions on how to save money or identify suspicious and fraudulent activities on the user's account. In 2018, Raiffeisen Bank developed a virtual assistant for the Serbian market called "Rea" in cooperation with the IT company SAGA. Rea is based on artificial intelligence and clients can communicate with it via FB Messenger and Viber. This digital assistant allows users to find the nearest branch and ATM, to check the account balance or euro exchange rate. Rea handles thousands of inquiries and requests, is available 24/7, and since it is based on artificial intelligence, it will eventually learn about the preferences of each user and will be able to provide more personalized services (REA – An AI-based avatar as themost popular banking officer in Serbia | Raiffeisen Bank International's blog , 2019). Restaurant usually use virtual assistant to communicate with customers about FAQs or to provide table booking options and orders through delivery. Pizza Hut Facebook Messenger digital ordering platform gives customers choices like including delivery or pick up in their purchase or saving past purchases for frequent repeat orders (Pizza Hut announces new social ordering platform | Pizza Hut Blog, 2016). This chatbot is specifically designed for mobile devices and it is making it easy for the customers to order pizza, but also keeps customers posted on the latest offers and updates from the menu. Healthcare bots allow professionals to spend more time caring for patients instead of spending time on a daily routine of providing answers to the same questions over and over. An essential step in developing chatbots for healthcare is knowledge gathering. Chatbots for healthcare need to contain knowledge from domain experts and then that knowledge should be structured and formalized before inputted into the knowledge base (Cameron, Megaw & Bond, 2018). Zumstein and Hundermark did a survey where participants were asked whether they want real-time information during the trip, such as delays or transfers. The survey showed that 84% of mobile users always want real-time information and updates about their trips, 12% of the respondents would like to receive information only if they explicitly ask for it, and 4% have indicated that they do not want to receive real-time information at all (Zumstein & Hundermark, 2017). Since most participants showed a desire for real-time information during the trip, chatbots are ideal transport partner for travel and tourism industry.

3.1. Approaches to chatbot development

We can distinguish two types of chatbots, rule-based and AI chatbots. Rule-based bots follow certain rules and their responses are based on predefined rules. Through the user interface, bot follows the designed paths using decision tree and if/then logic. Self-learning AI chatbots use machine learning algorithms and artificial intelligence to process the information that they receive from users. They use that information later in communication with a human being. Rule-based chatbots are for companies that want the bot to be in use as soon as possible. In comparison with AI bots, they are cheaper and easier to create. AI bots require more effort and investment and they are better for personalizing the user experience. The choice between the two types of chatbots depends on whether the company wants the chatbot to perform simpler functions or wants a virtual assistant based on efficient decision-making.

Table 1: Advantages and disadvantages of chatbots

Criteria	Advantages	Disadvantages
Costs	They eliminate need for additional human labour.	Cost for AI chatbots are high for R&D, initial installation and bot maintenance.
Time	Answers are provided in real time, quickly and efficiently.	They require maintaining and optimizing the knowledge base, as well as constantly analyzing conversations with customers.
Availability and character	24/7 service. Managing multiple clients at once	Lack of emotions and personality.
Efficiency	By giving quick and appropriate answers, customers will return to the chatbot again	If there are a large number of processes, it takes time to develop AI chatbot.
Customer satisfaction	Manage multiple clients at once Improves customer loyalty and company reputation	If chatbot gets confused, they can be turned into an annoyance for the customer.

4. E-COMMERCE CHATBOT FOR ONLINE CLOTHING STORE

E-commerce refers to various online commercial activities focusing on commodity exchanges by electronic means, Internet in particular, by companies, factories, enterprises, industrial undertakings and consumers (Qin, 2010). Online shopping, form of e-commerce, was invented by Michael Aldrich in the 80s and refers to a process of purchasing goods or services on the Internet. Even though online shopping has grown rapidly in the recent years, there are some limitations of an Internet retailing growth. Limiting factors by Grewal, Iyer and Levy are: lack of trial, interpersonal trust, loss of privacy and security, poor logistics, lower customer service and lack of in-store shopping experience (Grewal, Iyer & Levy, 2004). These factors are still actual even though authors published this paper 16 years ago. Some of these limitations can be solved with e-commerce chatbots.

E-commerce chatbots can perform various tasks such as answering FAQ questions, purchase assistance, customer order tracking and complaint management. In order for customers to buy a certain item on an e-commerce website, they need to have someone to answer their questions, understand their preferences, guide them in their purchase and provide product recommendations. In the physical store, the seller is in charge of all this tasks. Considering that nowadays most people practically live on the Internet, they also need an assistant in the digital sphere.

In this paper chatbot is implemented for an online clothing store. The store sells exclusively women's clothing for the following three categories: sportswear, casual wear and classy wear. The web shop has functionalities such as login and registration, adding an item to a shopping cart, access to the shopping cart and product filtering. The home page of the website lists all available items, their price, category, name and label. Label has blue and red background depending on whether the product is new in the offer or on sale. The user also has the ability to filter the product by name. Chatbot was created to reduce the number of frequently asked questions that companies receive on a daily basis. It represents a personal shopping assistant.

Terms of reference

In order to improve conversation strategy, it is mandatory to create chatbot and human conversation flows. A conversation is a particular instance of a protocol or set of protocols, it is an ongoing sequence of messages exchanged between two or more agents (Nowostawski, Purvis & Cranefield, 2001). In order for the answers to be organized, creating **conversation flow diagram** is a must. It provides content understanding and clarity of conversation between bot and human. Conversation diagram helps to map every possibility in which chatbot can be found in a conversation with a human.

Conversation flow diagram for online clothing store is shown on Figure 1. Conversations flows 1 and 2 from the diagram are described below in "Implemented features". Implemented chatbot in this paper has the following responsibilities:

- Displaying offers to customers about different product categories.
- Providing information about the price and composition of the selected item by the user.
- Providing basic answers to frequently asked questions like store location, opening hours and payment options.
- Providing product recommendations
- Saving user data using various reports so that it can be used in further customer analytics

Implemented features

The colors of the chatbot are in accordance with website design and there is a picture of a real company representative. Chatbot addresses the user with a welcome message and offers help in the form of an open question. If the user does not respond to the message within 3 seconds, the chatbot displays the call to action buttons with the offer. By simply clicking on one of the offered buttons, the user can get the desired information. Buttons are created according to the most frequently asked questions that website visitors have when they visit website. Buttons offer information about product categories, payment, location and contact.

Chatbot is in line with the brand identity. The color palette of the chatbot is the same as the website color and other brand materials. Simple color contrast leads to more conversions. Chatbot design should be emphasized because it communicates with users and increases sales. Color matching is creating a "visual hierarchy" that tells the visitor what is important and what is not.

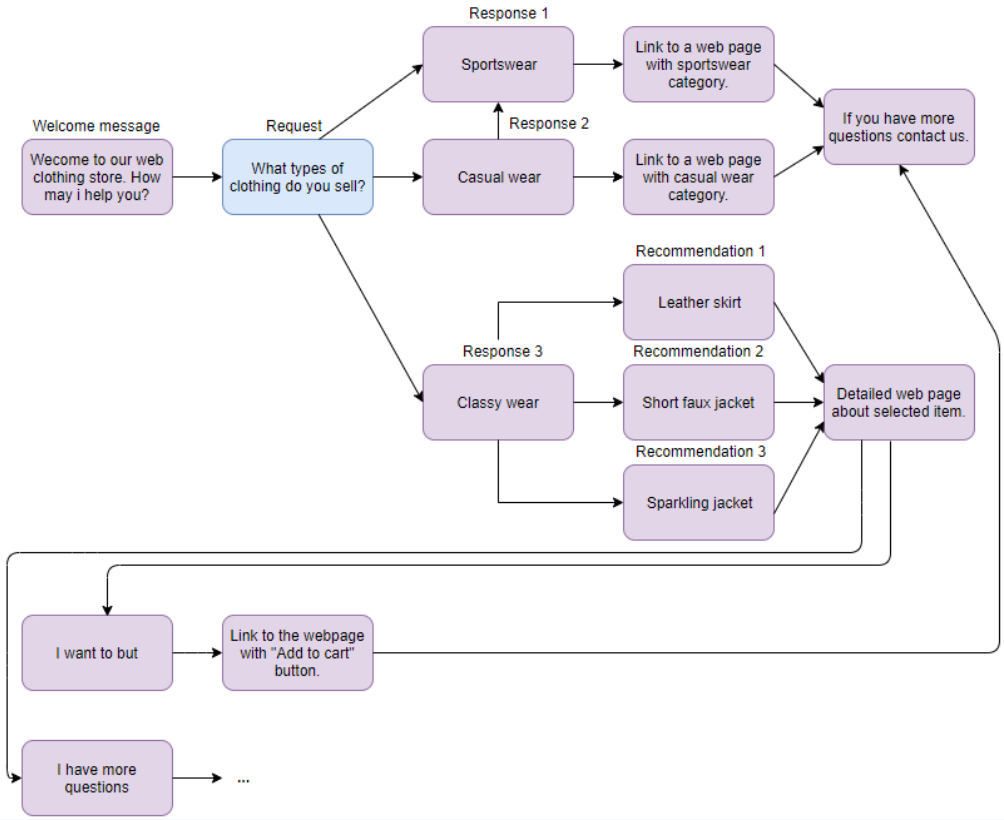

Figure 1: Conversation flow diagram

The image of the chatbot should not only exist to fill the empty space, but should have the image of a real representative of the company. Website visitors ignore generic photos of people or objects. A picture of a real company representative gives visitors the feeling that someone is actually reading their messages. The chatbot should be located on the part of the monitor where it does not interfere with visitors using the website. Companies usually choose to locate a chatbot in the lower right corner of the screen. Location can vary depending on the website design. Chatbot in this paper was created using the VirtualSpirits platform and is integrated in the lower left corner of the website so that it does not interfere with website user experience (Figure 2).

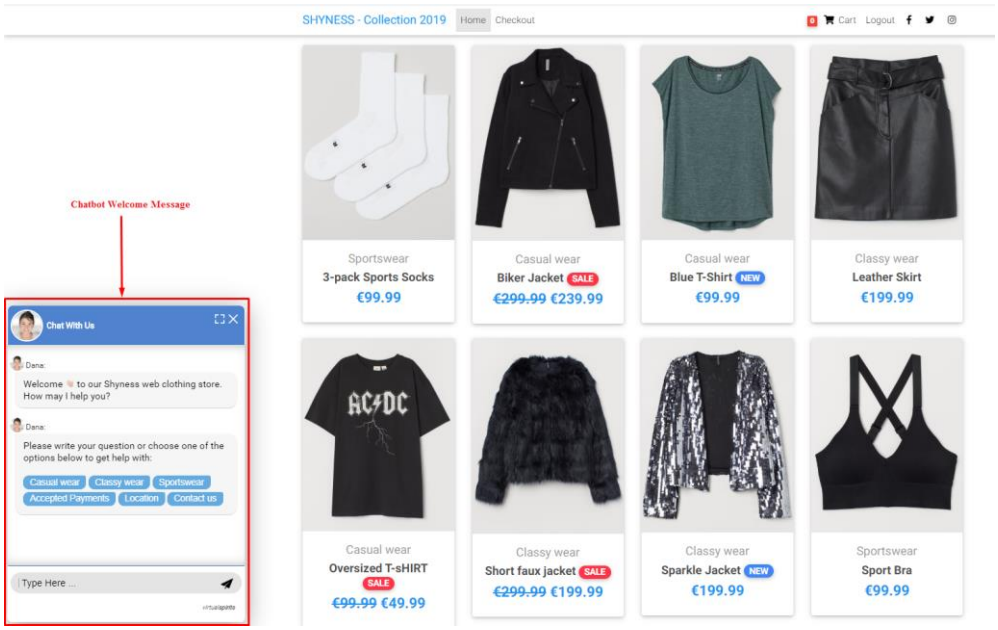

Figure 2: E-commerce chatbot for online shopping website

This chatbot provides answers to the following questions:

- What payment methods do you accept?
- How do you deliver the ordered items?
- Where's your store located?
- How can I contact you?
- Can you recommend a product?
- How can I return a product if it does not suit me?
- How can I get more information about your product categories?

Conversation flow 1 is related to the product category of sportswear and casual wear. When the user clicks on one of the offered categories, chatbot answers with a website link of the selected category. Integrated timer starts counting 3 seconds when the user opens a website link previously sent by chatbot. After this timer, the chatbot prints the message "If you have more questions, contact us by e-mail." If the user suddenly decides to stop communication, this functionality serves to encourage further interaction. The implementation of the chatbot based on the conversations flow 1 is shown in Figure 3.

Conversation flow 2 is related to the product category of classy wear. The most popular products belonging to the classy wear category are integrated in chatbot. When the user clicks on the button related to one of the offered items, the details of the selected product open. After detailed product description, the user gets the option to buy the product or ask additional questions. In this course of conversation, the online shopping company expects an increase in sales. When the user opens a link to the shopping website, a 3-second timer is set, which prints the same message as in the conversation flow 1. The implementation of the chatbot based on the conversations flow 2 is shown in Figure 4.

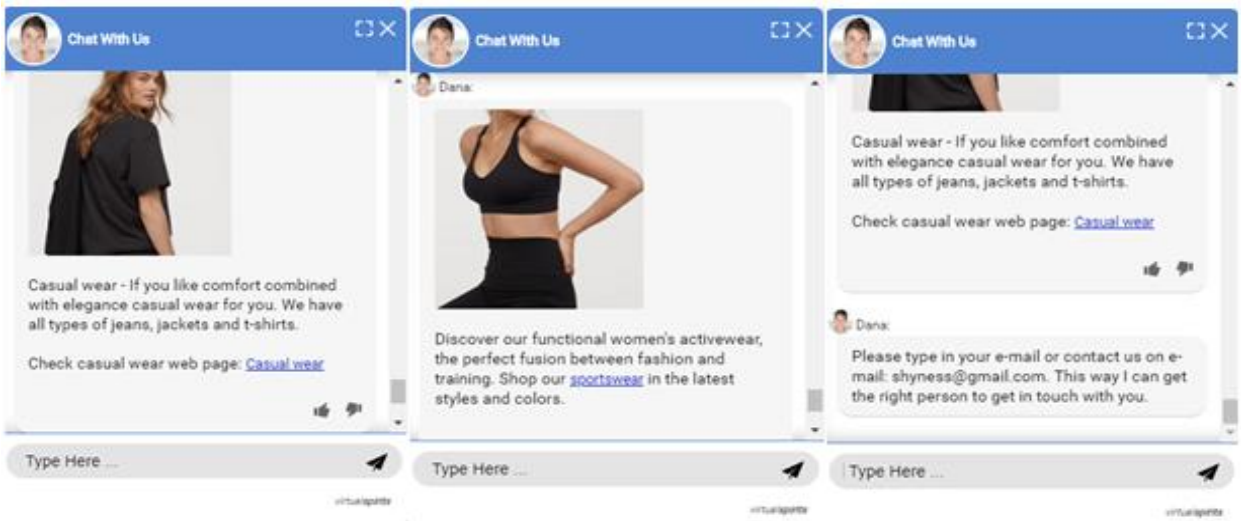

Figure 3: Implementation of conversation flow 1

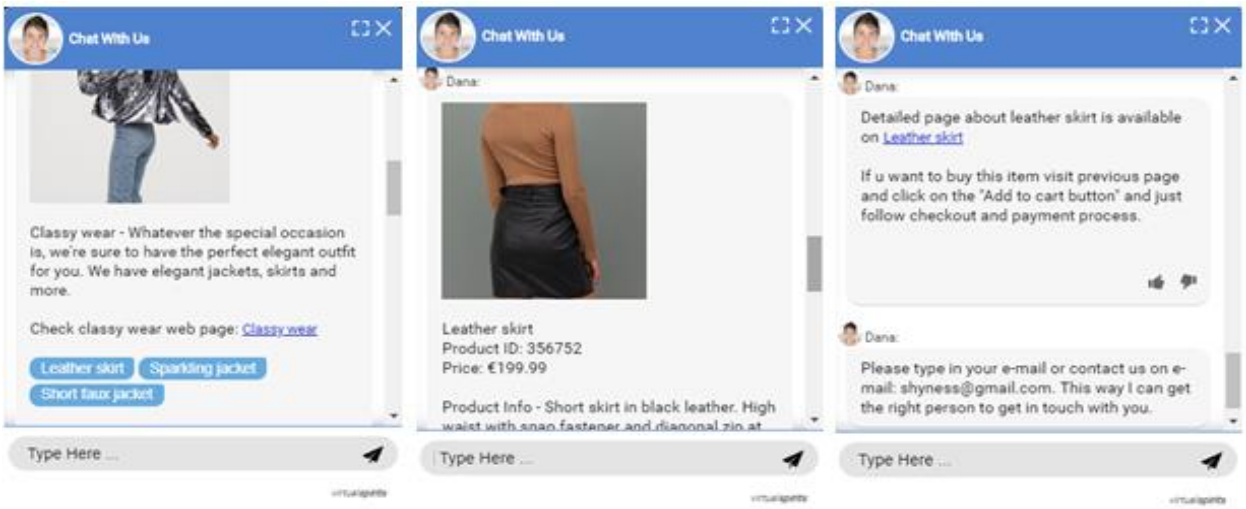

Figure 4: Implementation of conversation flow 2

Technology used in project

VirtualSpirits is a leading platform for creating chatbots founded by Nathan Bajrach. It is used by ten of millions of people worldwide. This platform uses machine learning and artificial intelligence algorithms to scan all conversations with website visitors, while learning new questions and optimizing their answers. Building on unique patented technology, Virtual Spirits chats automatically with website visitors 24/7, answering their questions, helping them purchase online and generating leads for human sales. (VirtualSpirits, virtualspirits.com, 2020.).

5. CONCLUSION

Messaging and chatbot applications have transformed the way companies communicate with customers. The largest social networks are investing large amounts of money in virtual assistants in order to automate conversations with people, so companies that use their platforms can have higher sales. The constant improvements envisaged for the future in the fields of artificial intelligence, machine learning and natural language programming will improve chatbots. Certain jobs performed by humans will disappear in addition to automation and the advancement of artificial intelligence. Virtual assistant developers will be needed more in the future. There will be less of a need for traditional manual jobs like telemarketers, cashiers and accountants.

Chatbots are no longer unknown to users and statistics are showing that they will not stop to make progress in the future. The size of the chatbot market is forecast to reach around 1.25 billion U.S. dollars in 2025, a great increase from the market size in 2016, which stood at 190.8 million U.S. dollars (Statista, 2020). According to industry research, it is predicted that chatbots will absolutely replace customer support representatives in companies in the near future. The main advantage of chatbots that users point out is that they are free to use and offer 24/7 support.

This paper has examined the area of AI in digital marketing. Focus was on the chatbot development in e-commerce for online clothing store. A key area was developing conversation flow diagram for product categories of sportwear, casual wear and classy wear which are part of the e-commerce website offer. This paper has also revisited history and usage of chatbots in various industries. In the future work, the idea is developing an AI self-learning chatbot in programming language like Python and training it to learn from past conversations.

Keeping up with digital marketing trends is not really a matter of choice for companies that want to stay competitive. As technology advances, customers' expectations for service continue to rise. Companies need to try and meet those expectations following the latest trends in AI in machine learning.

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AN APPLICATION OF INSTAGRAM IN HIGHER EDUCATION

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Abstract: *This paper discusses the possibilities of implementing social media in e-education. The focus of the analysis is on the Instagram social network. The main goal of the research is to analyze the possibility of applying the social network Instagram in higher education as a support method to formal e-learning activities. The paper presents the realization of a series of Instagram challenges within the course of Internet Marketing at the Faculty of Organizational Sciences, University of Belgrade. It involved students participating in a campaign on Instagram and then completing a survey related to the campaign. The campaign covered three challenges (Elab represents an abbreviation for the department conducting the campaign): Elab trends, learning with Elab, Elab quiz. The results show that using Instagram campaigns as an addition to the formal educational process contributes to students' satisfaction with the teaching process, encourages students' interaction and interest in learning.*

Keywords*: E-learning, Social media, Social networks, Instagram, Collaborative learning*

1. INTRODUCTION

The use of social media as a support to e-learning activities is generally accepted in higher education (Labus et al., 2015). Higher education institutions use social media platforms to promote study programs, enhance the distance learning process, communicate in real-time, and manage relationships with students (Labus et al., 2015). The most common social media user channels in higher education are social networks. Social networks are online environments that can be used as a comfortable place for e-learning (Labus et al., 2015). Many research showed that social networks can be used in higher education contexts as a personal learning environment (Dabbagh & Kitsantas, 2012; Ebner et al., 2011) that integrates formal and informal learning (Dabbagh & Kitsantas, 2012; Labus et al., 2015).

Social networks Facebook and Instagram have been used the most as support in the e-learning process in the last few years (Shane-Simpson et al., 2018; Ting et al., 2015). In the context of higher education, these social networks can be used to search and share materials for learning, but also to test students' knowledge. This way of communicating with students increases students' motivation to learn and encourages collaboration between participants in the educational process. The actual approach to using social networks in education depends on the teachers' creativity, who design educational activities.

Using Facebook and Instagram has a significant impact on the promotion of higher education institutions. Through these social networks, higher education institutions build their visual identity, provide information about study programs on different levels of study, implement marketing campaigns to promote education and science. Furthermore, social networks represent a communication channel for relationship management with students and other stakeholders.

The goal of this paper is to examine the possibility of using the Instagram social network in higher education as support to formal e-learning activities. The research was conducted at the Faculty of Organizational Sciences, University of Belgrade. It consisted of a series of Instagram challenges in the field of internet marketing. Thought the research, we tried to examine the readiness of students to use Instagram as support in e-learning, to explore good examples from practice, show their creativity, and to collaborate.

2. SOCIAL NETWORKS IN HIGHER EDUCATION

The term social media in a broader sense refers to the application of networking tools and technologies that enable easier communication, collaboration, content sharing, and creative expression (Dabbagh & Kitsantas, 2012). Social media can be used to develop informal learning and to support the formal education process (Dabbagh & Kitsantas, 2012). Higher education institutions have recognized the potential of social media for

the encouragement of collaborative learning, social interaction, and knowledge transfer within communities to which participants belong (Al-Rahmi & Zeki, 2017). The most commonly used social media channels are social networks. Social networks connect people based on their interests, provide the opportunity to view and share large amounts of multimedia content, knowledge, and experiences (Labus et al., 2015; Mayer, 2009). Further, social networks have been used as the main marketing tool for building a brand on the Internet, attracting new users to websites and interacting with existing customers (Thomas et al., 2018).

There is a rising trend in using social media as part of a formal education environment, although it was not created to be used specifically for education (Manca, 2020). The inclusion of social networks in the learning process enables the creation of the content that will encourage students to engage and creates an opportunity for learning in a way that is close to students (Blair & Serafini, 2014). In the educational domain, students often use social networks as a support in the realization of the education process, by exchanging multimedia content, opinions, and participating in knowledge testing. On the other hand, teachers have direct a direct channel of communication with students, which helps them provide relevant information related to individual subjects, exams, implementation of learning activities interesting and motivating for students (Labus et al., 2012). Also, research has shown that the inclusion of social networks in education encourages collective creation and knowledge transfer among students. Social networking applications are believed to promote active learning, better student organization, and building greater self-confidence in learning and project design (Tess, 2013). The use of social networks to support e-learning in higher education institutions is an excellent tool for improving the application of knowledge in practice. A sense of belonging to the community is an important element for successful e-learning (Akhiar et al., 2017; Hung & Yuen, 2010; Tess, 2013).

An analysis of the literature concludes that social media such as Instagram, Facebook, Twitter, LinkedIn, YouTube, represent a significant segment of students' daily lives (Al-Bahrani et al., 2015; Junco et al., 2010; Khalitova & Gimaletdinova, 2016). The research has shown that students rather use social media for communication than e-mail or other systems for e-learning support (Al-Bahrani et al., 2015). The idea behind the use of social media as a tool in the education process is based on the research that showed that teenagers and young adults (people in the early twenties) use social media more than any other demographic group (Arceneaux & Dinu, 2018). The Instagram platform, which represents the core of this research, is one of the most popular services for sharing photographic and video graphic content, allowing its users to publish and share content, modifying it with different filters and options provided by the platform (Manca, 2020). Besides the basic function of sharing content through a post, Instagram provides the ability to share content through stories, a functionality that allows time-limited content. The duration of the single story can be up to 15 seconds and it can be seen up to 24 hours (Al-Ali, 2014). Results of conducted studies showed that sharing content with given subject to the Instagram platform has a positive outcome related to visual learning through social media, approved by the students' creators and their peers and followers (Courneya & Cox, 2020). Social networks create an opportunity for the creation of the community that shares common interests by sharing common content (Purnama, 2017; Yen et al., 2019).

The potential of the use of the Instagram platform as support in informal education has been detected in the last few years (Addyson-Zhang, 2018; Al-Bahrani et al., 2015; Manca, 2020; Shafer et al., 2018; Shane-Simpson et al., 2018; Stojanović et al., 2019). The research aim is to examine the possibilities of using Instagram in higher education and students' the attitude towards this type of learning, as there is little research that explores the possibilities of the integration of Instagram as support in e-learning.

3. AN APPLICATION OF INSTAGRAM IN HIGHER EDUCATION

The research was conducted during the summer semester of the 2018/19 school year within the course Internet Marketing of the undergraduate studies at the Faculty of Organizational Sciences, University of Belgrade. The course aims to introduce students to business models for the presence on the internet, Internet marketing techniques and services, and social media tools in the development and implementation of an Internet marketing plan.

To examine the possibility of using Instagram social network as a support to the e-learning process and the promotion of higher education, an Instagram campaign named "Learning with Elab" was realized. The campaign with the mentioned slogan is used for promotional activities of the Department of Electronic Business (hereinafter: Elab). The campaign was divided into three parts: interactive challenges, knowledge testing, and testing the students' readiness to use Instagram as support in e-learning.

The right to participate in the Elab challenges had students active in the Internet marketing course, younger students who plan to take the course in the future, as well as all those who wanted to have fun, learn something new, and test their knowledge. Each of the challenges was announced through a post and a story

on Elab's official Instagram profile. The first two challenges were announced via an Instagram story and with a post that illustrated an example of a completed challenge.

The first challenge was "Elab Trends". The idea of this challenge was to show good examples of Internet marketing in practice through a picture or video (Figure 1). "Learning with Elab" was the second in a series of challenges covered by the Instagram marketing campaign. The idea of this challenge was to show which technologies, applications or platforms students use in the learning process, also via picture or video (Figure 2). The students had the task to present the solution of the given challenge within the stories on their profile by posting the hashtag #elabtrendovi and #ucimouzelab and by tagging the Elab page @elab_office. If the content adequately corresponded to the topic of the challenge, it was reshared by the Elab page and saved in the dedicated highlights section.

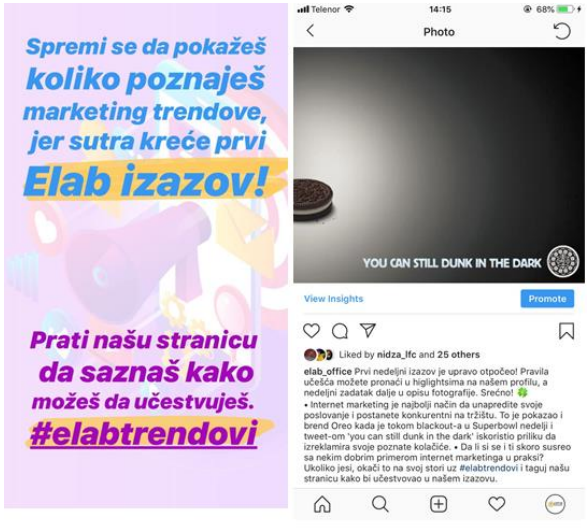

Figure 1: Announcement of the 1st challenge

Figure 2: Announcement of the 2nd challenge

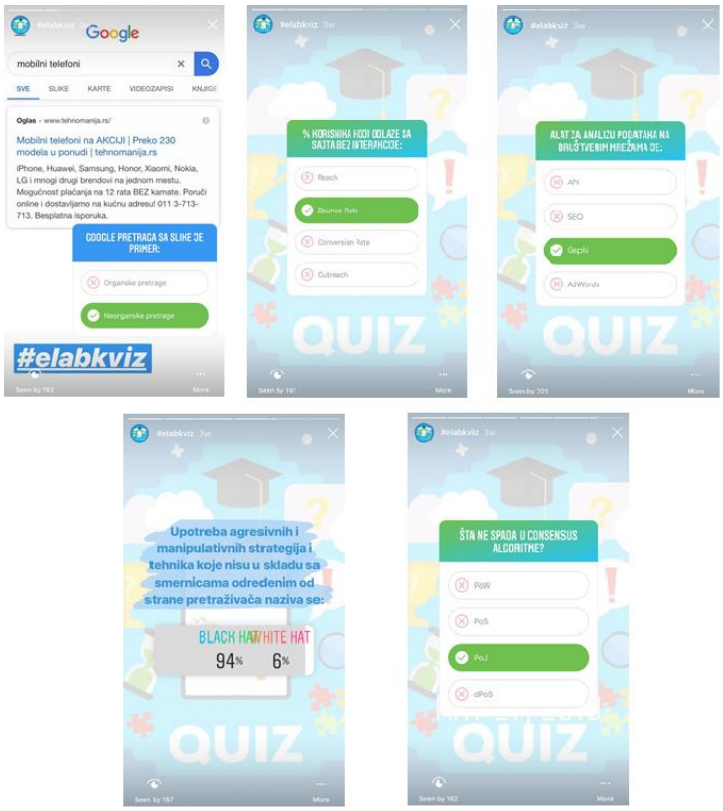

Figure 3: 3rd challenge - Elab quiz

The third challenge was the "Elab Quiz". It was announced earlier via an Instagram story, and questions that needed to be answered were posted for the next five days. The idea of Elab Quiz was to test students' knowledge in the field of Internet marketing in a creative way. For students to complete the challenge, it was necessary to answer all the questions correctly during the duration of the challenge. The questions took two forms: survey and multiple-choice questions (Figure 3).

After the end of the campaign, a survey was conducted in aim to examine the students' attitude towards this way of using the Instagram social network in education.

4. RESEARCH RESULT ANALYSIS

The research involved 144 participants who were students of the Faculty of Organizational who attended the course of Internet Marketing.

The survey was divided into several sections: demographics of participants (Table 1), use of Instagram by participants (Table 2), respondents' attitude towards the use of Instagram as support to e-learning (Table 3), analysis of the "Elab-Quiz" challenge (Table 4) and participants' collaboration (Table 5).

Table 1: Participants' demographic

Question	Total	%
Gender		
Female	67	58.8
Male	47	41.2
Age		
18 – 22	31	27.2
> 22	83	72.8
Instagram users		
Yes	95	83.3
No	19	16.7

The survey showed that only 4 people, out of the total number of females, do not have Instagram, while the number of males is 15 out of a total of 32 respondents, which is almost 50%.

During the implementation of the research, there was a problem related to the privacy of the participants' profiles. The results show that students care about privacy, but are willing to connect with the faculty and participate if using social media in educational activities is a voluntary (Al-Bahrani et al., 2015).

Table 2: The use of Instagram

Question	Total	%
Do you have a private Instagram profile?		
Yes	62	54.4
No	33	28.9
How often do you use Instagram?		
1+ times a day	85	74.6
1+ times a week	2	1.7
How much time do you spend on Instagram?		
Up to half-hour	52	45.6
Up to one hour	24	21.1
Up to two hours	8	7
More than two hours	10	8.8
How often do you post on your Instagram profile?		
Everyday	4	3.5
1+ times a week	34	29.8
1+ times a month	41	36
1+ times a year	18	15.8

In this research, we concluded that 62 respondents from those who use Instagram have a private profile, while 33 respondents have a public profile. Based on this result, it is concluded that a higher education institution that seeks to integrate social networks in support of the education system, should achieve two-way communication on its social media profiles with students attending their courses so that everyone has the opportunity to participate in learning without changing their privacy preferences.

During the research, we examined the extent to which participants use Instagram functions (posts/stories). Of the total number of respondents who use Instagram, 86 of them use Instagram story, while only 6 people do not use the mentioned function.

During the research, we concluded that respondents who use Instagram, mostly access the application several times a day. One of the important factors is also the time that the respondents spend on the Instagram social network. According to the survey results, when accessing Instagram, 52 respondents spend up to half an hour, 24 respondents spend up to an hour, and others spend up to two or more hours. According to the survey results, respondents usually post content several times a month (36%) several times a week (29.8%).

Table 3: Using Instagram as support to e-learning

Question	Mean	Std Dev
Using Instagram for educational purposes makes no sense at all.	2.42	1.23
Using Instagram for educational purposes is useful.	3.55	1.13
Using Instagram for educational purposes is interesting.	3.84	1.16
Using Instagram for these or similar purposes is not consistent with the content I post on my profile.	2.94	1.27
Using Instagram for these or similar purposes can positively affect the image I have among my peers.	2.97	1.07

According to the results of the survey, where we included the answers of both people who use and people who do not use the social network Instagram, 62.3% of respondents believe that using Instagram for educational purposes makes sense, 64% of respondents find the use of Instagram for educational purposes useful. Including respondents who do not use the social network Instagram, 68.4% of respondents find the use of Instagram for educational purposes interesting.

Within the first-week challenge #elabtrendovi, 54 students participated in the challenge. When asked about the topic of the challenge, 60.53% of respondents said they liked the topic. Within the second # ucimouzelab challenge, 50 students participated. When asked about the topic of the second challenge, 54.39% of respondents said that they liked the topic.

Table 4: Analysis of the “Elab-Quiz” challenge

	No. of participants	No. of participants who answered correctly (%)
First question	77	62 (80.5%)
Second question	84	62 (73.8%)
Third question	80	63 (78.7%)
Fourth question	71	67 (94.4%)
Fifth question	97	54 (55.7%)

An average of 80 students participated in the last #elabquiz challenge. The last challenge consisted of five questions. A total of 77 people answered the first question, while 62 people answered correctly. A total of 84 people answered the second question, while 62 answered correctly. A total of 80 people answered the third question, while 63 people answered correctly. The fourth question was in the form of a survey, the question had 71 answers, while 67 people answered correctly. A total of 97 people answered the fifth question, while 54 people answered correctly.

Of the total number of participants in the challenge, 83.33% answered 4 or 5 questions during the challenge. Which means that the participants followed the challenge to the end. When asked about the topic of the third challenge, 51.75% of respondents said they liked the topic.

Respondents were asked a question related to the difficulty of the question within the quiz. A score of 1 means that the questions were very difficult, while a score of 5 indicates that the questions were very easy. From the following table, we can conclude that most participants gave a grade of 4 or 5, indicating that questions were easy. While 25% of the total number of participants stated that the quiz was neither too difficult nor too easy.

Out of the total number of respondents, 52.63% followed the answers of other participants during the first challenge, while 33.33% of those who followed the answers did not participate in the challenge. Out of the total number of respondents, 50.88% followed the answers of other participants during the second challenge while 25.86% of those who followed did not participate in the challenge.

Table 5: Participants' collaboration

Question	Total	%
Did you follow the answers of other participants during the first challenge?		
Yes	60	52.63
No	48	42.11
Did you follow the answers of other participants during the second challenge?		
Yes	58	50.88
No	48	42.11
Would you participate in similar activities again?		
Score 1 and 2	16	14.03
Score 3	22	19.3
Score 4 and 5	58	50.88

In Table 5 we can see that 50.88% of students, when asked: "Would they participate in similar activities again?", gave scores 4 (Yes) and 5 (Yes, of course). Therefore, we can see that the reactions and students' attitude towards the integration of Instagram social network into higher education, were positive.

Table 6: Instagram Challenges - the number of survey respondents who participated in the challenge

Challenge	No. of participants	%
#elabtrendovi	46	40.35
#ucimouzelab	47	41.23
#elabkviz	49	42.98

Table 6 shows the number of survey respondents who participated in each of the challenges during the research. In the first challenge (#elabtrends) 40.35% of the total number of respondents participated, while in the second (#ucimouzelab) 41.23% participated, and in the third (#elabquiz) 42.98%.

5. CONCLUSION

After conducting research and analyzing the results, we concluded that the campaign, as the first step in integrating the Instagram social network into the e-learning process, was successful. Several parameters can be taken into consideration to prove this claim. The first is the number of students who actively participated in the challenges, which is an average of 60 students who participated in all three challenges. The second parameter is the result of the survey. When asked whether they would participate in similar activities again, as many as 51% of students answered positively, while only 14% answered negatively.

In addition to this question, students had the opportunity to answer questions related to the general impression of the campaign as well as to give suggestions for future improvement, which were answered by 55.3% of the total number of respondents, and comments expressed satisfaction related to the campaign and the introduction of Instagram in support to formal e-learning.

Previous studies on this topic used Instagram platform mostly for communication, promotion and sharing information (Purnama, 2017; Shafer et al., 2018; Shane-Simpson et al., 2018). Our paper includes this social media platform in the education process itself, with the specific goal of encouraging students' creation, research and mutual collaboration. As we could see from the statistics of the use of Instagram and the results of surveys, a large number of students spend a lot of time on social networks and this type of knowledge acquirement has proven to be positive. The research and evaluation confirmed our main hypothesis that students will embrace this method of learning and find it interesting. Even students who do not have a profile on the Instagram social network had a positive opinion about the project. Further research would relate to expanding the project to other social media as well as encouraging levels of collaboration among students.

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INTRODUCING SMART HEALTHCARE CONCEPTS INTO HEALTH INFORMATICS CURRICULUM AT VOCATIONAL MEDICAL STUDIES

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Abstract: *Analysis of the state of the IT market reveals the need for health professionals who have the knowledge and skills in application of innovative information technologies in healthcare. This paper proposes an improvement of healthcare informatics curriculum at vocational medical studies according to IT trends. A methodological approach of improving healthcare informatics curse is shown. The course was implemented at the College of Health Sciences in Belgrade, Serbia. Students from different study programmes who attended healthcare informatics course were learning about innovative smart healthcare technologies such as: smart mHealth services and applications, Internet of Things, wearable computing, artificial intelligence. In order to analyse the learning outcomes, we applied pre-test at the beginning of the course, and post-testing at the end of the course. The results of the research show that future healthcare professionals are easily acquiring smart healthcare knowledge and showing increasing interest in health informatics.*

Keywords*: health informatics, health professionals, smart healthcare, curriculum, vocational studies*

1. INTRODUCTION

Emerging technology trends, such as electronic health (e-health), mobile health, Internet of Things (hereinafter: IoT), artificial intelligence, 3D printing, wearable computing, and big data, in healthcare system can help health professionals to improve care delivery (Banova, 2019; Sadiku, Akhare, & Musa, 2019; Zeadally & Bello, 2019; Kuek & Hakkennes, 2019). E-health components, like Health information system (HIS) and electronic health record (eHR) became a dominant technology in healthcare business (Borycki et al., 2011). HIS is implemented in the most of developed countries (Jha, Doolan, Grandt, Scott, & Bates, 2008). Implementation of the HIS and eHR in a healthcare institution requires the permanent education of health professionals about the importance and use of these technologies before they are asked to really use it.

Depending on healthcare institutions' needs and the software manufacturer, eHR interface can be different. A lack of knowledge and inexperience in eHR by health professionals, can lead to its improper use, long queues of patients for examination, misunderstanding between colleagues or patients, etc. For health professionals it is important to gain experience in different software solutions for eHR. That enables health professionals to gain insight into the weaknesses of certain parts of the system and work on the improvement of the system, together with support of IT management of healthcare institution (Borycki et al., 2011).

Health professionals usually learn about health information systems in a couple of ways: a) through theory lectures or laboratory practice in a college, b) online, through examples on open-source solutions, c) on real-world setting when is organized training by health information systems' vendor. For the successful implementation of the health information system, certain prerequisites are necessary, such as: people with knowledge, supportive institutions, quality of data, and deploying related information and communication technologies. These prerequisites are often absent in low-income countries (Achieng & Tambovceva, 2017; Walsham, 2020).

In recent years, modern IoT technologies were widely applied through many projects in various health areas (Sinclair, 2017; Dhanvijay & Patil, 2019). Technologies based on IoT, like mobile technologies and wearable computing, are frequently used in the area of self-measuring of health metrics. Smart devices equipped with sensors and wearables are usually used to measure vital or environment parameters. Those measurements can be used for health promotion, well-being, home monitoring, remote diagnostics and better care delivery. For health professionals, IoT will provide new possibilities in home monitoring and remote diagnostics through reading vital signs with sensors and thus increase patient and health worker information exchange (Sinclair, 2017). There are a lot of examples of successful implementation of mobile health based on wearable computing in different healthcare areas. One of them is Monica Healthcare's AN24 is an electrophysiological monitor that allows pregnant women and doctors to monitor the well-being of an unborn child (Monica Healthcare, 2016). Similar is Owlet that tracks heart rate and oxygen levels in babies (Owlet Baby Care, 2018). Examples of implementation in rehabilitation are Rehabatic (Healthcare Global, 2012), Burnout (Mokaya, Lucas, Noh, & Zhang, 2016) and wearable system for prediction and muscle fatigue detection in real time (Al-Mulla, Sepulveda, & Colley, 2011; Dong, Ugalde, Figueroa, & El Saddik, 2014). For people, with associated chronic diseases, who need to be monitored, mobile platform eCAALYX can be helpful (European Commission, 2013). Occurrence and application of these modern achievements will assist different kind of health professionals in the delivery of safer and more efficient healthcare in the community (Australian Nursing and Midwifery Federation, 2015).

The main goal of this research is introducing smart healthcare concepts into health informatics curriculum at vocational medical studies. A methodological approach of improving health informatics course with learning how to use innovative information technologies in healthcare is shown. This is related to digital literacy of future health professionals how to use mobile, Internet of Things, wearable computing technologies and artificial intelligence in healthcare area. Furthermore, integration of digital literacy in health informatics courses would change the way of thinking, realizing and improving care of patients and the value of provided services from future health professionals (National Information Board, 2014; Kennedy & Yaldren, 2017).

2. HEALTH INFORMATICS IN EDUCATION OF HEALTH PROFESSIONALS

Competencies in health informatics are important in health professionals' work in numerous fields, including midwifery, nursing, radiology, dental prosthetics, etc. Further, acquired knowledge are fundamental in different health practice such as patient care, management, administration and continuing education (Kokol, Saranto, & Vošner, 2018). Low computer literacy may have an impact on the insufficient use of available scientific resources, the use of modern health care services, and implicitly affect the quality of the services provided (Kim & Xie, 2017).

Successful education of health professionals should be supported by faculties and colleges (Kinnunen, Rajalahti, Cummings, & Borycki, 2017). In many educational institutions for health professionals in Serbia, health informatics is offered as an elective subject on undergraduate or graduate level (VZSSS u Beogradu, 2020; Visan, 2020; VMSSS Milutin Milanković, 2020). Thus, many students, future healthcare workers, remain without a computer and information technology literacy.

Computer literacy was a sufficient education level for health professionals so far. However, as technologies become more pervasive and ubiquitous, transfer of information and healthcare delivery across healthcare settings has been changed (Kim & Xie, 2017). Accordingly, except computer literacy, healthcare professionals must be proficient in information literacy and information and data management (Australian Nursing and Midwifery Federation, 2015), as well as digital literacy (Skiba, 2016). The growing expansion of information technology provides new opportunities to teaching methods also. Teachers are able to prepare online material for health professionals as well as online practice and tests through different media. In recent years, mobile technologies (DeLeo & Geraghty, 2017) and social media (O'Connor, et al.) have been recognized as important educational tools for health professionals and has been transform way the knowledge is shared and created (Curran, et al., 2017).

Integration of modern technologies into health professionals' curricula is identified. Educational institutions for health professionals must adapt curricula to emerging technologies. Because of complex and long-lasting administrative procedures, it is often difficult for faculties and colleges to introduce a new study program, although there is an evident need for education of professionals in a specific field (Deltsidou, Gesouli-Voltyraki, Mastrogiannis, & Noula, 2010; Shaanika & Iyamu, 2019). Therefore, many faculties are opting for improvements in existing study programmes through introducing new subjects or innovating the contents of existing ones (Radenković et al., 2014; Rodic-Trmcic et al., 2017). Although, making improvements in curricula presents a challenge when it comes to matching the pace of technology trends (Risling, 2017). Besides that, adapting curricula could be complex process and deal with many other challenges:

- Innovative technologies are often trail in developing countries so it is difficult or impossible to organize appropriate practices for students in real-world setting.
- Funding institutions have not allocated sufficient funds for needed technology resources.
- Education of health informatics professionals is time-consuming process and there is significant shortage of qualified educators with sufficient knowledge in emerging technologies area (Rodic-Trmcic et al., 2017).

It is much easier for universities to innovate existing curricula and courses than higher schools or academies. Faculties have a large number of educated experts that are engaged in scientific research work and in funded ministry projects. Higher schools or academies do not have an opportunity to engage in scientific research work. Their professors are often left without valuable real-setting experience and insight into a possible advancement of technological solutions in healthcare. It is reflected in the slow changes of the health informatics course.

Healthcare informatics course for health professionals on Academy for applied studies in Belgrade, The College of Health Sciences, represents integration of computer and information literacy, and health information management (Faculty of health sciences, 2019). Such curricula, applied in formal education for health professionals, should provide basic knowledge in ICT in everyday work within the healthcare system. Also, it should provide capability of creating and collecting medical data, analysing it and making conclusions, generating, transmitting, storing and using the information to address health problems. Future health professionals would gain knowledge in application of ICT in research work and ability to evaluate information and knowledge in medical practice. Students would be trained to actively participate in the computerization of the health system and also, they would effectively use modern ICTs in the learning process, and afterwards in continuous medical education.

3. HEALTH INFORMATICS COURSE STRUCTURE

The course Healthcare informatics is an official part of the curriculum at the College of Health Sciences. It is elective course in the most of a study programs at the College. The course consists out of four units:

- Computer literacy,
- Information and communication literacy,
- Information and data management, and
- Digital literacy.

Computer literacy provides knowledge of the basis of computing and enables future healthcare professionals to use generic software applications as well as electronic communications such as email (American Nurses Association, 2001). This unit is important because students come with different knowledge levels in basic of computer literacy. This should equate basic computer knowledge so that everyone can follow the next units without difficulty.

Information and communication literacy unit consist of oral presentations and practical work where students practice with word processing, presentations, internet search tools and communication tools. On of the practical exercise is researching a bibliographic database of life sciences and biomedical information, such as Medline (National Library of Medicine, 2020). Besides, students through practice work, learn to recognize key social media channels and their presence and opportunities in healthcare system.

Since the data in healthcare organization is constantly being generated throughout the whole system, through the normal activities and providing services it is of the notable importance to critically evaluate data and information obtained from practice. Information and data management unit is being realised through oral presentation and practical work where students practice to explore the research data, work with databases, and create reports and presentations.

Digital Literacy includes getting introduction to trends in healthcare such as: Internet of Things, wearable computing, e-health and mobile health, telemedicine, and artificial intelligence. Through this chapter, students are introduced to technologies that may not yet be present in the market, but their introduction to the health care system is planned or envisaged. This unit consists of oral lectures and practical work through which students are introduced to existing solutions and propose solutions that would be useful in their work or life environment.

The curricula goals and outcomes are shown in Table 1.

Table 1. Description of the Informatics in healthcare course goals and outcomes

Domain	Goals/outcomes
Computer literacy	• Acquired knowledge in basic concepts of computers, electronic devices, operating systems, hardware, software and peripheral devices (Australian Nursing and Midwifery Federation, 2015). • Acquisition of specific aspects of computer literacy necessary for working in the healthcare.
Information and communication literacy	• Understanding concepts of Information and Communication Technologies (ICT). • Environment and legal framework for the introduction of e-business in health care. • Introduction to Internet terminology, online medical knowledge in specialized medical databases, library resources, and professional associations. • Practical implementation of state-of-the-arts information-communication technologies (ICT), necessary for the learning process and their appropriate, responsible, and critical application during the course of studies and for expert work. • Familiarization with the integrated healthcare information system functioning, supported by computer technologies and e-health components. • E-communication and e-learning platforms as a key requirement in contemporary health care and health education. • Introduction to ICT use in research in healthcare.
Information and data management	• Recognises the difference between data and information (Australian Nursing and Midwifery Federation, 2015). • Data collecting, classifying, and processing. • Students are trained to critically evaluate data and information obtained from practice. • Use data and information to support and advance professional health practice. • Understand the possibilities and limitations of data, information, and knowledge and their influence on the quality of decision making in everyday work. • Ability to create reports and presentation of data and information for the provision of education and health information.
Digital literacy	• Familiarization with the concept and technologies of e-health and its components, application of mobile technologies in healthcare (m-health applications). Ability to recognize the need for mobile application for healthcare. • Understanding of telemedicine systems and technologies necessary for their implementation. • Introduction to smart healthcare. • Introduction to wearable computing in healthcare. • Introduction to artificial intelligence in health and medical rehabilitation and expert systems.

4. METHODOLOGICAL APPROACH OF COURSE IMPLEMENTATION AND EVALUATION

The course was implemented at the College of Health Sciences in Belgrade in 2018/19 and 2019/20 school year. The aim of the course evaluation was to find out if the students acquired necessary knowledge predicted by the course objectives. The course was conducted using Moodle learning management system (Cole & Foster, 2007; Despotović-Zrakić et al., 2013). Moodle was launched at the beginning of the course and the students were introduced to it. Course, named Healthcare informatics consisted of oral lectures in classroom, presentations available to students, colloquiums, practical work and tests at the beginning and at the end of the course. It lasted for 15 weeks. Evaluation of the implemented course referred to students' performances and areas of knowledge and practice improvement.

The students who attended the courses were from the different study programs. The number of participants per study group and total number are shown in Table 2. All students were between 21 and 24 years old.

Table 2. Distribution of participants per study program

Study program	Number of participants
Professional nutritionist-dietitian (ND)	33
Professional nurse-midwife (NM)	59
Professional occupational therapist (OT)	30
Professional physiotherapist (PT)	22
Professional medical radiologist (MR)	76
Total	220

In order to analyse the learning outcomes, we applied pre-test and post-test design. Pre-testing was performed at the beginning of the course, and post-testing at the end of the course. Tests consisted of 20 multiple choice questions and questions were weighted equally. Learning experiences and students' satisfaction were examined verbally at the end of course.

Data were processed with the statistical package SPSS 20. To compare the results of the pre-test and the post-test, we have used a Wilcox sign test. The average score on pre-test was 12.73, and on post-test was 18.77, as shown on Table 3.

Table 3. Descriptive statistics

	N	Minimum	Maximum	Mean	SD
Pretest	220	6	19	12.73	2.415
Posttest	220	7	20	18.77	2.458

Wilcox sign test shows that the difference in the results of the pre-test and post-test for the respondents exists, and is statistically significant ($Z=-12.475$, $p<0.001$). The results seem to indicate that the post-test show an increased knowledge in students in regard to pre-test. Figure 1 shows the frequency of the points achieved at the pre-test and post-test in respondents.

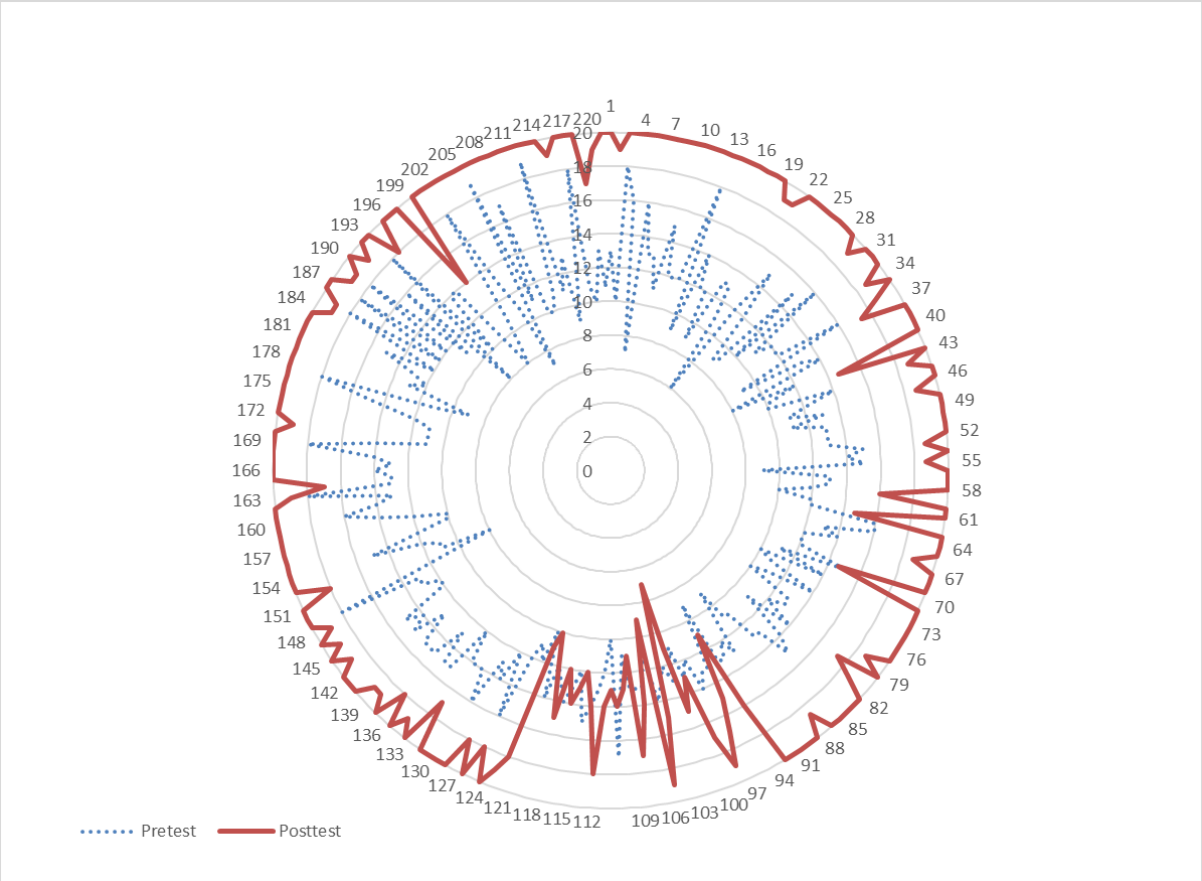

Figure 1: Frequency points achieved by students on pre-test and post-test

Distribution of the mean of pre-test and post-test scores across all study programs is shown on Figure 2. It is noticeable that there is significant discrepancy in post-test score in OT study group. Mean of the pre-test score is almost equalized across all study programs, while the average of the post-test is clearly lower at OT study program.

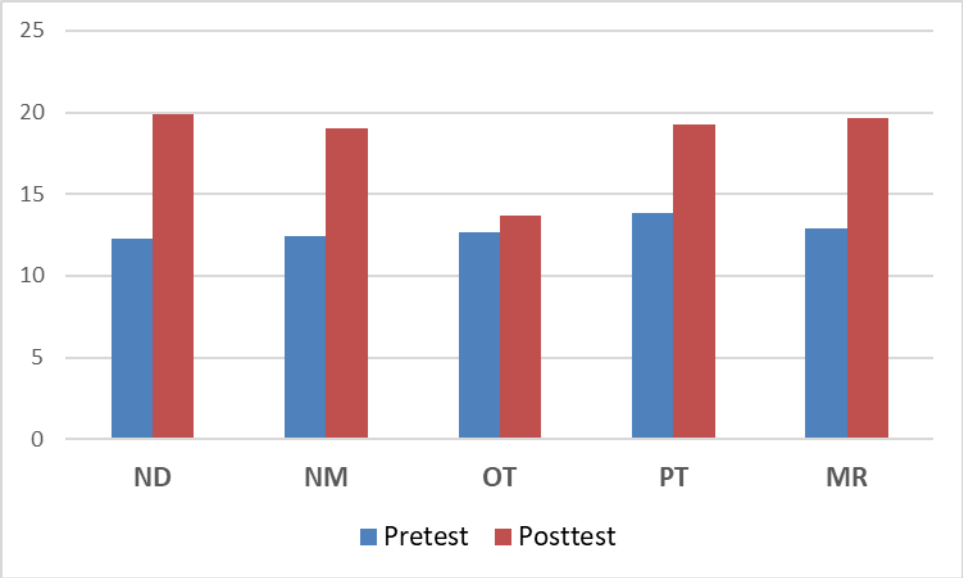

Figure 2. Distribution of mean of pre-test and post-test scores among study programs

4. CONCLUSION

Emerging technology trends such as mHealth, Internet of Things, wearable computing and artificial intelligence will probably become a dominant technology in healthcare. This research shown that inclusion of digital literacy has proven to be a good step forward improving knowledge of students' in health informatics. The results of the research show that future healthcare professionals are easily acquiring smart healthcare knowledge and showing increasing interest in health informatics. Likewise, the level of initial knowledge is fairly uniform across all study programs. Introducing smart healthcare concepts into health informatics curriculum has proven to be a good step forward in educating future health professionals.

Further research will focus on thorough examination of students' initial level of knowledge and comparison with students who do not have opportunity to listen a course Health informatics.

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CROWDSENSING MOBILE HEALTHCARE APPLICATION FOR DETECTION OF AMBROSIA

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Abstract: *The purpose of the paper is development of the crowdsensing mobile healthcare application for detection of ambrosia. The goal of the developed application is to enable patients with chronic allergic rhinitis access to important information about ambrosia. Users are provided with general information about ambrosia, symptoms and treatment suggestions. Furthermore, application furnishes locations where ambrosia is detected, as well as the recommendation of the nearest hospitals where users could seek for help. In addition to that, the application shows locations of the pharmacies nearby, in which users could purchase the appropriate medicine and get advice from the pharmacist. Users can include their locations in the database, if they detect ambrosia at their position. The map is up to date and other users are provided with real-time information. Finally, the application helps people suffering from allergens in avoiding pollen and relieving of symptoms, and makes an impact on the future development of smart healthcare services.*

Keywords*: mHealth, smart healthcare, crowdsensing, ambrosia*

1. INTRODUCTION

Accessibility and the cost of healthcare services are one of the biggest problems with the healthcare system encountered by many countries in the world. Digital transformation in the healthcare sector should enable overcoming these problems and the delivery of healthcare services with respecting privacy and protection of personal health information defined by the law of a specific country. Development of mobile technologies effects changing the way of the delivery of healthcare services. Following this trend, nowadays in the world exist around 5 billion mobile devices, many parts of the healthcare processes are being transferred from healthcare institutions to personal devices (Pew Research Center, 2019; Radenković & al, 2015; Internet 1, 2020).

M-health refers to a term used in the fields of medicine and public health, which refers to the use of personal mobile devices to improve healthcare delivery (Adibi, 2015). Mobile healthcare applications usually include the use of mobile devices for the collection of clinical data, the provision of patients' health information to doctors and specialists, real-time monitoring of patients' conditions, and the direct provision of healthcare services via mobile devices (Germanakos, Mourlas & Samaras, 2005). In this way, doctors, patients and other stakeholders in a healthcare ecosystem have improved communication, real-time monitoring and delivery of useful information, online consultations and other services by using mobile healthcare applications.

Nowadays, some mobile healthcare applications are based on the crowdsensing concept in the aim to collect data from the environment. This is usually enabled by using different sensors within mobile devices. Crowdsensing mobile healthcare applications often monitor (Luis, 2017): 1) environmental variables such as air pollution, pollen levels, temperature or humidity, 2) vital parameters of the user such as heart rate, skin temperature, respiration, stress levels, levels of physical activity and blood pressure.

The main goal of this research is the development of a crowdsensing mobile healthcare application for detection of ambrosia. The application aims to provide information about ambrosia, as one of the leading causes of allergic rhinitis. The main functionalities of this application are collecting information about the nearby locations where ambrosia is detected, providing information about ambrosia, how to recognize this allergen and recommendation of the nearest healthcare hospital and pharmacy.

2. MOBILE SMART HEALTHCARE APPLICATIONS

Mobile healthcare applications usually enable improving healthcare delivery, engaging patients to participate in disease management and to actively engage in their therapy (Wildevuur & Simonse, 2015), and sharing useful information from the doctors or other patients with similar health problems (Steinhubl,. Muse & Topol, 2013; Athilingam & al, 2016; Mora & al, 2017; Omboni, Caserini & Coronetti, 2016). These applications are making easier remotely monitoring of patients' health, respond faster to their needs, securely transfer confidential medical information between different healthcare institutions, and increase the efficiency and effectiveness of medical business processes to improve the general health status of patients (Internet 2, 2020; Qudah & Luetsch, 2019).

Some mobile healthcare applications are connected with external sensors which can help in collecting, analyzing, or predicting important medical information. Devices that have various sensors became ubiquitous. Mobile phones can measure ambient light, noise, location, movement, and other environmental factors. This data can be used in a variety of ways. This development of information technology leads to a new generation of technologies such as the internet of things (hereinafter: IoT), cloud computing, big data and artificial intelligence which aim to transform the traditional process of healthcare delivery. Application of these technologies in healthcare can be defined as the concept of smart healthcare. Smart healthcare is a health service system that uses technology such as wearable devices, IoT, and mobile internet to dynamically access information, connect people, materials and institutions related to healthcare, and then actively effectively responds to medical ecosystem needs (Tian & al, 2019). Users of smart healthcare application are doctors, patients, hospitals, and research institutions.

Smart healthcare applications today have a significant number of applications. Some applications are used in clinical practice to eliminate paperwork. Applications are aiming to patient empowerment, clarifying symptoms, improving self-management. Also, applications are used often to speed up the process of registration and reimbursement of medicines, as well as in research, or studies done by epidemiologists.

As concept, mobile crowdsensing represents the expression for widely collecting and sharing data in different domains via mobile devices, smartphones and tablets, with various sensors. With these sensors, a huge among of data can be collected. Also, not only smartphones can be used for crowdsensing, but many other IoT sharing devices or consumer-centric devices can gather useful information (Giannotta, 2017). For example, some applications monitor information about traffic, other applications monitor environmental variables such as pollution or temperature, while others monitor vital health signs such as heart rate or skin temperature in the context of crowdsensing in healthcare. Many studies presented that usage of different sensors in mobile healthcare application can be of great benefit. Giannota in his paper (Giannotta, 2017) presented a crowdsensing application aiming to help the patients suffering from diabetes to help them in their daily self-care. The application is collecting data about the blood glucose level and weight and notifies patients when is the time to measure blood glucose level. Crowdsensing can be also used in hypertensive patients, for collecting data with external ECG sensor that enable capturing ECG with or without electrodes making device flexible and easy to use. Also, without additional devices, smartphone camera itself enables the heartbeat detection (Jovanovic & al, 2019). On the Faculty of Organizational Sciences, a team of students developed an IoT prototype application with the heart rate sensor, which collects data about heart rate and displays measured data on ThingSpeak IoT platform (Rodic-Trmcic & al, 2017).

Different sensors can also be used to monitor allergens in air. One of the examples for this type of application is application for asthma patients that is connected with sensors for inhalers. Those devices don’t yet exist for Allergic Rhinitis (hereinafter: AR), but there are attempts to connect pollution sensors to m-Health application. Most application for treating AR support patients via self-monitoring through electronic diary, personalized feedback, or patient education. As many smart healthcare applications use external sensors for collecting various type of data, it represents the concept of crowdsensing (Bosquet Jean & al, 2019).

Every individual is exposed to a wide range of potentially allergenic sources, indoor and outdoor, which can enter the body through the respiratory tract, and cause inflammation in the nose, which occurs when the immune system overreacts to allergens in the air. This is known as allergic rhinitis and symptoms can include stuffy nose, red, itchy, sneezing eyes. Developing these symptoms in some patients can be only during specific times of the year, often in the spring, as a result of higher exposure to pollen. Furthermore, a large number of people with AR also have allergic conjunctivitis, atopic dermatitis, or asthma, thus it is of great importance to lower the exposure of these people to environmental allergens, as well as to better forecast pollen concentration in air so that disease control can be improved, and AR symptoms reduced. Monitoring environmental variables, such as pollution, pollen levels, temperature, or humidity, can be significant in reducing the pathogen of allergic rhinitis [18-19] (Bosquet Jean & al, 2019; Skoner, 2001).

3. SYSTEM FOR AMBROSIA DETECTION

Developed system for ambrosia detection is shown in Figure 1.

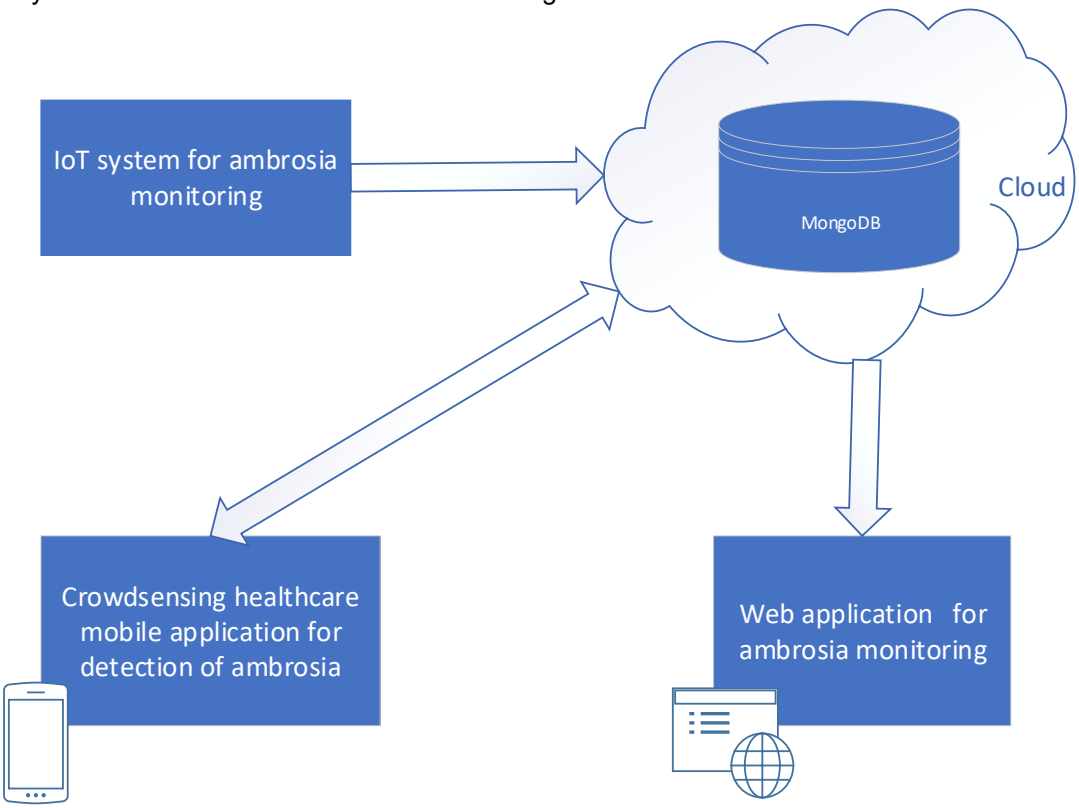

Figure 1: System for ambrosia detection

The Internet of Things system for ambrosia monitoring consists of Raspberry Pi microcomputer and the combination of appropriate pollen sensors. The components used for measuring pollen are Enviro Plus pHAT Board (PIM458) and Pimoroni Particulate Matter Sensor with Cable (PMS5003). Enviro Plus includes several sensors that enable indoor monitoring of air quality, temperature, humidity, pressure, light and level of noise. Combined with PMS5003, it can measure particulate matter (PM) from the outside, such as pollen, dust and smoke particles. This sensor contains a small fan that pulls in the air. The air passes by laser which detects concentration and size of particles. Pairing two specified components are conducted using a cable of PMS5003 sensor. The examination of measured data is provided by the Python library, developed by the manufacturer. The IoT system measures the concentration of allergens in the air and forwards the results to the MongoDB, Cloud-hosted database. Furthermore, measurements are shown in the web application.

When the user of the mobile application for ambrosia detection, who is located near an allergenic plant, selects the appropriate option in the application, the system takes the coordinates of its current location and forwards them to MongoDB. From the database, the mobile application reads the coordinates of the saved locations. Coordinates consist of latitudes and longitudes of locations. Then, it converts coordinates into markers and displays them in a custom Google Map embedded in the app. If a user is located near one of the locations where ambrosia is detected, they will be notified accordingly. Additionally, if the IoT system detects enormous allergens in the air, the user receives an alert with measured values. Using the functionality of the Google Places API, the app shows to the user the hospitals that are near their current location on the map.

The web application contains Google Map. Map shows the locations where the ambrosia was detected. The coordinates of these places the web application retrieves from MongoDB. In addition to that, the web application displays the history of the measurement of the allergen concentration in the air. The allergen intensity is measured by sensors in the IoT system. The history of measurements is displayed graphically, according to the period that the user chooses.

By the time of writing this paper, a crowdsensing healthcare mobile application with most of the previously mentioned functionalities has been implemented. A more detailed description of how the application works is specified in Chapter Four.

4. CROWDSENSING MOBILE HEALTHCARE APPLICATION FOR DETECTION OF AMBROSIA

This paper describes the development of the system for ambrosia detection. The segment that has been developed is a crowdsensing mobile healthcare application for ambrosia detection. The purpose of the application is to provide access to information about the allergenic plant, to provide a visual representation of the locations where ambrosia has been detected, as well as to enable users to be informed about the concentration of allergenic pollen in the air in several cities in Serbia.

The information module of the mobile application contains general information about ambrosia. In addition to that, the user is presented with useful information about the symptoms caused by the pollen of this allergenic plant, as well as suggestions for their treatment. The information module is the main activity in the application. In other words, it represents the home screen. The main activity consists of three types of XML elements: View Pager, Button, Text View. View Pager enables the implementation of the slider with images. The purpose of the buttons is to show and hiding the matching text box. The toggle functionality of buttons is implemented within Java code.

The interactive map module consists of a custom Google Map. The map is embedded in the application. The module is implemented by using the Maps SDK for Android. The API automatically handles access to Google Maps servers, data downloading, map display, and response to map gestures (Internet 3, 2020). While loading a map, latitude and longitude of coordinates of all locations where ambrosia is detected are being retrieved from the database. The application, in the background, receives these coordinates and converts them into markers. Thereafter, it pinpoints markers on the map and shows them to the user. If a user is near one of the marked locations, the app will show them a corresponding notification. Notification is shown in the form of the *Toast*, a small pop-up on the bottom of the screen. Additionally, the user is also shown the position of his current location. If a user has detected ragweed at their current location, by selecting the appropriate option in the application, coordinates of the location will be forwarded to the database. As a result, a marker of detected ambrosia at the aforementioned location will be displayed to all users of the application.

Monitoring of user location's changes is enabled by applying Location Manager. Location Manager is a Java class that can be found in Android Location package that contains the framework API classes that define Android location-based and related services. Location Manager provides access to the system location services. These services allow applications to obtain periodic updates of the device's geographical location, or to be notified when the device enters the proximity of a given geographical location (Internet 4, 2020). For displaying information on the concentration of allergenic pollen in the air, application uses data from the official website of the Environmental Protection Agency of the Ministry of Environmental Protection of the Republic of Serbia. An adapted version of the website is built into the mobile application via Web View.

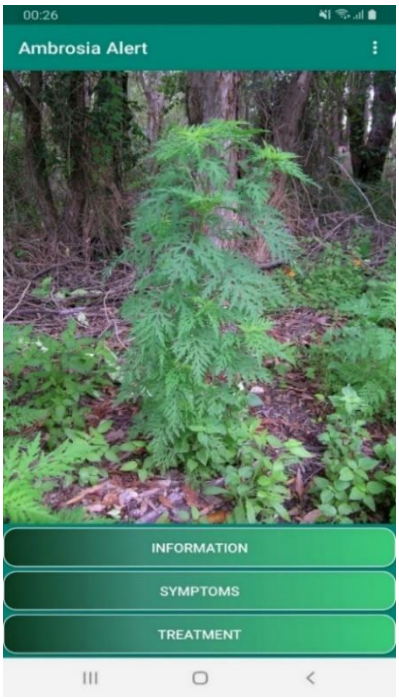

Figure 2: Home screen of the application

Figure 3: Home screen when button "Symptoms" is clicked

Web View Java class reads the content from the specific web page and include it in the application as part of the activity. The crowdsensing mobile healthcare application is developed in Android Studio. The mobile application for the detection of ambrosia has been developed by coding in the object-oriented programming language Java. Furthermore, the data is stored in NoSQL cloud-hosted Firebase Realtime Database.

The home screen of the mobile application represents a realization of a module that contains information about the allergenic plant. The screen consists of a section with photos, which are displayed within the Image Slider, and three buttons (Figure 2). Depending on which button the user clicked on, a text box with the corresponding information is displayed, as in Figure 3.

By selecting the appropriate item in the menu bar of the application, which is located in the upper right corner of the screen, the user is forwarded to the module with a map. The screen displays an adapted Google Map, centered on the current location of the application user. User's current location is indicated by a red marker. The application reads the coordinates of the locations where ambrosia was detected from the database and displays them in the form of green markers (Figure 4). If a user is near one of the marked locations, they will be notified.

The "My location" button centers the map on the user's current location. By clicking on the "Save" button, the application shows an alert to the user that their current location will be forwarded to the database. After confirmation by the user, the location is saved in the database and displayed as a green marker on the map. Furthermore, the menu bar of the application contains an item named "Allergy forecast". By choosing that item, application opens a module for displaying statistics on the concentration of allergenic pollen in the air in several cities in Serbia. The screen, in the form of WebView, displays an adjusted official website of the Environmental Protection Agency, as shown in Figures 5 and in Figure 6. Values are shown for those plants whose pollen has been registered during the on-going period.

Figure 4: Map Activity

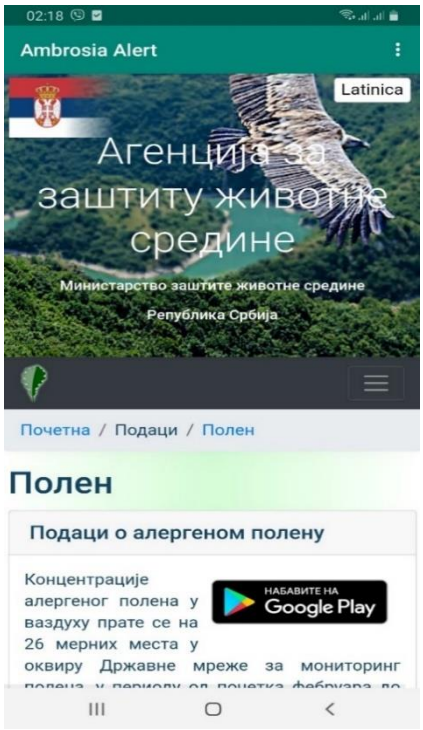

Figure 5: Allergy forecast activity

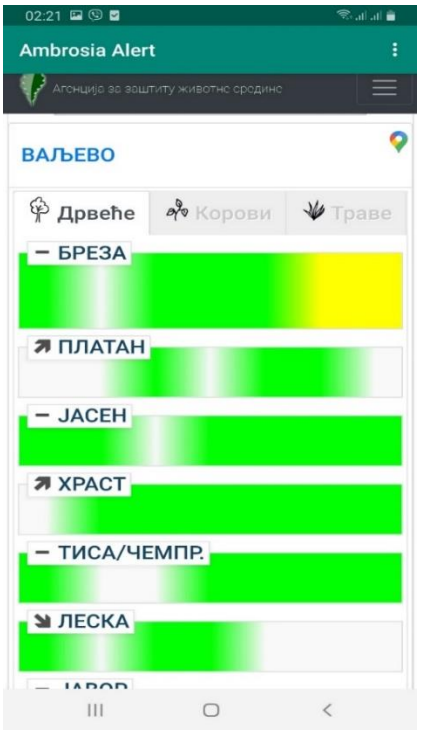

Figure 6: Statistics of the pollen concentration

5. CONCLUSION

This paper presents an application of applying smart healthcare concepts, especially in detecting and avoiding allergens of the ambrosia plant. The comprehensive analysis of the existing smart healthcare applications, in the area of detecting allergens from the environment, is analyzed. The paper analyses possibilities of using the crowdsensing concept in healthcare. The crowdsensing approach is applied for collecting data from the environment, likewise for improved providing information and services to the people suffering from allergies.

Above all, the paper contains a detailed description of development of the crowdsensing mobile application for ambrosia detection. The mobile application provides access to information related to the allergenic plant. Information consists of not only general facts about ambrosia but also symptoms and treatment suggestions. In addition to that, the crowdsensing application furnishes the visual representation of the locations where ambrosia has been detected, implemented via adapted Google Map. The map displays the locations in form of the markers. Users can add their current location to the database, if they find ambrosia near their position. Furthermore, application enables users to be informed about the concentration of allergenic pollen in the air in several cities in Serbia.

Future development of the developed crowdsensing mobile application for ambrosia detection is going to be focused on building up the whole Internet of Things system. The IoT system is going to contain appropriate sensors for pollen detection. Sensors are going to measure the concentration of allergens in the air and forward the results to the database via microcomputers and web services. Users are going to be notified about the allergen intensity in the air. Furthermore, a history of measurements is going to be visible in the web application graphically.

The proposed crowdsensing mobile application for ambrosia detection is not only going to help people suffering from allergens in avoiding pollen and relieving of symptoms, but also to make a step forward in smart healthcare development.

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A WEB APPLICATION FOR MANAGING SMART RESIDENTIAL COMMUNITIES

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Abstract: *The subject of this paper are smart residential communities. The goal is to develop a set of services for managing smart housing and residential communities using the Internet of Things. The paper analyses the concepts and solutions for managing homes, buildings, and other residential buildings. The possibilities and architecture for a smart residential community management are explored, with the focus on middleware platforms and their possibility to overcome interoperability issues. In this paper we present web application for smart residential management which is connected to smart devices within their homes, as well as to the use of smart community services, such as electronic sessions of the house council, participation in investment decisions within the housing community, common lighting management, energy consumption management, common areas management, and other.*

Keywords: *smart residential communities, smart homes, smart buildings, Internet of Things, Mainflux*

1. INTRODUCTION

In the technologically advanced societies, smart environments are becoming omnipresent and their contribution to the quality of life is rising. Internet of Things (IoT) has enabled numerous devices, such as phones, TVs, and home appliances, to be connected to the internet, and to provide their users with new possibilities and scenarios of usage. Smart appliances can interact and have their own intelligence, creating environments adaptable to residents' needs. These systems are usually managed through various interfaces and software solutions (A. Verma, 2019). Besides smart homes, the IoT devices can be embedded into various city infrastructures such as roads, electricity grids, water supply systems, making the development of new services for smart traffic, smart parking, smart electricity management. Research shows that these systems can contribute to the integration of city services, leading to a better resource management, energy efficiency, cleaner environment, and higher quality of life in general (The future of industries: Bringing down the walls, 2016).

The analysis of literature and existing solutions points out several models for smart home management, as well as various services for residents. Infrastructures for smart buildings are also available, mainly related to energy management. However, there are still not many models that focus on integrating home, building and community services of a residential community into a single system available for all the residents. This paper aims to contribute to this research direction, through the development of a web platform for smart residential community management. The goal of the platform is to become a portal that integrates smart home, smart building, and smart community services, where each resident can have a set of personalized services.

2. THEORETICAL BACKGROUND

2.1. Smart cities

A smart city is an urban area that combines technology and devices to provide its citizens, businesses, and government agencies with a variety of services (Radenković, Despotović Zrakić, Bogdanović, Barać, & Labus, 2015). A definition for a smart sustainable city (Shaping smarter and more sustainable cities: Striving for sustainable development goals, 2016) says that "[a] smart sustainable city is an innovative city which uses information and communication technologies (ICTs) and other means to improve the quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects". For modern cities to remain competitive and provide a decent quality of life to their citizens, the following must be ensured: enough fresh water, universal access to cleaner energy, an ability to travel efficiently from one point to another, a sense of security and safety.

According to the UN (2018) by 2050, 68% of the world's population is expected to live in urban areas. The challenge will be to supply the population with base sources such as safe food, clean water, and enough energy, while ensuring overall economic, social, and environmental sustainability.

2.2. Smart buildings

According to International Electrotechnical Commission (Smart Cities - Sustainable, smart buildings, 2020), "Buildings make up 40% of global energy demand. They use electricity and include electronics in nearly everything". Due to inefficient building management systems, 30% of energy spent in buildings is being wasted (Tricoire, 2013). A smart building is an M2M service that uses a collection of sensors, controllers, alarms, the gateways deployed in the right places in the building, combined with applications and a server located on the Internet to enable automatic management of the building with limited human work (ITU-T YSTR-M2M-UCC, 2017, p. 26). Improvements in energy efficiency of smart buildings go from better use of sunlight and natural ventilation to the proper use of heating, ventilation, and air-conditioning system (HGI-GD017-R3, 2011, p. 16).

For smart building systems to work together and be part of a sustainable system, sensors, actuators, and smart devices must be provided: automatic lights, heating, air conditioning, water; automatic escalators and driveways; automatic door opening and closing; fire and movement detection; remote monitoring or social alarm systems. It is assumed that, in the future, commercial and residential buildings will be fully intelligent systems, where systems will be able to adjust on-the-fly. They will integrate available data from weather monitors and financial information – like the price of electricity and other utilities with building systems that include (Smart Buildings and the Internet of Things: Unlocking Value, 2018) (Batalla, 2019):

- Networked lighting,
- Heating, ventilating, and air conditioning (HVAC),
- Fire, security, and access control,
- Electric meters,
- Workplace management,
- Visualizing and reporting on such things as utility bills while offering interactive dashboards,
- Detecting and diagnosing faults through benchmarking and performance analysis,
- Providing predictive maintenance through asset monitoring.

An example of light control in a smart building is reflected in the need to control light in different areas of the building as well as on different floors. Management is done from the control center. Gateways can be located on any floor of a building, and all lights are connected to it through a wireless network. Gateway connects to the M2M platform, which is further connected to the control center software. In order to control the lights and avoid the need for the light bulbs to be switched off and on individually, groups of light bulbs are created on the side of the gateway. Groups can be created differently for different lighting needs. When a new light bulb is installed, the worker adds the installed light to a group located on that floor. Maintenance is done using a smart mobile device and the software of the control center. The initial cost of developing intelligent buildings might appear expensive; however, the total life cycle costs of intelligent buildings are generally lower than the costs of conventional buildings (Reffat, 2010).

2.3. Smart homes

Smart home technologies promise to transform home comfort, convenience, safety, and leisure while reducing energy consumption. Fulfilling these promises depends on how they are adopted and used in homes (Hargreaves & Wilson, 2017). A wide range of IoT devices and applications are emerging for use at home, including connected thermostats, smart appliances, and self-guided vacuum cleaners. As these devices evolve, it is expected that the greatest economic impact from the IoT at home will be in automation. It is estimated that smart home devices and services will cut down the labor per year in the household for 100 hours. The next-largest impact would come from energy management followed by security (Manyika, et al., 2015).

Smart homes are based on the usage of ICT in a residential space. Introducing smart home appliances is called home automation and involves the integration of home electrical control systems such as heating systems, cooling systems, burglar and fire systems, home lighting systems, audio systems, video systems, etc. (Radenković, Despotović-Zrakić, Bogdanović, Labus, & Bojović, 2017) Residents in the households are provided with real-time experiences, and control and monitoring applications. Taking into account the homeowner's long-term goals as well as external services, the future home will actively optimize its activity in real time (Behmann & Kwok, 2015). The technologies behind a connected home can be grouped in the following categories (Connected Home, n.d.):

- Networking
- Media and Entertainment

- Home Security/Monitoring and Home Automation
- Energy Management
- Healthcare, Fitness and Wellness

The literature claims that some resident behaviors significantly affect home energy use. It is also believed that it is critical to understand the different behaviors and comfort needs of people in different climates. For example, there is a close relationship between temperature and humidity, and how they together affect residents' temperature comfort. Due to natural ventilation, opening/closing windows and using a fan will sometimes result in better temperature comfort without the need to activate air conditioners. Literature believes that water heating as well as the frequency of showering, washing dishes, laundry, etc., can have a major impact on energy consumption. (Zhao, McCoy, Du, Agee, & Lu, 2017)

2.4. Smart energy management

The smart meter can reduce the demand for electricity by monitoring the consumption and price of electricity in real time. The smart meter refers to the use of intelligent meters and measuring instruments so that the consumption in the buildings will be more transparent and, in this way, it enables automatic electrical power management. These meters provide customers and energy suppliers with accurate information about the amount of used energy; instead of measuring energy consumption at the end of each accounting period, smart meters give this information at shorter intervals. In the future, the smart meter will play a more important role in residential and business buildings, and the reasons for this are (HGI-GD017-R3, 2011, p. 15): preparation of monthly bills, monitoring of non-standard consumption in buildings (for example, the bursting of water pipes), informing tenants about consumption patterns, preparing energy bills at short notice, delivering energy efficiency information.

The application of smart networks in the management of smart houses and residential communities is reflected in the interactivity of the devices (smart devices, smart ports, home displays, etc.) with control units and management and monitoring of energy consumption. The role of the control units is:
- constant availability;
- connection with distributors, for conducting communications in both directions;
- connection to smart devices.

2.5. Smart residential communities

Residential community presents public spaces, equipment, and facilities that are shared among residents of the building as a residential unit or a set of homes and buildings that can be called residential quarters. A smart residential community is a place that recognizes the trend and willingness to adopt the intelligence infrastructure of smart environment to manage home, manage energy consumption, enhance security, and include social and communication aspects as a part of smart system. The final goal of connected community is to achieve economic, social, and environmental sustainability.

Smart residential community systems that are also part of the smart home environment are lighting, humidity, smoke detection, flood detection, autonomous management of windows and curtains (with moisture sensors it can be ensured that the window closes automatically if it rains), and management of the grass spray systems network (Unleashing the potential of the Internet of Things, 2016). In addition, it is necessary to enable the monitoring and management of energy consumption, especially if the community has solar panels and produced energy should be adequately distributed among residents (HGI-GD017-R3, 2011). Further, security systems include video surveillance, alarm systems, presence, and motion sensors, opening and closing doors (windows, doors, garages), access control in buildings and shares areas.

Solutions for connected homes and residential buildings must include a set of integrated services and applications to manage the smart residential community (Aheleroff, et al., 2020). Users need to have remote access and all the necessary data and services from the smart environment should be provided through a single application. Also, if multiple objects (buildings, homes, facilities, apartments, etc.) are managed jointly, it is necessary to provide access and visibility of all objects through the same centralized application. These systems need to include heat maps through a user interface, asset and property overview (monitoring of the condition, the degree of use of the appliance and facilities as well as the location of them), powerful analysis of data-using dashboards, algorithms, and other data interpretation tools to achieve identifying anomalies and events in order to be able to ensure preventive and predictive object maintenance.

Examples of how to use a smart residential community service:
- The humidity sensor can affect the activation of the humidifier if the air in the room starts to dry.

- By using the presence sensor, system can decide not to waste energy on the heating if no one is on the premises.
- The Fitbit or Jawbone smart watch can be used to realize that the owner is awake and activate the smart thermostat for the powering of the heating system.
- When a resident exits the house, the smart door openers can run the smart thermostat at a lower temperature setting.
- When the car approaches home, the car can start a smart thermostat to turn on the heating, ventilation, and air conditioning.
- The smart smoke alarm can activate the LED lighting to blink.
- The smart thermostat, while in automatic shutdown mode, can randomly turn on or off lighting when residents are away from home.

3. DEVELOPING A SYSTEM FOR SMART RESIDENTIAL COMMUNITY

3.1. Project requirements

It is necessary to provide connectivity of smart devices to the residential community. Each smart residential community object (facility) needs to enable assigning another object (facility) and/or device. That allows the building to be assigned to an apartment, or other object, and to assign a sensor or device to the object. In addition, the building or house can have its own environment, which can have a sensor or device. The user needs to keep track of the environment data within the object and in the surrounding area.

It is required to enable a two-way communication with the smart environment for a user. That is done by the Smart Environment module, which can view the information received from the smart environment, and to give commands to which the environment will respond. The user, if authorized, can review various service information from smart devices built into the building or apartment. This includes information such as temperature, humidity, air pressure, the presence of carbon dioxide or other particles in the air. Additionally, it is necessary to keep track of where the devices are placed within the smart residential community. It is only necessary to display the data from the sensors/devices in the locations (objects) to which the user is entitled.

3.2. System architecture

System architecture is shown in figure 1. Devices from a smart environment connect to the Mainflux platform. A prerequisite is that there is an installed MQTT broker Mosquitto or Paho on Raspberry Pi 3. This protocol ensures that data is sent to the Mainflux platform. The Mainflux platform is hosted on a Linux server. The platform is deployed using Docker containers and Docker composition. When deploying the Mainflux platform, other services are also deployed within the Docker composition:

- Grafana – data analytics and visualization,
- Influx DB – time series database,
- PostgreSQL – relational database.

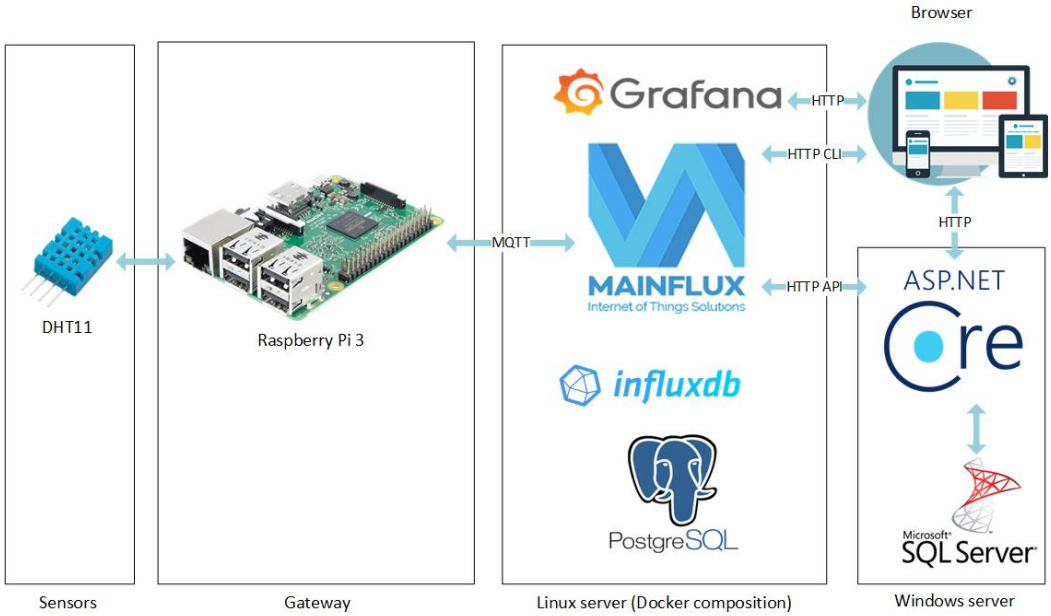

Figure 1. System architecture

The web application for managing the smart environment is developed in the ASP.NET Core framework and it uses SQL Server for the database. Grafana is deployed together with the Mainflux platform. The platform is used to create dashboards and view data obtained from a smart environment. Raspberry Pi 3 Model B, DHT11 sensor, protoboard, T-cobbler, IO wires, 10K Ohm and 330 Ohm resistors and 1 LED diode are used as edge network devices.

Raspberry Pi collects the data from the edge of the network, it converts the data to SenML format and publishes the data using the MQTT protocol to channel to the Mainflux platform. Mainflux uses the NATS message broker which forwards the messages toward a microservice called “Writer” which automatically writes messages to the Influx DB as time series data. After data is collected, results are shown using Grafana panels which are embedded in the web application. The web application can communicate with Mainflux with HTTP requests and send commands to it. This is possible with protocol bridging where HTTP message can be converted to MQTT. PostgreSQL is used for storing data about things and channels created on the Mainflux platform. This can be done with Mainflux API.

3.3. Designing web application

Architecture of the web application is shown in figure 2.

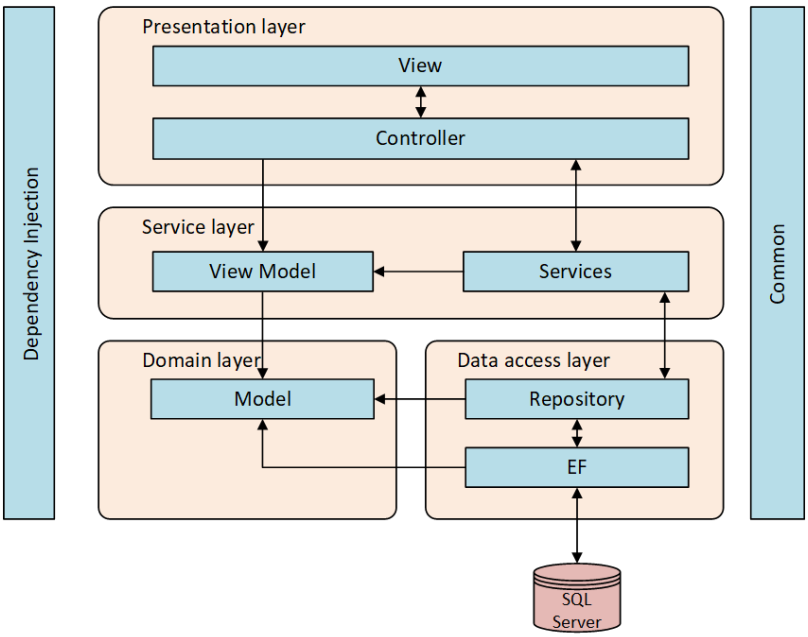

Figure 2. Web application architecture

The Entity Framework Core framework is used for the data access layer, allowing connection to various SQL and NoSql databases. EF Core serves as an object-relational mapper (O/RM). It can access many different databases through plug-in libraries called database providers. Within the presentation layer, the controller oversees communication between the service layer and the view (user interface) of the application itself.

The service layer solves most of the business logic. It hosts and develops services that invoke API’s and other services. In addition, objects are being prepared at this level for forwarding to the presentation layer.

A domain model is important for defining a database structure because we use the Code First principle, which automatically generates a database structure. EF API will create the database based on the domain classes and configuration. Using this approach, focus is on the domain rather than on the database design. Microsoft SQL Server is used for the database.

3.4. Mainflux middleware platform

Mainflux is a performant and secure open-source IoT platform with the complete full-scale capabilities for the development of the Internet of Things solutions, IoT applications and smart connected products (Full-stack Open-Source, Patent-free IoT Platform and Consulting services, n.d.). Mainflux is written in Go (Varga, Draškovic, & Mijic, 2018), built as a set of microservices containerized by Docker and orchestrated with Kubernetes. Mainflux IoT platform serves as a software infrastructure and middleware which provides:

- Device management
- Data aggregation and data management

- Connectivity and message routing
- Event management
- Core analytics
- User Interface
- Application enablement

With the possibility to be deployed both on the cloud and on premise, scaling from gateway to full clusters, Mainflux has been used to build modern IoT systems. It allows device, user, and applications to connect over various network protocols, like HTTP, WebSocket, MQTT, CoAP, LoRa, OpcUa.

A use case of the Mainflux platform can be found as part of the Industrial Internet of Things. As there is a need to start digitization of manufacturing and logistic processes by implementing monitoring, alerting, and reporting system that will provide better real-time insight into employee productivity, provide measurable KPIs and optimize operational costs. Smart cameras are installed to measure employee productivity and utilization, by detecting people presence in marked zones and sending data using MQTT protocol to the Mainflux platform. Real-time production line machine data is collected using the OpcUa protocol. When all data is available custom dashboards are created and collected data is presented.

4. IMPLEMENTATION OF A WEB APPLICATION FOR SMART RESIDENTIAL COMMUNITY

The user interface consists of the following system usage modules (figures 3 and 4): Login module, Asset Management Module, Poll module, Tenant Assembly Module, Notification module, and Module for smart environment.

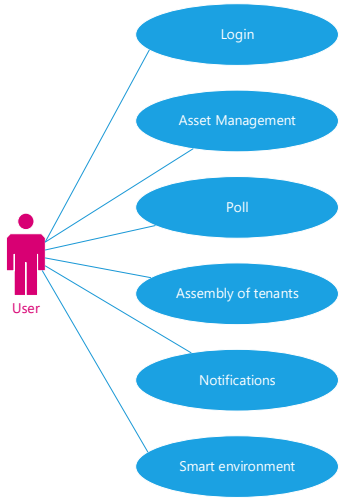

Figure 3. Use case – modules

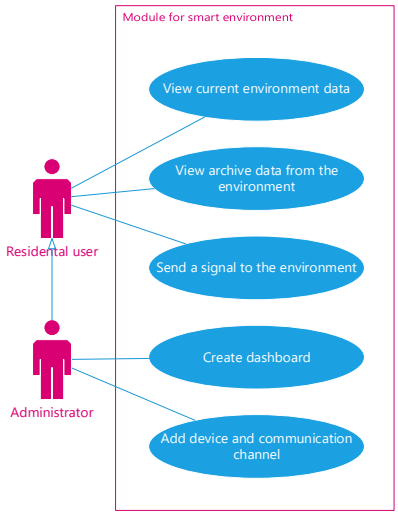

Figure 4. Use case – Smart environment

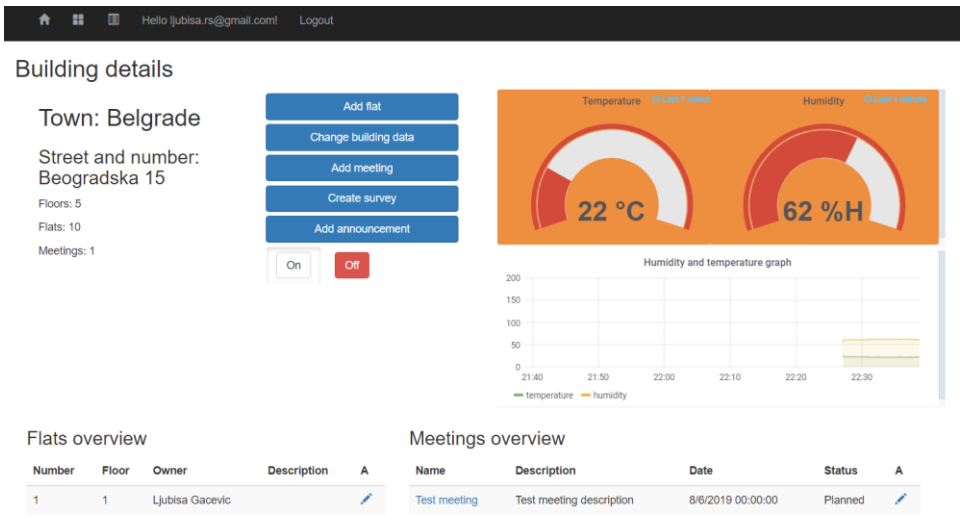

Figure 5. Building details

Figure 5 shows the building details page. On this page there are following options: Add flat, Change building data, Add meeting, Create survey, Add announcement. Below the options for adding new actions, there is a button to send a signal to a smart environment. In this case, the signal is sent to turn on and off the LEDs connected to the Raspberry Pi.

The right side of the figure 5 shows the data when it is available within a smart environment. The upper right part of the figure shows the current temperature (top left) and the current humidity (top right). The bottom of the figure shows a chart with historically (archived) measured values from a smart environment. By dragging the cursor over the chart, temperature and humidity are displayed for the selected time as it is shown in the figure 6.

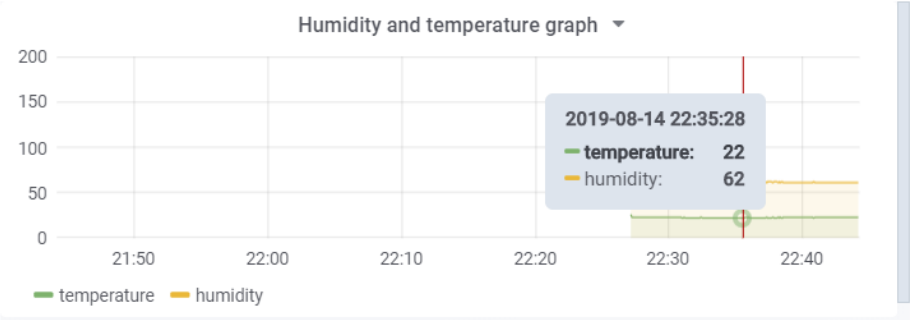

Figure 6. Archived data values

5. CONCLUSION

The aim of this paper is the development of a smart environment system and web application for management of smart residential communities. This paper is based on the development of an application that serves to monitor the temperature and humidity, as for the management of the residential community. The reason for choosing the system for managing the residential community is the increasing need of tenants and managers for making transparent and joint decisions remotely, as well as the possibility of remote monitoring of the situation homes, where the use of modern solutions based on the Internet of Things is increased.

The adoption of home automation systems and Internet-based management will depend on the development of accessible and simple devices and systems. Consumers will have to be convinced that these systems are saving time and effort. Interoperability will likely be especially important for broad adoption, so that consumers can easily manage multiple devices.

The greatest challenge in the development of these solutions will be the interoperability of devices, scalability, networking, and safety. Safety must be provided at all levels and elements of a solution because the vulnerability of one of the elements of the system can affect the entire system. One of the challenges, in ensuring security, is not to endanger the interoperability of devices and systems. Devices in urban areas, which are not physically secured, can easily be accessed by attackers, who get direct access to these devices. DDoS attacks can take advantage of devices from these systems for mass attacks and overwhelm the network. It is especially necessary to emphasize that the Internet of things opens doors between the world of the Internet and the physical world, and that the consequences of security failures in this domain have consequences in the physical world and can pose a danger to the environment, and even a danger to human life (Isidorović, 2019). Decision-making will be put closer to the edge of the network, that is, to devices that will be in the immediate vicinity of sensors and actuators. These devices will filter and distribute the data and send them further onto the network, where the goal is to analyze and manage in control centers by end users.

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PROJECT-BASED E-LEARNING IN VIRTUAL TEAMS

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Abstract: *This paper analyses project-based e-learning in virtual teams. The main goal of the paper is to point out the need to understand the implementation of project-based e-learning organized through virtual teams in an educational environment. The focus has been given on the performance and evaluation of the project-based e-learning environment in virtual teams. It describes the methodology and the results of practical experience from the Department for e-business, Faculty of Organizational Sciences, University of Belgrade. This paper aims to explain the experience in designing an effective model that encourages project-based e-learning to acquire and evaluate successfully organized groups of students who communicate via electronic communications.*

Keywords*: project-based learning, virtual teams, e-learning*, *learning in virtual teams*

1. INTRODUCTION

A trend in education worldwide is to move the focus from that of teaching to that of learning (Lin & Hsieh, 2001). Among the most well-known models is Project-based learning (PBL), a valuable educating and learning model that is accepted to be viable in specific circumstances, for example, sorting out IT anticipates. It is a constructive model of teaching and learning that is regarded to be effective in situations such as organizing IT projects. Despite the positive attitude for PBL, there is a challenge to find a generally recognized model or theory (Mergendoller & Thomas, 2000; Thomas, 2000). It demands more effort and more resources than traditional models (Synteta, 2003).

PBL study proposed that it would be suitable to provide the basic pedagogy of experience in the workplace and teaching skills of lifelong learning developed by students working in collaborative virtual teams (Goold et al., 2006). Collaborative learning or team learning is one of the greatest advances of the past decade. This comes from the fact that people like to work in groups, and thus collaborative learning becomes effective. Due to the growth of the Internet and more sophisticated telecommunications systems, the expansion of virtual teams seems to be ensured (Mackay & Fisher, 2013.).Collaborative learning is reflected in current international educational practices with the rapid progress of virtual teams. Students learn better in teams and find the experience more enjoyable, such as successful collaborative work, developing critical thinking skills, and building lifelong learning skills. Virtual teams are of great importance in the structure of a global organization, so it would be desirable for students to adopt the skills of working in a team environment before coming to work.

The goals of the paper are to show the model for project-based e-learning in virtual teams, its key elements, and factors, to explain the benefits of managing projects in e-business using this model. With changes in the methodological approach to teaching, students' can be organized using project-based learning through collaboration in virtual teams, which are expected to provide students with knowledge for solving problems on projects throughout collaborative work in virtual teams. The main goal of the paper is to analyze the project-based e-learning in virtual teams. Suggestions on creating and nurturing project-based e-learning in the virtual teams model will be explained in this paper.

2. LITERATURE REVIEW

2.1. Project-based e-learning

Project-Based Learning (PBL) is a philosophy of teaching and learning that provides a scaffolding for how education will be organized in the time to come (Markham, 2012). The structure includes interdisciplinary information development while finishing a social movement that assembles setting subordinate mindfulness of learning and knowing (Tamim & Grant, 2013).

Engineers continuously engage in projects and display an intensive effort to solve problems in projects throughout their whole career. Recently a very rapid increase has occurred in the interest of educational institutions orienting to PBL. As a result of this intensive interest, the institutions providing engineering education have started to create their engineering formation curricula and course programs through and based on PBL.

PBL has evolved as one of the most dynamic teaching practices in learning (Drake, 2012; Jones, 2019). The“Project” is located at the center of PBL. It is conceivable to consider PBL as a 'model arranging learning around projects' in the general sense (Thomas, 2000). PBL is a learning approach that encourages understudies' critical thinking abilities under natural conditions on an individual basis or in small groups (Iscioglu & Kale, 2010). According to another description, the PBL approach is an approach that furnishes the students to explore the subjects in depth in real life, again in a group or individually during a certain period (Gültekin, 2005). Further-more PBL is an approach that focuses on learning using experiences and construction of ones own knowledge, experiences, and information by understanding the subject matter relating to the problems, utilizing their expertise, knowledge, and experiences to synthesizing solutions to such real-life problems through focused activity and research to arrive at the solutions whilst reinforcing their project management, research, and information problem analysis skills (Iscioglu & Kale, 2010).In PBL courses, the task is at the center of the educational program, including an inside and out request and requiring updates of and reflections on the artifacts created. PBL commonly expects understudies to undertake effort for a considerable length of time or months to finish the work and to bring up understudy voice just as educators in the course usage (Jones, 2019).

In the literature, there are many references to PBL strategies that are implemented successfully (Gonzalez-V. & Loya-Hernandez, 2007; Machado et al., 2009; Macías-Guarasa et al., 2006; Rush, Monica et al., 2007; Stojcevski & Fitrio, 2009).

PBL in engineering education and formation aims to ensure the participants (students) deal with engineering problems taken from real-life in a class environment and to help them understand these problems (Anette et al., 2004; Kjersdam, 2020; Pan & Allison, 2010). It is also emphasized in the literature that PBL provides many advantages and benefits for students. The benefits of PBL are as follows: it increases the motivation of students, helps in the improvement of their knowledge and abilities, and ensures they see real-world problems (Gültekin, 2005). Moreover, PBL also helps improve the students’ sense of responsibility and their learning skills (Krajcik et al., 1999). Besides, another benefit afforded by PBL is that students taking engineering education get a chance to learn whilst enjoying the projects they undertake as part of their studies at the same time improving their engineering skills through the application of their theoretical knowledge into practice (Iscioglu & Kale, 2010; Moore et al., 2003).

2.2. E-learning in virtual teams

Virtual teams, also known as distributed collaborative teams, included individuals who communicate utilizing telecommunications and electronic means who intends to finish a specific organizational assignment (Edwards & Wilson, 2004). In the IT sector, there is expanding utilization of worldwide virtual teams, where individuals are geologically and socially scattered (Goold et al., 2006; Massey et al., 2001; Powell et al., 2004). Fundamentally, a virtual group requires insignificant up close and personal physical cooperation and is regularly dissipated genuinely utilizing broadcast communications based innovations, (for example, email, Skype, web conferencing, and so on) to communicate asynchronously. Components that make a virtual team hard to structure and to work in, incorporate various nationalities, associations, and societies. The training is generally to get the virtual team to be established to handle a specific undertaking and will be incapacitated down when the plan procedure has been finished. A review by the Society for Human Resource Management (Minton-Eversole, 2012) found that almost 50% of organizations overviewed exploit virtual teams and that they were utilized by 66% of global associations (Gibbs et al., 2017).

In modern educational environments, teachers should involve students in real-world problem solving, create workplace-like experiences, using digital tools and resources that are students likely to use in their future work in companies. This approach is expected to promote student reflection, to clarify their conceptual understanding, and to better prepare them for the labor market. Educators are required to show creative information, abilities, and work forms required for experts in a worldwide and computerized society by using tools for communication and collaboration in the digital age.

In higher education, as a result of technological development and globalization, virtual teams are used. Also, the virtual team became the definitive process of team learning in addition to fulfilling the task (Hu, 2015).

3. METHODOLOGY

3.1. Research context

The research was conducted in the Department of e-business, Faculty of Organizational Sciences. Among other areas, the Department realizes research related to the development of e-learning infrastructure and applications that support numerous areas of teaching and learning: e-business, internet technologies, internet of things, smart environments, DevOps tools, and technologies, etc.
The assessment of the approach presented in this paper is applied for organizing the students' teams working on the development of smart environments.

3.2. Procedure

The fundamental plan was to locate a satisfactory answer for arranging and controlling a large number of IoT ventures with the assistance of well-designed project management, utilizing the undertaking based e-learning model in virtual teams (Figure 1).

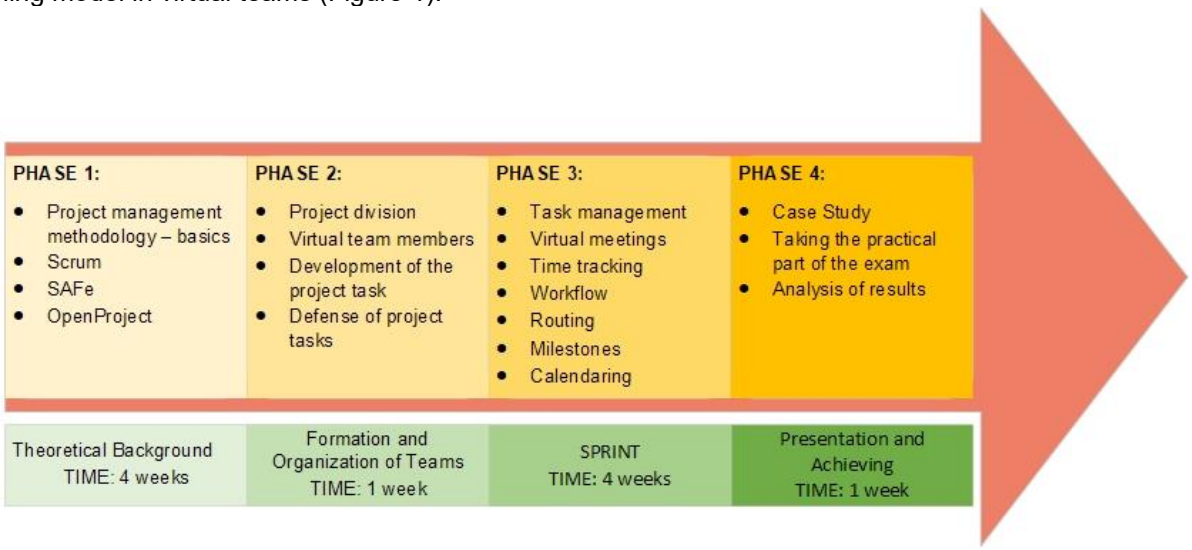

Figure 1: Learning process

The aim was to locate the most appropriate answer for sorting out the IoT projects with the assistance of appropriately characterized project management, utilizing the Scrum framework, and adjusting it to the necessities of the educational environment. The greatest challenge was to arrange the students' work in virtual teams. The research was performed with students of two undergraduate courses: Internet of things and Risk management in e-business. The courses adopted the Scrum agile framework, intending to empower students with an experience similar to working in real software companies. Students attending the Risk management in e-business courses were given a task to manage the IoT projects and play the role of a Scrum Master. The IoT teams were assigned to play the role of developers working in the Scrum structure. The educators controlled and assessed all the work (Mihajlović-Milićević et al., 2019). The research was conducted in the spring semester of 2019/20 school year, during the coronavirus pandemics, so students had to work in virtual teams, use different online communication methods, without any physical meetings.

IT project management was based on the use of the Scrum framework. The Product Owners (Professors) created a list of IoT projects and a list of features that the team had to implement (Product Backlog). Each team was assigned to one project. Team members and a Scrum Master were given initial instructions from Product Owners but were allowed to self organize, in terms of specifics of work dynamics, selection of communication tools, organization of work within the team, etc. The task of the Scrum Master was to keep the team focused, to ensure that the team works according to the planned dynamics, and to communicate with Product Owners. The teams had to work in sprints to complete their work (Royle & Nikolic, 2016).

All work and communication on the project between team members were organized with the help of Microsoft Teams or Viber/WhatsApp. Teaching materials and project development instructions required for implementation were posted on Moodle. All sections of the Sprint were checked with the assistance of the OpenProject (Figure 2 and Figure 3).

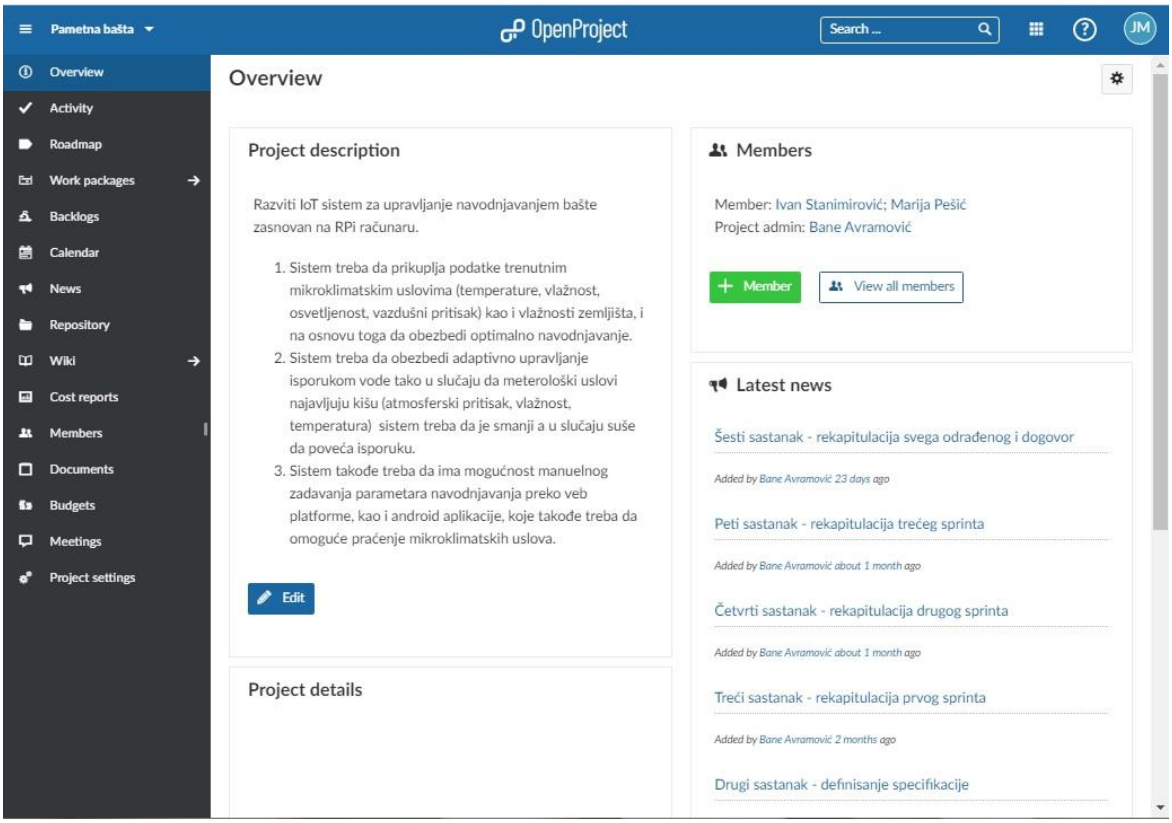

Figure 2: OpenProjectOwerview

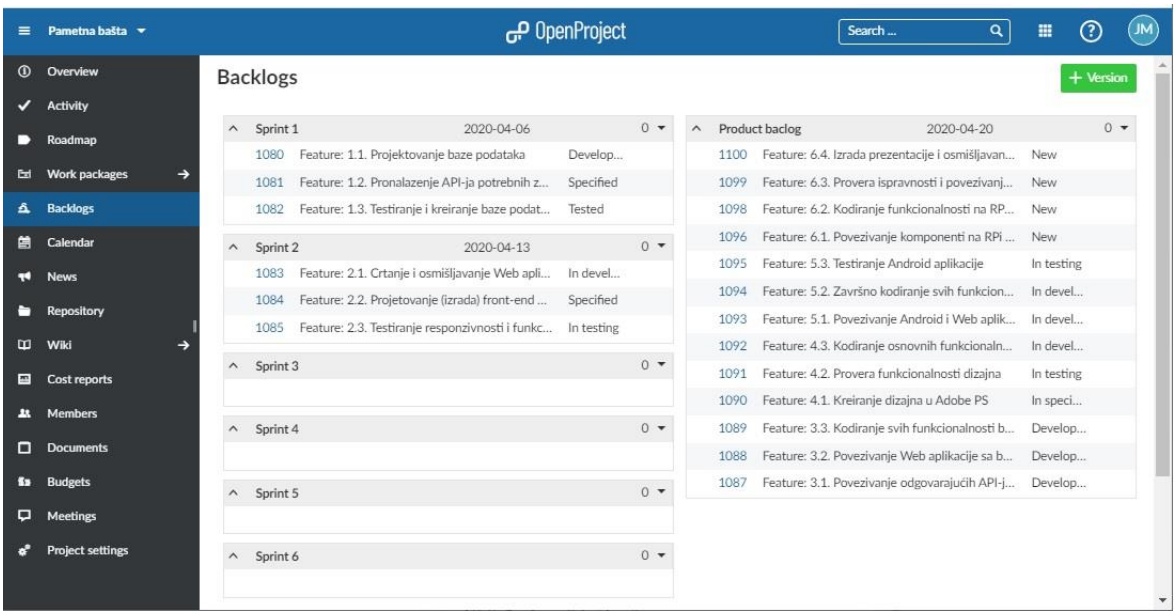

Figure 3: OpenProjectBacklog

4. EVALUATION - RESULTS AND DISCUSSION

The project-based e-learning in virtual teams was implemented using the proposed methodology. In the project, 113 students of undergraduate studies and 3 professors have participated. The students were asked to organize into Scrum teams and complete a realistic four week sprint-long systems development project. The project included optimal amounts of teacher interaction. The project was complex, ambitious, and considered changes in organizational and technical environments.

After the end of the project, a case study was created for students and professors about their work in project-based e-learning in virtual teams. By the date of submission of the paper, 59 students and professors have participated in the case study. In this case study, they were approached to think about their encounters. They depicted what their group progressed nicely and what added to the achievement of their group. They likewise detailed the difficulties in their groups and the answers to the issues.

The basic tools for cooperation and communication within the team were MS Teams (20 participants), Viber/WhatsApp (31 participants), OpenProject (3 participants), and some other tools (4 participants) (Figure 4).

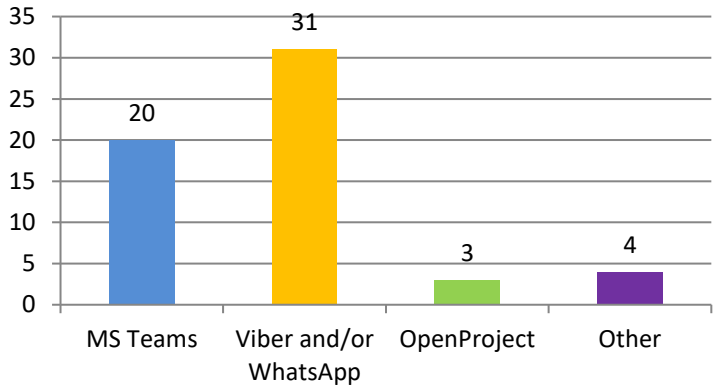

Figure 4: Collaboration tools

During the work on the project, a sufficient number of virtual meetings were held, which were attended by all team members. Virtual meetings were held in most cases 2-3 times a week. On average, they lasted about 30 minutes. A small number of teams held meetings for more than 1 hour (Figure 5).

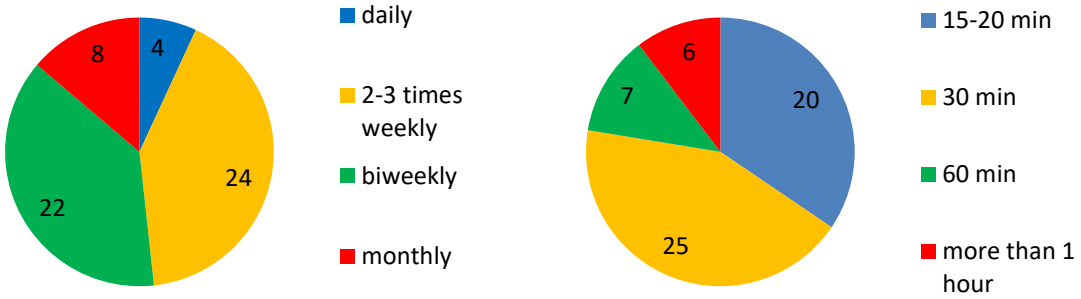

Figure 5: Meetings statistics

The best disposition towards experiential finding out about virtual teams was observably obvious in the understudies' reasoning. Most of the students considered a virtual team productive: “What I liked the most was that the project was nicely designed so that we could put ourselves in the right role and experience what it is like to realize a project in real-time. I like that the project is quite realistic and that through this project I have seen at least to some extent what it is like to be a scrum master and I would also praise the cooperation and communication with the project team.”

Differences in opinions and ways of working were not easy to avoid in 3/4 of the surveyed students. Problems appeared in understanding the role of the Scrum Masters as well as accepting the existence of such a role that in some way directs and takes care of the work of the team. Then, the challenge was to coordinate and organize the time for the virtual teams to meet. They tried to overcome communication difficulties, time differences, and other distractions that could have prevented them from achieving their goals. Students’ wrote: “What I liked the most was that we had very good communication with the Product Owner and student Scrum master, for each of our questions and some ambiguity we got an answer in a very short time and that answer was precise and clear.”
Most students appreciated the chance to take a shot at pertinent, genuine important points and learn current innovative tools, which could be valuable for a coordinated effort in genuine regular day to day existence or

work circumstances, while a smaller group of students found this type of work complicated and unnecessary. Some acknowledged the difficulties they encountered during the projects. One understudy put it: “A large number of requests and a large number of obligations, as well as a lot of documentation that significantly complicates matters and at the same time reduce the desire to work, we managed to solve using new technologies and tools, as teamwork in new areas.”

From the professor's point of view, it was seen that group members were gaining from one another on the best way to work MS Teams and OpenProject during the project procedure, and they thusly turned out to be nearer in close to personal and professional connections since they had created trust in one another and improved collective abilities.

5. CONCLUSION

The contribution of this paper is an approach to implementing project-based e-learning in virtual teams. We have presented an approach to organizing and managing students’ projects using scrum, and conducting communication and collaboration of virtual teams using tools that are typically used in software companies, thus providing students with an experience similar to their expected future workspace.

Utilizing rising innovations inside and outside this course guaranteed all members had the chance to take part in authentic problem-solving using advanced instruments and assets. These innovations upgraded course content as well as motivated and encouraged students to take an interest in collaborative (community-oriented) learning forms, which conforms to the results of other researches (Roodt et al., 2014).

Another significant characteristic of present-day building instruction is the need to create instructive methodologies that address understudies' inventiveness and persuade them to create imaginative arrangements. Even though imagination in instruction has been saddled in inventive controls, there is an absence of inventiveness based teaching methods in engineering disciplines (Bogdanović et al., 2019).

All through this undertaking, the students figured out how to cooperate, create proficient associations with one another, be progressively participative and inventive. The students were keen on the educator playing the facilitator role and directing the gatherings through the procedure. A few students remarked that, although they haven’t previously worked together, their group was coherent, efficient, and professional.

The future work on this topic will be mainly oriented to adopting the principles of DevOps methodology, and organizing virtual teams to use tools characteristic for all the DevOps phases.

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RESEARCH OF SCRUM IMPLEMENTATION IN IT COMPANIES IN SERBIA

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Abstract: *The aim of the paper is to analyzes the results of Scrum research in IT companies in Serbia, to understand, compare, and consider the effectiveness of the implementation of Scrum, in the given IT companies. The paper also states the objectives of conducting this research, as well as assumptions and hypotheses of the results of this research, an online survey was used as the measuring instrument. The survey data were collected by forwarding the survey directly to IT sector employees and groups on social networks dedicated to IT. Some questions included in the survey allow multiple choice answers or the option to add personal answers. If a participant selected multiple answers, the percentage refers to the number of respondents who chose an individual, single answer. The survey is divided into two parts, depending on whether Scrum is applied in the given respondent's company or not, so different questions arise further in the survey, based on the answer to that question, accordingly.*

Keywords*: SCRUM, Agile Methodologies, IT Companies, Research*

1. INTRODUCTION

As the use of Scrum continues to grow, the project's top business priorities are meeting customer needs, accelerating market delivery time, and reducing the life cycle duration. Scrum implies the implementation of an agile framework to improve products, improve the working environment, services and create an overall better experience in industries around the world. (Scrum Alliance, 2018) Scrum can be applied in various industries such as IT, finance, healthcare, manufacturing, education, retail, etc. However it is primarily used for software development projects with the goal of delivering new software. The Scrum methodology follows the values and principles of agile but includes further definitions and specifications, especially regarding certain software development practices. (Collab Net Version One, n.d.) This paper describes the value of and roles, events, artifacts and rules defining the Scrum methodology along with its application within IT companies in Serbia.

2. SOFTWARE DEVELOPMENT

In this chapter software development life cycle, software development phases and software development methodologies are described.

2.1. Software development life cycle

"The software development process is called the software development life cycle, since it describes the "life" of a software product, from the very beginning of its development to its operational use and maintenance." (Osivčić, 2019) It is a process used by the software industry to design, develop, and test high-quality software. SDLC aims to produce quality software that meets or exceeds customer expectations, achieves completion on time and estimates costs. SDLC defines the tasks that are performed at each step during the software development process.

The international standard used for software life cycle processes is ISO / IEC 12207 and it serves to define all the tasks required for software development and maintenance. (IEEE Standards Association, 2017) SDLC is a process that follows a software project within a software organization and consists of a detailed plan which describes how to develop, maintain, replace, and modify or improve a specific software. The life cycle defines the methodology for improving software quality and the overall development process (*SDLC - Overview*, n.d.).

2.2. Software development phases

The phases of the software development life cycle are:

- Planning - collecting any relevant information from stakeholders, review of project requirements, analysis of project requirements priorities, resource allocation, project plans, schedules, cost estimates, and procurement requirements...
- Analysis – "*this is the phase where the requirements that the system should meet are determined, which is achieved through the cooperation of the development team and the customers or users of the system. The result of this phase is a list of user requirements."* (Osivčić, 2019)
- Design – "*during this phase, a project of the system, which provides a solution plan or system architecture, is generated.*" (Osivčić, 2019) This stage involves the design of the entire system and its components which helps in specifying hardware and system requirements and also helps in defining overall system architecture.
- Implementation - the stage during which developers write software code and the software is produced. The result of this phase is a functional software that can be tested.
- Testing and integration - *the stage where errors in the system are detected and corrected, the software is installed in the work environment and the user training is performed*. (Osivčić, 2019) During this phase, the QA and testing team may find the errors and the development team fixes them. This phase continues until the software is stable and functions as expected and according to the business needs.
- Maintenance - a long-term stage, during which errors in the system are corrected and discovered after its delivery. (*SDLC (Software Development Life Cycle) Phases, Methodologies, Process, and Models*, 2020).

2.3. Software development methodologies

The software development process has changed over time. In the beginning, the software was very simple and the developers could reduce the software development process to writing code directly. Later, when the requirements became more numerous and complex, the software could only be developed by a larger number of programmers who made up the development team. It has become a process in which experts of various profiles now participate: analysts, designers, engineers, developers… Due to the increasing complexity of software, adding new functionalities has become increasingly difficult, as well as finding and eliminating errors. Over time, the idea has emerged that this problem could be most easily overcome by introducing a software development methodology.

There are various software development life cycle models, that are defined, designed, and monitored during the software development process. These models are also called software development process models. Methods used for software development can be traditional or agile. Traditional methods are based on one step, after another. The entire project is planned in advance, without any room for changing requirements, it is rigid and highly controlled. On the other hand, agile methodology is a way of thinking and a set of values and principles. Agile includes short cycles, iterative, and incremental delivery. "*By using short iterations, agile method keep the feedback cycle short, allowing more responsiveness to change" and reducing the risk of making mistakes or not understanding customer requests.* (Aguanno, 2005) This allows fast delivery of value to customers. Some of agile frameworks are Scrum, Kanban, KSP, Cristal, XP, Lean, etc (Wendler & Gräning, 2011). "*In order for an IT project to run smoothly, quickly, on time and without any unplanned costs, it is necessary to apply a certain project management methodology."* (Isaković, Salkić, & Veletovac, 2019) Which of the existing methodologies will be chosen depends on the project itself, because not every method is applicable for every project. Depending on the chosen method, the planning approach, team structure and way of communication are also chosen.

Some of the best-known methodologies are: (Khan et al., n.d.)

- Build and fix model
- Waterfall model
- Waterfall model with a prototype
- Methodology for parallel development
- Incremental model
- Spiral model
- Rapid Application Development (RAD)
- Rational Unified Process
- Extreme Programming (XP)
- Scrum methodology

This paper focuses on Scrum among those methods which will be described in the next section.

3. SCRUM

"The Scrum method is one of the most popular and most widely used methods of agile software development management in practice. This method is based on the basic principles that characterize the agile approach and is convenient in practice since it is very simple and easy to use." (Jovanović, Jovanović, Miletić, & Berić, 2016) This approach to the project allows going backward and adapting to changing requirements by the client. (Hasteer et al., 2016) *The project is divided into cycles called sprints that last a maximum of one month, and usually two or more weeks.* (Jovanović, Jovanović, Miletić, & Berić, 2016) Each of these cycles adds new functionality to the project and allows for movement towards change and improvement. *Like projects, Sprints are used to accomplish something. Each Sprint has a goal of what is to be built, a design, and flexible plan that will guide building it, the work, and the resultant product increment.* (Schwaber & Sutherland, 2017) Individual steps, tasks and problems are constantly reviewed during the meetings that are organized before and after each sprint and on a daily basis by people who have various responsibilities in the process (Menzinsky et al., 2019)

Sprints consist of: (Schwaber & Sutherland, 2017)
- Sprint Planning
- Daily Scrum
- Sprint Review
- Sprint Retrospective

The Scrum Team consists of: (Schwaber & Sutherland, 2017)
- Product Owner
- Development Team
- Scrum Master

In addition to team members working on software development, there are two specific roles: Product Owner and Scrum Master. The Product Owner is the person responsible for writing the Product Backlog, defining requirements (user stories), and for the product being developed and delivered to client's requirements and expectations (*What is a Product Owner?*, n.d.). *The Product Owner represents the connection between the development team and the client.* (Jovanović, Jovanović, Miletić, & Berić, 2016) Scrum Master organizes the team in the process of making the plan, helps them to overcome difficulties and obstacles and Scrum Master is there to make sure that the implementation of the scrum takes place properly. "*The Scrum master has a specific role in software development related to establishing a connection between the Product owner and members of the development team."* (Jovanović, Jovanović, Miletić, & Berić, 2016). The scrum process begins with the idea of a product. The idea is shared wıth the Product Owner who composes the Product Backlog, a list of all user requirements that the product should contain in order to represent a functional product. After creating the Product Backlog itself, Sprint Planning follows. The new Sprint starts immediately after the end of the previous one. In that time period, the Scrum team makes the functional features that are part of the Product Backlog into one whole that is part of the product. From the Sprint Planning itself, the Sprint Backlog emerges, which represents the priority tasks that have been selected and should be performed in the next development cycle, ie the sprint.

Scrum Master supports the team in the overall development. They hold daily meetings that discuss the window development process itself and with which they can resolve to help each other achieve sprint goals. Upon completion of the sprint, all tasks/functionalities from the Sprint Backlog are expected to be developed, tested, documented, and ready for delivery. The Sprint review itself reviews the work done. A Sprint Retrospective is an event where the team focuses on the sprint itself that has just been completed, and then analyzes the entire time period trying to re-examine the problems they encountered, what was done well and what was bad, what could have been done differently. Sprints are repeated until all tasks from the Product Backlog are completed. After completing all the tasks, all the functionalities that a product should have been visible at the end, and a fully functional, tested, and the documented product has been produced. Once the Sprint Planning meeting is over, the team begins to track their progress using well-visible information indicators. To track the progress can be used as a burn-down chart, scrum board, burn-up chart, or cumulative flow diagram.

It is necessary to keep track of:
- *Sprint progress: Within a Sprint, progress is tracked on a daily basis. The Sprint Backlog always holds the most accurate, realistic plan for the work remaining to implement the Sprint Goal.*
- *Product progress: The progress indication at the level of the Product Backlog is updated and reviewed at a minimum at the Sprint Review. The proven progress of past Sprints gives the Product Owner and its stakeholders a forecasted delivery date for releases, individual features, or feature sets.* (Verheyen, 2019)

4. RESEARCH OBJECTIVES

This paper aims at exploring the uses of Scrum within IT companies in Serbia with the objectives defined below:

- Examining experience in using agile development methodologies or Scrum
- The extent to which companies in Serbia apply Scrum or other methodologies
- Reasons for adopting agile methodologies
- What are the biggest challenges experienced adopting and applying agile methodologies
- How Scrum is implemented
- How different is the implementation of Scrum in practice from the previously defined rules of Scrum application
- Whether organizations that do not implement Scrum plan on implementing it

Those objectives are achieved by conducting an online survey among IT employees and individuals active on social networks dedicated to IT, collecting results, and analyzing them.

5. EXPECTED RESULTS

In this chapter, the expected results or hypotheses related to individual questions from the survey are presented. The expected results relate to issues related to IT companies business methods, advantages and disadvantages of adopting agile development methodologies, the use of Scrum now and in the future.

5.1. IT companies business methods

"The business of domestic IT companies is quite simple: most of them are engaged in outsourcing and providing technical services to their foreign clients. Some of them also develop their own in-house products, while certainly, the smallest number of companies work on their own solutions and products." (Rašić, 2019) Thus, as a result of questioning the way IT companies in Serbia conduct business, by conducting a given survey, it is expected that most respondents work in outsourcing companies or companies that have a combination of both solutions.

When it comes to companies that create their own solutions, there is a much greater opportunity to work with technologies and solutions that the developers choose themselves. Developers are likely to have more freedom in organizing their work. (Rašić, 2019) On the other hand, developers working on product development at an early stage are definitely much more exposed to the company's business issues. Services do not require large investments and time, to be placed on the market, while product development requires a significant amount of both time and effort. "*There is not much room for innovation in the service company, most decisions have already been made and the company is only there to complete a certain job, according to the requirements established in advance."* (Vatić, 2018) The reasons why companies often develop their own product in addition to their services are various. Some of them are attempts to find a solution to their own problem and solve the problem through a product that would benefit not only the company's team but the entire community. Another reason would be the desire to experience and understand the entire process of product development.

5.2. Advantages and disadvantages of adopting agile development methodologies

According to the latest research (CollabNet VersionOne, 2020) conducted at the global level, related to agile methodologies and Scrum, the biggest advantages of adopting agile methodologies are the ability to manage changing priorities, project visibility, business/IT alignment, delivery speed/time to market and increased team productivity. Therefore, similar results related to the advantages of adopting agile methodologies are expected after conducting this research.

The biggest challenges of the adoption and implementation of agile development methodologies are considered to be the following challenges: general organization resistance to change, inconsistent processes and practices across teams, organizational culture at odds with agile values, inadequate management support and sponsorship and lack of skills/experience with agile methods. Therefore, similar results related to these challenges are expected as the result of this survey. (Miller, 2013)

5.3. Using Scrum now and in the future

Scrum is a widely practiced agile methodology and many companies plan to use it in the future, therefore it is expected that most of the participants already use Scrum in their companies or are expected to use it in the future. (Heikkilä et al., 2015)

6. RESEARCH RESULTS

This chapter presents the results of the research, their analysis, and conclusions. The survey contains questions related to the demographic data, Agile methodologies data, Agile methodologies, techniques and tools, implementation of Scrum, and accuracy of the individual statements related to the implementation of Scrum in their companies.

6.1. Demographic data

In this research, responses were collected from organizations of different sizes. As for the location of the companies, they are all based in Serbia, but with different geographical locations in terms of cities, they are located in. The survey was completed by a total of 34 different individuals and data on their gender and age were collected, as well. The respondents have different roles in their companies operating in different areas.

Out of a total of 34 people, 18 are male and 16 are female. Out of a total of 34 respondents, 16 of them are under 25 years old, 17 of them are between 25 and 34 years old, and 1 respondent is between 35 and 44 years old. Most of the respondents work in Belgrade, 79.4%, that is, 27 respondents. 5 respondents work in Novi Sad and there was a single (1) respondent from Niš and Kragujevac.

When it comes to their roles in the team, among the respondents there are following: Development Team Member (Architect/Developer/QA/Tester/UI or UX Designer) 64.7%, that is 22 respondents, Consultant/Trainer, Product Manager/Product Owner and Business Analyst 5.9 % each, that is 2 of them, Computer scientist, Data Scientist, Software Engineer, ScrumMaster/Internal Coach, Development Leadership (VP/Director/Manager) and Project/Program Manager 2.9% or 1 respondent each, respectively. C-Level Executive and DevOps positions/team roles were both among the possible answers, however, none of the respondents belonged to either of them. From the several answers that were offered, it was possible to choose one of them or add the title of the role, if it was not on the list. The roles that were not listed are Informatics engineer, Data Scientist, Software Engineer. The following chart displays the collected data in percentages.

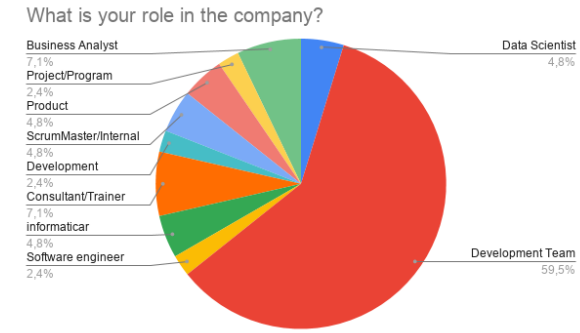

Figure 1: Job role

The respondents mostly work in companies with less than 100 employees, that is 16 of them or 47.1%, while 12 of them work in a company with between 100 and 1000 employees, 3 respondents or 8.8% of the total number work in companies that have between 1,000 and 5,000 employees and those over 5,000 employees. The following chart shows the data expressed in percentages.

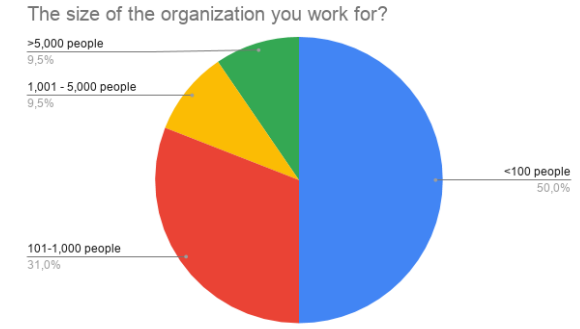

Figure 2: The size of the organization

Although companies that do outsourcing are the most common ones in Serbia, the respondents of this survey mostly work in IT companies that develop their own product, that is 14 of them or 41.2%, 12 of them or 35.3% in companies that do a combination of both, and only 8 participants or 23.5% are employed in outsourcing companies.

Regarding the business sectors of IT companies in Serbia, various sectors exist, and they include: technology 38.2% or 13 of the respondents work in an IT company in this sector, IT Consulting 20.6% or 7 of them, finance 11.8% or 4 of the respondents, e-Commerce 8.8% or 3 of them, government 5.9% or 2 of them, Betting and games of chance, Warehouse, Security and Games 2.9% or 1 respondent each works in a company in these sectors. From the multiple answers offered, it was possible to choose one answer or add the name of the sector in which the IT company operates, if it was not among the given offered answers. The sectors that were not listed are Betting and games of chance, Warehouse, and Security. The following chart shows this data in percentages.

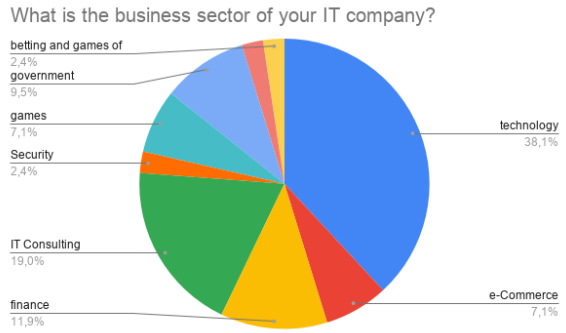

Figure 3: IT company business sector

6.2. Agile methodologies data

This chapter analyzes the respondent's experience in using agile methodologies and what they consider to be the greatest advantages and challenges in their adoption and application. The given respondents mostly have experience in working with agile methodologies of up to 2 years, and the advantages and challenges they perceive are various. More detailed results of these items are shown below.

Regarding the experience of the respondents in working with agile methodologies, most of them have 1-2 years of experience, that is 19 of them or 55.9%, 32.4% of the respondents have experience in working with agile methodologies for less than a year, and the minority of the respondents have 3-5 or more than 5 years of experience, that is only 2 of them (5.9%).

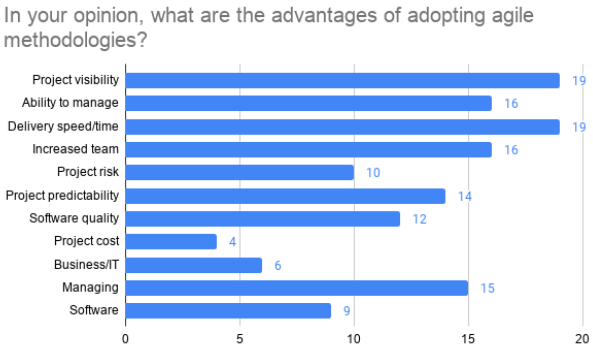

Figure 4: Advantages of adopting agile methodologies

There are many advantages that the companies discover when they adopt agile methodologies and the project visibility, as well as delivery speed/time to market, should be emphasized since the respondents consider them to be the greatest advantages of adopting agile methodologies, 19 of them or 55.9%, to be exact. The ability to manage changing priorities and increased team productivity is the next important advantages for the respondents since 16 of them consider this a significant advantage, ie 47.1% of them. The expected results were obtained, apart from the advantage of business/IT alignment, which is considered to be somewhat less important by the respondents, since only 17.6% of them perceive it as one of the advantages. Other percentages are shown in the chart below. It is important to note that the given

percentage refers to the part of the respondents who chose an individual answer since it was possible to choose multiple answers or write your own.

The respondents consider the fact that organizational culture at odds with agile values to be the biggest challenge in the adoption and implementation of agile methodologies, 15 of them, or 44.1%. The next challenge is considered to be a lack of skills/experience with agile methods and inadequate management support and sponsorship for 14 respondents, which is 41.2% of them. The obtained results were as expected. It was possible to choose multiple answers or provide your own. It is important to note that the percentage here refers to the part of the respondents who chose an individual answer. Other challenges are represented as percentages, in the chart below.

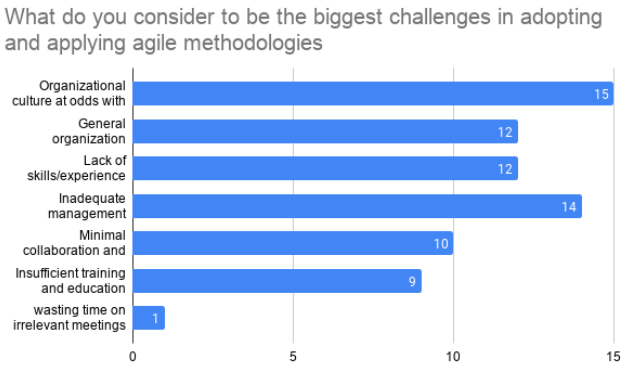

Figure 5: Challenges in adopting and applying agile methodologies

6.3. Agile methodologies, techniques and tools

This chapter provides the results of the application of Scrum and other methodologies, as well as which techniques and tools are used. The data is divided into the respondents in whose companies Scrum is applied and those who work in companies where it is not applied.

Most respondents use Scrum, as much as 88.2%, ie. 30 of them, while 11.8% of the respondents (4 of them) do not use Scrum, which was expected. Based on this question, the survey is further divided into two segments, so that respondents would be given different questions, which will be addressed later on in the paper. The implementation of Scrum is expected in the future as well, in most companies of the respondents, which is why 70.6% of them, that is, 24 respondents, answered "Yes", 23.5%, ie. 8 of them answered with “Very likely”, and only 1 respondent, ie. 2.9% of them, answered “No” and “Very unlikely” for each option, as expected.

Respondents whose companies do not implement Scrum were asked an additional question about which agile methodologies/frameworks they use. The results of this question are shown in the following chart. Kanban, Continuous integration and Test-driven development are often used. The obtained results are as follows: Test-driven development was used the most, since 2 out of 4 respondents chose this answer, ie. 50% of them, followed by Lean startup, Kanban, and Continuous integration with 25% each.

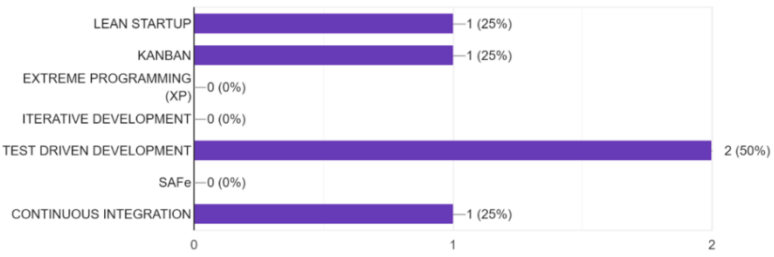

Figure 6: Agile methodologies/frameworks

According to the latest research (CollabNet VersionOne, 2020) most commonly used agile techniques are:

- Daily standup
- Sprint/iteration planning
- Retrospectives

- Sprint/iteration review
- Short iterations

Therefore, similar results related to this issue are expected as a result of the application of this survey.
Among the respondents working in companies where Scrum is used, the most common agile techniques used are Daily standup, 96.7% (29), Sprint/iteration review 93.3% (28), Sprint/iteration planning 83.3% (25)… This is in line with the expected results, with short iterations being used somewhat less, with 20% of respondents (6). Other techniques and their use are shown in the following chart:

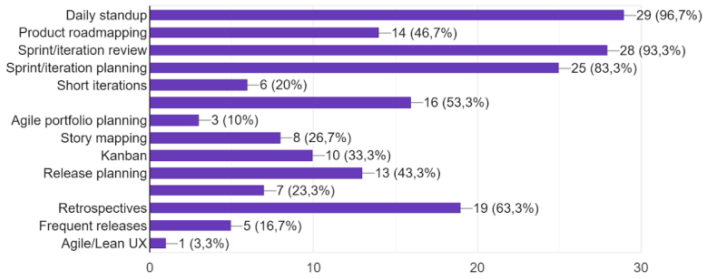

Figure 7: Agile techniques

Among the respondents working in companies that do not use Scrum, the most common agile techniques used are Kanban 50% (2), Sprint/iteration planning, Retrospectives, and Frequent releases, with 25% each (1). The data is shown in the following chart:

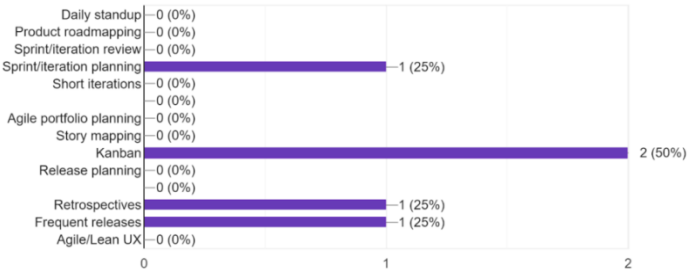

Figure 8: Agile techniques

Among respondents working in companies where Scrum is used, Jira is the most commonly used tool, among 90% (27) of respondents, followed by Asana with 10% (3), and Pivotal Tracker, Azure DevOps, and Quire.io are also used, with 3.3% each (1) respondent. It was possible to choose between multiple answers to this question or provide your own, so the percentage refers to the number of the respondents who chose an individual answer Since, in addition to the offered answers, there is also the possibility of providing additional information, the answers added by the respondents were Azure DevOps and Quire.io.

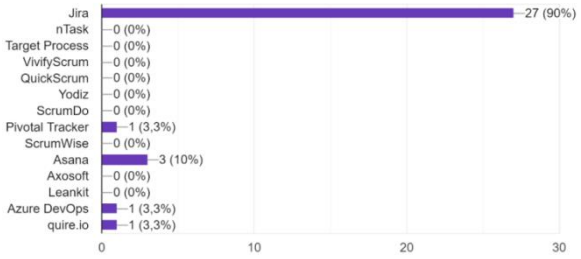

Figure 9: Tools

Among the respondents who work in companies where Scrum is not used, Jira is the most commonly used tool as well, among 100% (4) of the respondents, and ScrumDo is also used by 25% of the respondents (1 respondent).

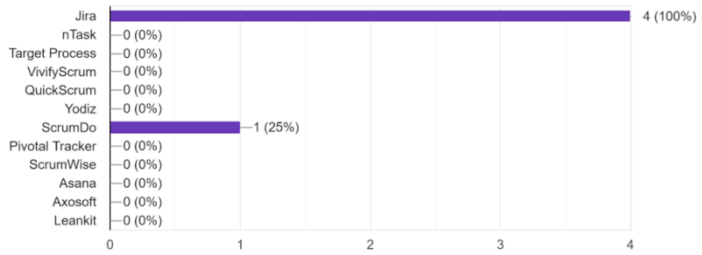

Figure 10: Tools

6.4. Implementation of Scrum

After answering the question about the use of Scrum, 30 out of 34 respondents answered that the company they work for implements Scrum. The third segment of the survey was then presented to the respondents, with questions related to the application of the Scrum methodology. The questions are given and the analysis of their results is presented below.

Each of these items should be part of Scrum's implementation practice, so it is expected that most companies do apply these items. Most of the items are implemented in the companies of the majority of the respondents, which was expected. The following items are the ones most often applied: the role of Scrum Master is present, Sprint planning is applied, etc. According to 13 out of 30 respondents, all the items listed were implemented in their companies. Other items and their results are shown in the chart below.

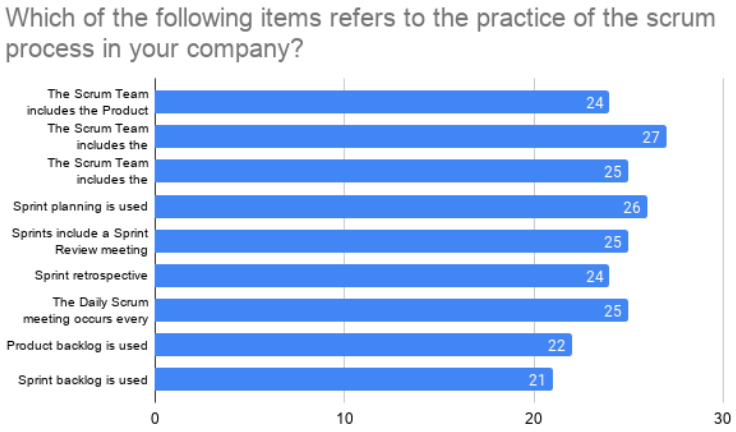

Figure 11: Scrum process practice in the company

The ideal number of team members should be between 3 and 9 since the team should be small enough to remain flexible and large enough to complete the assigned part of the job within the Sprint period. Smaller development teams may face a lack of skills during the sprint, causing the development team to be unable to deliver potential improvements. If a team has more than nine members it requires too much coordination. (Schwaber & Sutherland, 2017) The Product Owner and Scrum Master roles are not included in this count. In most of the companies surveyed, this number is exactly between 3 and 9, but looking at the results, companies whose number of team members is exactly 9 or more than 9 are the majority, which makes it difficult for teams to coordinate work and cooperate with each other. Individual answers of the respondents related to the number of team members are shown in the chart below.

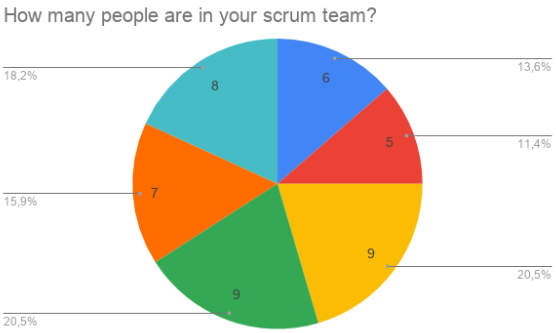

Figure 12: Number of team members

Sprint is a time period of the project that should not last longer than a month and within which certain tasks are completed and product improvement is achieved. In the companies the majority of the respondents work for, Sprint lasts 2 weeks, which is consistent with 73.3%, ie 22 respondents, respectively. Other results, expressed as percentages, are shown in the following chart.

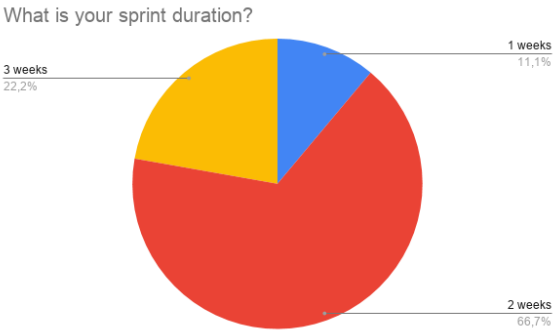

Figure 13: Sprint duration

During Sprint planning, the work to be done during the Sprint is considered. This plan was created by the joint work of the entire Scrum team. Sprint planning takes a maximum of 8 hours for a one-month Sprint (Rosenberg et al., 2020), while for a 2-week sprint, it can take a maximum of 4 hours. *Sprint planning answers the following questions:* (Schwaber & Sutherland, 2017)

- What can be delivered in the Increment resulting from the upcoming Sprint?
- How will the work need to deliver the Increment be achieved?

The Development team chooses the tasks that will be completed in the upcoming sprint, from the Product Backlog. After choosing the tasks, the entire scrum team determines the objective of the upcoming sprint. The second part consists of considering how to complete the selected tasks. The tasks selected from the Product Backlog list are called the Sprint Backlog. Given that in the companies of most respondents the sprint lasts for 2 weeks, accordingly, it should be expected that sprint planning for the majority of the respondents does not last longer than 4 hours, but between 1 and 4 hours. In the following chart, we can see that for most respondents (43.3%) sprint planning takes 30-60 minutes, which is shorter than expected, followed by those for whom the planning lasts for 61-90 min. etc.

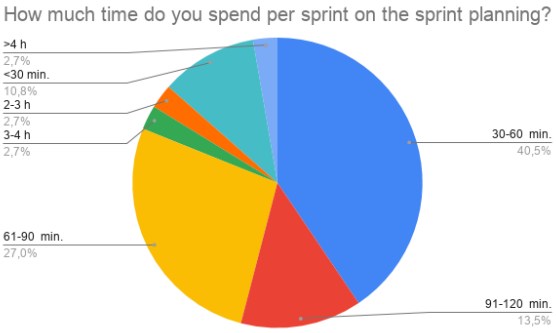

Figure 14: Sprint planning duration

The Daily Scrum is a fifteen-minute development team meeting, during which a plan for the next 24 hours is made, taking into account what has been completed compared to the previous daily scrum. These meetings serve to monitor the process of achieving scrum goals. The Scrum Master ensures that the meetings take place daily, with a time limit of fifteen minutes. Daily scrum enhances communication, quick decision making and overall team knowledge. (Schwaber & Sutherland, 2017) The next question of the survey referred to the time spent on daily scrum meetings, on a weekly basis. Considering that the daily scrum meeting should last 15 min., therefore, daily scrum meetings on a weekly basis should last between 60 and 90 min. However, different results were obtained, since the majority of the respondents have daily scrum meetings that last less than 30 minutes on a weekly basis, by as many as 56.7%. Interestingly, as many as 10% of respondents do not have daily scrum meetings at all. Other results are shown in the graph below.

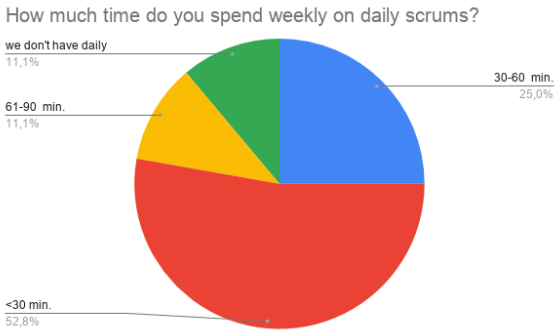

Figure 15: Daily Scrum

At the end of each sprint, a sprint review, a four-hour meeting for a one-month sprint, is held. (Schwaber & Sutherland, 2017) During this meeting, the team discusses what has been done from the Product Backlog and what could be implemented in the next sprint. The development team states what went well during the sprint and also the problems that they faced and how they solved them. Time and budget constraints, as well as the current state of the market, are taken into consideration (Eckstein, 2010). Considering that in the companies most of our respondents work for the sprint lasts 2 weeks, accordingly, it should be expected that the sprint review of most respondents does not last longer than 2 hours… Most respondents have a sprint review lasting 30-60 min. ie 61-90 min.a, in fact 53.3% and 20% of them, which was expected. A much smaller number of respondents have meetings that exceed 90 minutes, and the percentage of those whose meetings are shorter than 30 minutes is as high as 20%. These results, expressed as percentages, are shown in the following chart.

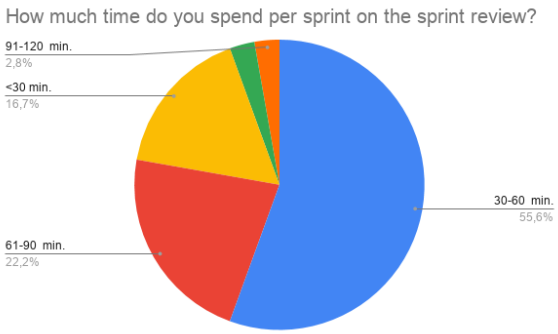

Figure 16: Sprint review duration

A sprint retrospective is a three-hour meeting (for a one-month sprint), (Schwaber & Sutherland, 2017) that examines the interpersonal relationships and composition of the development team, tools, techniques, and processes used in a newly completed sprint. The sprint retrospective provides a better working environment, facilitation of the development process, commitment to quality, and new knowledge that will be useful in the next sprint. Given that in the companies of most of our respondents the sprint lasts for 2 weeks, accordingly, it should be expected that the sprint retrospective of the majority of the respondents does not last longer than 1.5 hours. Most respondents have a sprint retrospective that lasts 30-60 min. ie 61-90 min., that is 50% and 20% of them, which was expected. A small number of respondents have meetings lasting less than 30 min. and between 90 and 120 min., 10% each. Also, 10% of respondents do not have a sprint retrospective at all. These results, expressed as percentages, are shown in the following chart.

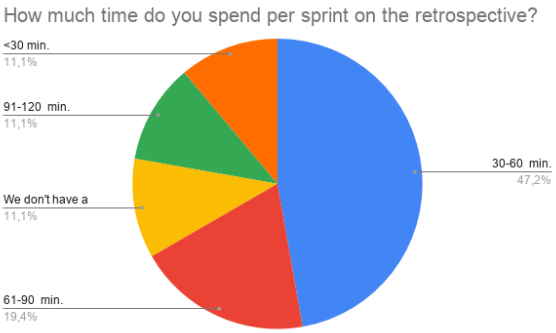

Figure 17: Sprint retrospective duration

6.5. Accuracy of the questions

Respondents were able to answer the following questions/statements with:

- True
- Mostly true
- Sometimes true
- False
- Not sure

It can be concluded that the majority of respondents:

- Scrum team consists of Product Owner, Scrum Master, and Development team
- Each Sprint results in a potentially releasable product increment
- The Daily Scrum meeting occurs every day, at the same time
- Product owner allows the team to freely decide on the number of Product Backlog Items to do in a Sprint

As it should be.

The structure of the daily scrum meetings is set by the development team and can be guided in a variety of ways, as long as it focuses on progress toward the Sprint objectives. Some development teams will use questions, some will use discussion.

When questions are used, 3 key questions are usually asked: (Schwaber & Sutherland, 2017)

- What was done yesterday?
- What will be done today?
- Is there any obstacle that prevents you from reaching the Sprint objective?

Approximately half of the respondents do not use such an organization of the scrum meetings, ie the meeting is not reduced to only 3 questions. These results are shown in the following chart.

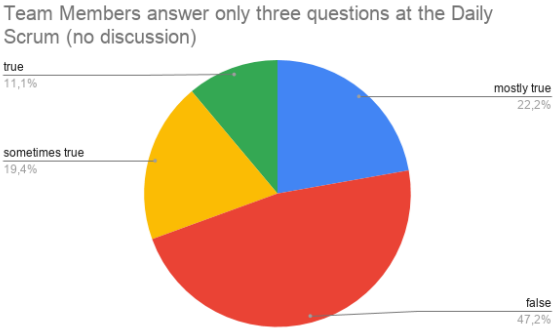

Figure 18: Daily Scrum meetings questions

7. CONCLUSION

Continuous growth in the use of Scrum can be noticed even outside of the IT sector. *It became clear that the Waterfall method and top-down management have reached the end of their use. Changes are happening fast, with new demands from both the employees and the consumers. The real strength of companies that*

use Scrum and agile methodologies is the ability to see business results that directly improve their financial position and also improve the work culture, customer satisfaction, customer loyalty, product delivery, etc. (Scrum Alliance, 2018) Almost 70.6% of employees in IT companies in Serbia believe that they will continue to use Scrum and 23.5% consider it a very probable possibility in the future.

Employees consider the project visibility and delivery speed/time to market, followed by the ability to manage changing priorities and increased team productivity to be the biggest advantages of Scrum. Scrum is not difficult to implement. Discipline, commitment, ability, and skills are what is needed to achieve real value. However, the biggest challenges lie in the lack of skills/experience with agile methods, inadequate management support, and sponsorship and organizational culture at odds with agile values.

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SMART ENVIRONMENT FOR MARKETING AND COMMUNICATIONS

CONTENT

PUBLIC RELATIONS FOR SCIENCE PROMOTION: PERSPECTIVES FROM SCHOLARS

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Abstract: The purpose of this research was to explore the theoretical and practical knowledge and attitudes of scientists regarding public relations in science, perception of scientists' role in current public relations efforts at the home institution, connected with the knowledge about public relations, and the EU project experience. A web-based survey of scholars working at Croatian public universities showed that scientists have a positive attitude towards public relations of science, but they do not think that only public relations professionals should be involved in public relations of the university. Scientists believe that communication with the general public is an advantage in promoting scientific work, where those who have previous knowledge about public relations are willing to use the communication channels to promote science. The need for professional support from the home institution, as well as for further training/education in the field of communication and public relations is welcomed.

Keywords: *public relations, science communication, scientific communication, scientific promotion, universities*

1. INTRODUCTION

Public relations of one institution are usually relying on one person or agency but should be supported by all employees of the institution (Tkalac Verčić, 2015). Universities, as a scientific and higher education institution, have put a rising PR efforts in recent years (Vogles & Schäfer, 2020). As Roberson (2020) states, the broad motivations for science communication is to enhance public understanding, make science accessible, secure ongoing political support and democratically account for use of public funds and enable public participation in the processes of science and technology. On the other hand, the increasingly competitive environment for universities has made the public relations and public visibility in the media essential (Vogler, 2018). Autzen and Weitkamp, (2020) argues that the rise of institutional public relations in science communication serve the interests of the scientific community.

Hence, the main research question of this paper is about the knowledge and education of scientists about public relations and communication. One of the important distinctions should be made between 'scientific communication' or 'communication about the science', where the first is mostly related to academic publishing, and the latter is about the popularization of science. Although different types of communication are known, the focus of this paper will be communication about science with non-scientific stakeholders. With respect to previous scientific efforts in this field, Besley, Dudo and Yuan (2017) identified eight different communication goals from the perspective of scientists: 1) ensure that people are informed about scientific issues; 2) getting people interested or excited about science; 3) demonstrating the scientific community's expertise; 4) hearing what others think about scientific issues; 5) demonstrating that the scientific community cares about society's well-being; 6) demonstrating the scientific community's openness and transparency, 7) demonstrating that scientists shared community values; and 8) framing research implications so members of the public think about a topic in a way that resonates with their values. Perkmann et al. (2012) underlined the importance of university-industry knowledge transfer, helped by proper science promotion. Another issue that arises is the language, which needs to be adjusted for the general public, and therefore needs to be different for academic purposes. Lederbogen and Trebbe (2003) realized that the Germany universities' websites used inappropriate language for the general public. On the other hand, Lo et al. (2018) finds out that the Taiwanese universities lack of professionalism in the communication of science.

This paper examines the implication of scholars of science promotion, their intention, and knowledge of PR, and willingness to promote their scientific achievements.

2. COMMUNICATION AND SCIENCE

Cutlip, Center, and Broom (2003) noted the 'seven Cs' in communication: 1) credibility; 2) context; 3) content; 4) clarity; 5) continuity and consistency; 6) channels, and 7) capacity of the audience. Those 'seven Cs' are important guidelines for any communication, and are timeless. Most of the problems arise from the scientists' perspective, that knowledge and research are not for the general public, except social science and humanities (Peters, 2013). Pavić and Šundalić (2017) stressed out the importance of a scientists' role in the communication of science to society in general. Furthermore, Bentley and Kyvik (2011) revealed the fact that scientists with more popular communication have also better scientific results.

One of the previous research (Marušić, Mišak, & Marušić, 2002) reveals a lack of communication skills of a scientist, as the main concern in the communication of science. Schäfer et al. (2018) find out that scientific topics are usually presented on commercial television or radio. Communication with the general public is highly dependent on the existence of a person or position which is in charge for that purpose, within an organization. With the aim to develop and establish a positive image of an organization, it is far more important to have communication as a priority, along with a dedicated person and the budget (Feldy, 2015).

Since scientists have many teaching and academic duties, it is far more important to reveal if they have enough time and knowledge to be dedicated to the communication of science to the general public and society. Also, it is interesting to realize what is the motive for scientists to be involved in general communication? Batitude (2011) found out that these motives are more social than institutional. Although there are debates about what is the most important in science communication, Hunter (2016) stressed out a few important facts: the message is more important than media, media and journalists should perform its double role of informing the public and acting as a watchdog, choosing the right level and tone is important, targeting audience and overcoming public lack of knowledge.

3. METHODOLOGY

Data was collected by a survey, using a questionnaire, distributed by e-mail and 212 scholars participated, from all seven Croatian public universities. Demographic characteristics of respondents were 140 female (66%), and 72 (34%) male respondents, 16% were younger than 31, 39.5% were between 31 and 40, 25.5% between 41 and 50, and 19.3% were older than 51 years. The respondents were scientists ranging from research assistants to full-time professors, employed by Croatian public universities. The survey was conducted over three weeks between February 2 and 24, 2018. The aims of the research were to examine the attitude of Croatian scientists towards public communications, the effects of promoting the scientific work, the need for professional support, and further training in this field, as well as to analyze public relations activities undertaken by the scientists. The descriptive of all items is presented, the normality of distribution was tested by Kolmogorov-Smirnov test, while the correlation by Spearman's rho. Finally, the Wilcoxon signed-rank test was used for hypothesis testing.

4. RESEARCH RESULTS

As it is shown in Table 1, university staff understand the need for communication of science, even though some of them would appreciate it if communication relied on a public relations office.

Table 1: Scientist attitude regarding science communication

Items	Mean	SD
The public needs to be informed about advances in science	4.60	0.738
The public should be informed about the achieved scientific results	4.50	0.812
The public should be informed of scientific knowledge	4.55	0.749
Scientific staff should be involved in the public relations of the university	4.06	0.914
Scientific staff should communicate directly with the public	3.65	0.969
University public relations should be left exclusively to public relations experts	3.12	1.185
The public should be involved in two-way communication with scientists	3.78	0.919

Regarding the positive effects of communication of science, questioned with a Likert scale from 1 to 5, most of the respondents agree or strongly agree with statements regarding the public visibility of scientist (88.3%), public image of institution (84.5%), university-industry cooperation (83%), understanding of science within public (82.6%), public knowledge about the science (80.6%), public engagement with science (71.7%), attracting of funding (62.8%), and positive impact of personal career development (59.9%).

Since it is obvious that scientists are aware of the need for communication, the main question arises: ‘’why they fail to put more effort into the communication of science?’’. In the first step, we explore previous education (Table 2), where we can see that the majority of the current academic staff do not have a relevant educational background in a related topic. According to the survey results, scholars lack in the educational background for related topics, especially in Public relations and Marketing.

Table 2: Educational background

Inclusion of related topic in education	Very poor	Poor	Fair	Good	Very good
Marketing	43.4%	19.3%	9.4%	12.3%	15.5%
Public relations	48.6%	21.3%	13.2%	10.7%	6.2%
Communication	33.0%	15.6%	17.9%	21.7%	11.8%

Familiarity and usage of Social Media (Table 3) showed that the respondents are familiar with popular social media, but figures measuring usage showed that some very important media for professionals are not so popular for usage. Twitter and Blogs are the most popular media for scientists, but not used enough. Besides the most popular Social media, other media were neglected.

Table 3: Familiarity and usage of relevant Social Media

Inclusion of related topic in education	Familiarity	Usage
Facebook	63.7%	48.1%
Twitter	27.4%	11.7%
Blog	41.0%	10.4%
ResearchGate	75.4%	56.6%
LinkedIn	58.5%	33.5%

Being asked to additionally provide other media, Academia.edu was mentioned 7 times by respondents, Google Scholar 4 times, Instagram 3 times, and YouTube 2 times.

As the most often used media tool for communication with public, 27.1% of respondents used interviews, media statements 24.6%, appearances on TV or radio 23.6%, media reports 22.7%, press releases 19.4% and press conferences 13.2%, what is in line with the familiarity of respondents with mentioned tools (Table 4).

Table 4: Familiarity with Public Relations tools

Tools	Very poor	Poor	Fair	Good	Very good
Press releases	16.0%	25.0%	24.1%	25.9%	9.0%
Media reports	14.2%	24.1%	26.4%	26.3%	9.0%
Press conferences	18.4%	25.9%	25.0%	22.2%	8.5%
Interviews	12.1%	14.6%	22.1%	38.6%	12.6%
Media statements	13.1%	16.6%	25.6%	35.7%	9.0%
Appearances on TV and radio	15.6%	16.1%	28.6%	28.6%	11.1%

Furthermore, one of the goals was to explore the relation between respondents' engagement in the EU project and their acquaintance with the official guidelines for communication. In total 60.4% of respondents participate in EU projects, while 26.8% are familiar with communication guidelines, and 39.2% of them participated in communication activities for the general public in the last three years.

The most popular way of popularization of science within respondents in the last five years are: public lectures 84.9%, public presentations 81.2%, 44.8% Festival of science, 68.4% participated in faculty events, and 58.5% participated in activities for children or youths. Horizon 2020 – Researchers’ Night was a form of popularization of science for only 21.2% of respondents.

As it is shown in Table 5, respondents see the biggest obstacle in the language of the communication science to the average public, which may be directly connected with the lack of respondents' education in related topics (Table 5).

Table 5: Obstacles in communication with general public

Items	Mean	SD
The public does not have enough prior knowledge to understand the message a scientist is sending to the public	3.25	1.100
The message addressed to the public is difficult to convey in a language understandable to the average recipient of the message	2.77	1.108
The public is not sufficiently interested in the content being transmitted	3.29	1.079
The message is misinterpreted by the media	3.52	0.995
Through the media, the meaning of the message is lost	3.27	0.974
Public relations is not sufficiently recognized as a criterion for advancing in science	3.50	1.116

Furthermore, one of the most important feedback was respondents' answers about the support from the home institution regarding the communication (Table 6).

Table 6: Resources provided by home institution

Items	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Home institution provide directions for communication with public	27.4%	27.8%	31.1%	12.3%	1.4%
Offered additional resources for education in the field of communication	29.2%	26.4%	29.7%	12.3%	2.4%

Respondents agree or strongly agree that some institutional activities will be helpful for the improvement of science communication, where 69.9% referred to in-house education, 65.1% to written guidelines, 58.9% to online content, and 64.1% to personal counseling.

4.1. Hypotheses testing

After the descriptive overview, five hypotheses were tested:
H1) Scientist have a positive attitude about the communication of the science,
H2) Scientists believe that communication with the public has positive effects in the promotion of scientific work,
H3) There is a link between scientists' knowledge about the communication and public relations and the activities undertaken in the field of public relations,
H4) Scientists/researchers need professional support of the home institution in communication with the public,
H5) Scientists/researchers would accept all three types of support from their home institution,
H6) Scientists/researchers need additional training/education in the field of communications and public relations.

Using the Wilcoxon Signed Rank series of tests the first two hypotheses were tested. The for Wilcoxon Signed Rank series of tests one sample determined the corresponding significance (p) approximately equal to 0, which is further interpreted as statistically significant at the level of 1% and thus indicates that the median in the population of scientists is significantly different from 3.

Table 7: Hypothesis 1 tested with one-sample Wilcoxon Signed Rank Test

Statement	Z	*p*
The public needs to be informed on the progress in science	12.555	<0.001
The public needs to be informed on the achieved results in science	12.206	<0.001
The public needs to be informed about scientific knowledge	12.287	<0.001
Science staff need to participate in the public relations of the university	10.467	<0.001
Science staff need to communicate directly to the public	7.888	<0.001
Public relations of the university need to be handled only by the experts for public relations	1.674	**0.094**
The public needs to be involved in two-way communication with scientists	9.085	<0.001

According to the results presented in Table 7, tested with the Wilcoxon Signed Rank test Hypothesis 1, "Scientist have a positive attitude about the communication of the science" was accepted. There is an obvious statistically significant difference with all statements at the level of significance of 1%, except for the statement "Public relations of the university need to be handled only by the experts for public relations", which resulted in p=0.094. Considering the form in which this statement is given, and the distribution of the responses given by participants, it is possible to observe that scholars would not let the public relations to

the professionals from this field. They did not suppose that only professionals should participate in public relations. Finally, these results related to this statement did not compromise observed positive attitudes towards communication to the public.

Table 8: Hypothesis 2 tested with one-sample Wilcoxon Signed Rank Test

Scientists' communication to the public has positive impact on:	**Z**	***p***
the reputation of their institution	11.368	<0.001
the visibility of their work	11.435	<0.001
the visibility of their work within academic community	10.763	<0.001
relations of their science institution with the industry	11.308	<0.001
relations with other science institutions, domestic and international	10.475	<0.001
the external funding of their institutions	8.641	<0.001
the recruitment/attracting the young scientists to their institutions	10.236	<0.001
the general knowledge of science in the public	10.175	<0.001
the general understanding of science in the public	10.462	<0.001
the public engagement with science	9.503	<0.001
Scientist scientific career	7.620	<0.001

The attitudes of respondents detailed descriptive analysis rated very positively. The second hypothesis "Scientists believe that communication with the public has positive effects in the promotion of scientific work," was accepted. The alternative hypothesis that indicates a positive attitude of scientists was accepted from the perspective of several statements which show different aspects of positive attitudes of scholars about public relations (Table 8). The Wilcoxon Signed Rank series of tests for one sample determined the corresponding significance (p) approximately equal to 0, which is further interpreted as statistically significant at the level of 1% and thus indicates that the median in the population of scientists is significantly different from 3. The attitudes of respondents detailed descriptive analysis rated very positively. The second hypothesis accepted.

The third hypothesis aimed to explore a link between scientists' knowledge about communication and public relations and the activities undertaken in the field of public relations.

Table 9: Correlation between knowledge and usage (activities) of communication channels and tools

	Knowledge of online channels	Usage of online channels	Knowledge of communication tools	Usage of communication tools	Activity of direct communication	Communication through mass media	Acquaintance with regulations/guidelines for communication in project implementation	Implementation of the activities for the communication of projects
Knowledge of online channels	1	0.710**	0.276**	0.139	0.327**	0.181**	0.282**	0.272**
Usage of online channels		1	0.280**	0.319**	0.361**	0.274**	0.337**	0.363**
Knowledge of communication tools			1	0.676**	0.249**	0.480**	0.403**	0.397**
Usage of communication tools				1	0.340**	0.585**	0.415**	0.494**
Activity of direct communication					1	0.280**	0.328**	0.412**
Communication through mass media						1	0.362**	0.459**
Acquaintance with regulations/guidelines for communication in project implementation							1	0.641**
Implementation of the activities for the communication of projects								1

** correlation is significant at the 0.01 level

The value of the r_s = 0.71 confirms that there is a strong, positive correlation between a good personal knowledge of online communication channels and the frequency of use at statistically significant at the 1% level. The correlation of knowledge about communication tools and usage showed a significant correlation (r_s = 0.67 and p <0.001), so respondents with the attitude of how well they know certain tools, more often and use these communication tools. In further consideration of the individual connection between knowledge

and activities, familiarity with the rules/guidelines for communicating the results and activities of EU projects to the public was linked to the implemented communication activities with the public. A positive correlation was observed (r_s = 0.64 and p <0.01) and it was noticed that the respondents who declared themselves familiar with the rules and guidelines on the communication of EU projects, more often and carried out activities and communication with the public. Furthermore, the correlation between knowledge and performed actions in public relations is r_s = 0.676 and p <0.01. In line with all that third hypothesis was confirmed.

The next hypothesis addresses scientists/researchers' need for professional support of the home institution in communication with the public. Research results of the Wilcoxon Signed Rank test showed Z=7.510 and p <0,001, p-value indicates that the median is statistically significantly different from the value of 3, and further analysis revealed an average value of 3.66, mode is 4 and median is 4. According to that, the null hypothesis is rejected and we can conclude that there is a need for a greater support to the scientists in their communication to the public, provided by their home institution.

Continued analyses searched for the type of the support that the scientists would like to receive from their home institution. For all three types of support, null hypothesis was rejected and the respondents agreed that it would be easier for them to communicate to the public if their home institution would support them with written guidelines for successful communication to the public, directing to the online contents about the communication to the public and personalized counselling with the professionals for public relations (Table 10).

Table 10: Analysis of the scientists' attitude towards types of support by their home institution in communication to the public by Wilcoxon Signed Rank test

Statement	Z	p
Written guidelines for successful communication to the public	7.957	<0.001
Directing to the online contents about the communication to the public	6.196	<0.001
Personalized counselling with the professionals for public relations	6.797	<0.001

In order to test the sixth hypothesis which says that there is a need for additional training/education in the field of communications and public relations, Wilcoxon Signed Rank one sample test was applied as shown in the Table 11.

Table 11: Analysis of the scientists' attitude towards training and education on the public relations by Wilcoxon Signed Rank test

Statement	Z	p
Organized training for successful communication to the public	8.386	<0.001
Formal education for all future scientists should include learning contents from public relations	6.349	<0.001

The above tests demonstrated that there is a statistically significant difference from the neutral attitudes towards given statements and consequently, the sixth hypothesis about the need to provide additional training/education for scientists in PR and communication was accepted.

5. CONCLUSION

From the practical perspective, this research aimed to explore one of the important topics for the universities, awareness, and attitudes of scientists regarding public relations as a field. Furthermore, there are lots of practical reasons for the introduction of public relations at Croatian universities, most of the project funding requires the dissemination of project outputs. Also, the visibility of research and university and faculty activities makes those universities and faculties a more desirable partner for future cooperation and studying. So, more or fewer universities need to behave like regular businesses at a competitive market, using public relations as a tool for reputation building. Along with that, university professors need to have knowledge about public relations tools and benefits.

Furthermore, the attitudes and activities of Croatian scientists in public relations and public outreach were not sufficiently covered in the presently available literature. Therefore, these findings open the unexplored field of science communication and public engagement for further research. Additionally, public relations and communication practitioners/specialists and experts are invited to conceive and promote training and coaching, addressing scientists' communication skills and practice.

6. RESEARCH LIMITATIONS

One of the limitations identified in this research is that it targeted the respondents-scientists, only at Croatian public universities. Scientists employed at other types of research organizations were not included in this survey. Also, a comparison between public and private universities can be developed, as well as a comparison of different universities' sector with a larger sample can be studied.

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APPLICATION OF NEUROMARKETING IN PRODUCT CREATION PROCESS

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Abstract: *Neuromarketing is a relatively new scientific discipline, created by combining neuroscience and marketing. Utilizing the benefits of modern technology, neuromarketing and its instruments delve deep into the human brain, trying to discover how it responds to marketing stimuli from the environment. This paper analyzes different aspects of the application of neuromarketing in the process of product creation and development. A study of representative examples from practice was conducted using the case study method. On that occasion, three companies that successfully upgraded their products through neuromarketing testing were analyzed. The results of the research showed that the potential for neuromarketing to be applied in the product creation process is limited in the initial stages of the development process, while its contribution is far greater and more useful in the final testing of products intended for possible pre-market corrections.*

Keywords: *neuromarketing, product development, marketing research*

1. NEUROMARKETING

Neuromarketing is a branch of neuroeconomics. It is an interdisciplinary scientific field that combines economics, neuroscience and psychology in order to study how the human brain functions when making decisions in different situations (Kenning & Plassmann, 2005). The term neuromarketing was introduced by professor Ale Smitds as a reference for the application of neuro techniques in marketing research (Roebuck, 2011).The essence of neuromarketing lies in gathering meaningful information about how the human brain responds to marketing stimuli (Murphy et al., 2008) all with the aim of precisely detecting unconscious human reactions. It is a part of marketing aimed at discovering the influence of marketing instruments on consumer reactions and behavior when making purchasing decisions (Zurawicki, 2010).

Relying on a numerous sophisticated techniques and methods for monitoring biological and brain waves and signals that occur inside individuals, this scientific discipline allows deeper induction into human behavior, thus creating a basis for defining marketing strategies that will have minimal risk of failure. The above suggests that neuromarketing studies consumer sensory, cognitive and emotional responses to marketing stimuli (Bahtia, 2017). The results obtained through the use of neuromarketing research are applied till now in the process of product creation, in the creation and implementation of promotional and advertising activities, in defining prices, arranging outlets and in improving the general consumers shopping experience (Thomas et al., 2017).

There are three key cognitive processes that marketers pay the most of the attention to, in their efforts to understand how the consumers' brain functions: 1) Attention, is a product or advertisement noticed? 2) Emotions - did they like it? 3) Memory - will individuals remember the product or advertisement (Pradeep, 2010)? Each of those processes has its conscious and unconscious elements. Marketers have been trying to understand these processes for a long time, that is, to determine the impact of different stimuli on the consumer, but only with the use of advanced technology more precise answers can be given. So far, there are several key areas in which neuromarketing has been introduced (Horská & Berčík, 2017):

- Brand - understanding how a brand is perceived by consumers;
- Product - creation and development of the product, its design and packaging;
- Advertising - how a particular advertisement is more successful than others and what its effects are in relation to consumers;
- Shopping - visual and sensory stimuli that affect an individual as he or she moves through the store and how he or she makes purchasing decisions;
- Online environment - a way to attract and persuade users and activate them;
- Entertainment - understanding how individuals perceive television, movies, video games, and what reactions arise as a result of their influence.

2. METHODS AND TECHNIQUES OF NEUROMARKETING

Neuromarketing applies modern technology in the analysis and monitoring of brain waves and biometric responses to environmental stimuli (Pradeep, 2010). According to Genenco et al. (2013) neuromarketing research techniques and instruments can be grouped into two categories. These are biometric methods, which are used to measure the reactions of the human body, and methods which are used for brain measurements, the ones that referee to brain waves and reactions resulting from the influence of marketing stimuli. Each of these categories records and monitors different types of signals and can be attributed to certain advantages and disadvantages, depending on the used measurement technique (Genco et al., 2013).

Some of the most important biometric reactions that are the subject of neuromarketing research are facial expressions, facial muscle movements, eye movements, electrodermal activity, and heart rate, blood pressure and respiration (Genco et al., 2013). In addition, methods for measuring brain waves are blood flow measures, which measure brain activity at localized increases in blood flow necessary to deliver energy (oxygen and glucose) to activated neurons and electrical measures, which include electrical and magnetic signals produced when neurons are activated (Calvert & Thensen, 2004). Methods such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), magnetoencephalography (MEG) are used for these types of measurements. Combined appropriately, these methods allow scientists to dive deeper into the essence of consumer behavior that cannot be reached by relying solely on traditional methods of marketing research (Bahtia, 2017).

2.1. Functional magnetic resonance imaging (fMRI)

Functional magnetic resonance imaging (fMRI) represents a method for conducting neuromarketing research based on the identification of changes in blood flow and the accompanying oxygen level created in response to cognitive tasks (Reimann et al. 2011). The subject lies inside a large cylindrical machine - magnetic resonance imaging, with its head located inside a large magnetic ring. As the magnetic resonance imaging is very sensitive to movements, examined subjects are expected to rest in order to keep the brain image clear and sharp. When the test is initiated, the respondent completes the assigned tasks, using a box with buttons for giving answers (e.g. comparing product packages). During this process, the activated parts of the brain require more oxygen, causing increased blood flow to the brain, which is identified through the machine (Kenning, 2007).

fMRI has a great spatial dimension, but the temporal dimension is bad - it can be used to identify certain activity in smaller parts of the brain, but it can't provide enough information about the duration of that activity (Logothetis et al, 2001). Thus, there are several areas relevant for the application of functional magnetic resonance imaging (Levy et al., 2011):

- New products testing,
- New marketing campaigns testing,
- Testing and development of commercials or videos,
- Identifying key moments of a particular advertisement or video,
- Packaging testing,
- Price testing,
- Brand repositioning,
- Identifying needs.

2.2. Electroencephalography (EEG)

Unlike functional magnetic resonance imaging, electroencephalography (EEG) uses equipment that is lightweight and portable. It is a technology that uses small but highly sensitive microsensors to measure waves in the upper cerebral cortex (Palokangas, 2010). The electrodes are placed on the subject's head often by a helmet or strap. Some of the new EEG helmets can measure up to 10,000 times per second. This is important given the speed at which a person receives and processes information on a daily basis through his senses and the speed at which he thinks. Brain waves can thus be recorded in a very short period of time (Perrachione & Perrachione, 2008).

Accordingly, authors Horska & Berčik (2017) point out that it is possible to identify the some advantages of the EEG method: 1) it isn't financially, spatially and time demanding method; 2) it draws on the support of scientific literature; 3) provides real-time results; 4) there is mobile version available. In addition, electroencephalography has application in the following fields (Vechiatto et al., 2011):

- Advertising testing and development,
- Testing new marketing campaigns,
- Testing movie trailers,

- Identifying key moments in commercials or videos,
- Website testing,
- Testing the shopping experience.

One of the disadvantages of the EEG method is the lack of adequate spatial resolution, which means that it is not possible to accurately locate where neurons shoot, especially in the deeper parts of the brain. The reason for this is the fact that helmet electrodes cannot identify electrical signals that are positioned well beyond the cortex (Logothetis et al., 2001). The disadvantages that can be cited are the following (Horská & Berčík, 2017): 1) there is no way to measure activity in the deeper parts of the brain, 2) the need for specialized staff to interpret the results, 3) the difference in the "electrical conductivity" of the respondents, and 3) the unrealistic assumption that brain impulses arise only on the basis of a particular stimulus.

2.3. Eye tracking method

As a concept that involves measuring the physiological responses of the body to external stimuli observed by the senses, biometrics is commonly used methods for neuromarketing research. Specifically, the most used biometrics are the ones that measure cardiac and respiratory activity, eye movements, electrodermal activities, facial expressions and body movements (Pradeep, 2010).

Measuring eye movements and pupil dilation when observing objects, scenes and movements is followed by two types of devices, both used as a part of eye tracking method, namely fixed and mobile (Kalliny, 2010). Fixed devices are attached to the screen on which the research material is projected. When using these devices, subjects are expected to sit in front of the monitor and use certain content on the computer. Mobile devices are glasses that are put on the head of the test subject. When using this group of devices, the respondent moves through the shop, wearing special glasses on his head. Both, fixed and mobile devices record eye movements and changes in the pupil. This information is combined with blinking frequency (Zurawicki, 2010). All of these data make it possible to determine the visual path of the subject's eyes, or in other words, the visual stimuli to which the subject is paying more attention, to which he does not pay at all, and in what order (O'Connel et al., 2011).

Many companies combine the eye tracking method with the electroencephalography in order to implement neuromarketing research. By using sophisticated eye tracking equipment, it is possible to determine where the subject is looking while being exposed to and experiencing the same stimulus. In this way, it is far more precise to determine how the brain of the subject responds to marketing incentives from the environment, saving time and simplifying the research procedure that the subject goes through (Zurawicki, 2010).

3. PRODUCT DEVELOPMENT

According to Kotler, a product can be defined as any good that can be offered to the market in order to satisfy the wishes and needs of consumers (Kotler et al., 2013). It is the materialized result of human labor that can take the form of not only physical good, but also services, ideas, information, or more precisely, the product is a combination of all of the above.

The product is one of the marketing mix instruments that the company relies on in its effort to adapt to the changing market demands. Taking into account the dynamic of market conditions, the challenge is to create a product that will fully meet the wishes of consumers when it comes to its characteristics, and that's why the company is expected to continuously monitor trends and show innovation in the product creation and development process. (Khushaba et al., 2013).

The basis of each product are its physical, functional and symbolic characteristics (Keller, 2013). While physical features refer to the form of existence of the product itself and include size, weight, appearance, construction and more, functional features indicate the ability of a product to meet certain consumer needs. Symbolic properties are important to conquer the market and, as such, include design, packaging, fashion line and other product elements. These properties represent the interpretive aspects of the individual physical attributes of the product.

3.1. Product characteristics

Product functionality is a set of operations and transformations that contribute to its overall performance. More specifically, functional features of a product include specifics in the purpose, construction, method of making a single product, i.e. the specifics that differentiate that product from its competitors. Most often, these features are schematically described and presented so that they can be implemented as accurately as possible in technological and physical terms during product creation and finalization (Ulrich & Eppinger, 2016). Functionality, as a feature of a product reflects the ability of a product to meet consumer needs. The

higher the functionality of the product, the greater is the customer satisfaction with its use, and as a result of that the better the market position is (Keller, 2013).

According to Kotler et al, design is one of the basic elements of a product, which represents the harmony of colors, lines, shapes, appearance of the product, which should be composed to attract the attention of customers (Kotler et al., 2013). In order for a design to contribute to its marketing goals, it needs to fulfill five basic functions: 1) design for competitive differentiation, 2) design as a function of production, 3) design as a function of consumer needs, 4) aesthetic design, and 5) design as a function of distribution (Lidwell et al., 2003).

Packaging is an element of the product crucial for consumer acceptance and use of the product, and accordingly, the packaging should send a message of product attractiveness, differentiation and recognition (Ulrich & Eppinger, 2016). All packaging characteristics can be classified into two groups: 1) graphic elements, such as packaging color, text, graphics, images on the packaging and 2) structural elements, such as the shape, size of the package and the material from which it is made. The graphic elements of the packaging should attract attention, further emphasizing the aesthetic dimension of the packaging. The structural elements of the packaging send a compelling message about the product and aim to evoke certain emotions in the consumer, so their impact is often realized at a subconscious level, where it is manifested through numerous associations (Beckley et al., 2017).

From the consumer's point of view, packaging plays an important role in which product is selected, since it is the first thing the customer notices when making their purchasing decisions. Therefore, it is essential that all packaging elements, including text, colors, structure, images, shape, are mutually compatible and combined so as to make the packaging attractive to the customer (Ulrich & Eppinger, 2016). In addition, it is necessary to communicate the true values of the brand and product through the packaging, while at the same time achieving an adequate aesthetic and visual level.

3.2. Product development process

The product development process can be defined as a series of successive activities that one company undertakes to design, create and commercialize a product (Bruce & Cooper, 2011). Another way of defining this process is the one by which the product development process is initially aimed at creating a set of alternative production concepts, in order to gradually narrow down the offered variants by specifying the product characteristics, until the desired product of adequate characteristics is obtained as the one that will become a part of the regular production program (Armstrong et al., 2017).

There are different approaches to defining the stages and steps of the product development process. According to Armstrong et al. (2017), the following stages are: 1) collection and selection of ideas, 2) product concept development and testing, 3) business analysis, 4) product prototype development, 5) market testing, and 6) product commercialization.

The process of gathering and selecting ideas is the first stage of the development process and can be realized by relying on different techniques. After the ideas are collected, they are selected based on predefined criteria. The selective process eliminates all alternatives that are not aligned with the company's goals, market requirements and product requirements (Crawford & Di Bendetto, 2010). The following phase is developing a product concept and testing it. In order to develop an appropriate product concept, it is necessary to first identify and analyze consumer needs, then transform those needs into product specifications, then select from several alternative product concept variants, and finally conduct concept testing. Concept testing and evaluation is performed on a selected sample of the target audience.

After selecting the appropriate concept, a business analysis is performed. This analysis is aimed at forecasting the sales volume of a new product at different prices, as well as projecting costs and profits. What is important for this phase is the existence of an appropriate information base. After a decision is made about the economic viability of a new product, its prototype is being developed. It is a product model presented in one or more dimensions. If the prototype results in the desired direction, it enters the market testing phase.

Testing is performed in the selected parts of the market from which information is collected about consumer's reactions to a new product and its performance. If the product has passed the market test, then it enters the final phase - commercialization. At this stage, the company is facing a lot of investment and high risk.

3.3. Neuromarketing and product development process

Nowadays, a large percentage of products do not experience the market success, while long-term life expectancy cannot be guaranteed for those who survive (Pradeep, 2010). Developing prototypes designed to carry out various forms of testing costs a lot, so companies rely on neuromarketing to achieve significant savings (Georges et al., 2013). Namely, neuromarketing and its methods can be successfully applied in product design, packaging or brand development (Agarwal & Xavier, 2015). This way it is possible to measure consumer reactions to (Madan, 2010):

- Some elements of the product, such as taste, material, composition, color, sound, smell and others;
- Packaging elements, such as an image, logo, font, place where product related information is highlighted, and the content of that information;
- Ease of use, opening, handling, using the product.

All the above indicates that the practice of neuromarketing research can help companies to understand the answers to some of the questions which refer to the basis of the new product development process: How will consumers react to a new product? How will it react to product features? Will packaging produce the desired effects in key elements of consumer behavior such as attention, emotional engagement and memory? How will consumers perceive the connection between the new product and the brand? Which product features will be most valued by users (Pradeep, 2010)? Answering these questions reduces the risk of the product failure in the market, and therefore increases the return on investment and generates greater profit from the newly introduced product.

4. CASES OF NEUROMARKETING IN PRACTICE

4.1. Hyundai

One of the neuromarketing studies was conducted in 2011 by Hyundai Motor America. The study included 30 participants and the aim of the study was to test the sporty silver model, which was supposed to be launched on the market that year. The participants, 15 men and 15 women, were tasked with looking closely at certain parts of the car - tires, windshields and bumper for an hour. The brain reactions that took place in their minds during the course of the study were influenced by the various elements of the car's design.

For the study purposes the respondents wore helmets with electrodes that recorded electrical impulses that were manifested in their heads. It was necessary to find out what customers think of the car before its mass production.

By relying on electroencephalography, Hyundai has given guidance to its manufacturers in designing the new exterior of this car model. Changes were made as an adjustment to the results of the study, before the commercialization of the product on the market (Bhatia, 2017).

4.2. Frito-Lay

The study of the famous American brand Frito-Lay is an example of the successful use of the EEG method, resulted in eliminating the identified problem while achieving the optimum packaging appearance, followed by increased sales of this product. The study relied on neuromarketing through testing the packaging of one of its well-known products. By combining EEG methods with biometric analysis, 100 female subjects were tested to determine how bright and light packaging with the image of the chips influences them. The results showed that such packaging caused negative emotions to the tested subjects, because it affects the part of the brain that binds to create a sense of guilt. In this case, women identified the packaging with poor eating habits that made them feel guilty.

Opposite to the first packaging, the company has introduced a matte, beige packaging featuring images of potatoes and other ingredients that the public finds healthy. After testing, it was found that there were no adverse reactions from the subjects tested, as was the case with the first version of the package. Based on the results obtained, the company introduced changes in the design and appearance of the packaging in terms of color, text and images. Frito Lay opted for a matte packaging design with healthy ingredients as opposed to glitter (Kumar et al., 2015).

4.3. Campbell's soup

The well-known Campbell brand has conducted neuromarketing research to evaluate what the average consumer is looking for and expecting from the company's products. Over 2 years numerous tests have been conducted on over 1500 subjects using various techniques and methods such as heart rate monitoring, facial expressions, electro-thermal activities and other biometric methods (www.fastcompany.com).

What this study came up with is the opposite of what was expected - instead of people feeling warm when using or thinking about Campbell soups, biometric neuromarketing methods showed that positive feeling fades when a consumer faces a wall of nearly identical red and white cans in a supermarket. Campbell went on to test a number of different packaging design variants, monitoring how consumers respond to them.

Based on the results of the tests, the company decided to introduce new packaging to better connect with its customers. The key packaging characteristics that were changed on this occasion were the following: 1) different color packages for different soup lines, 2) smaller logo, 3) buckets were no longer displayed on the packaging as it has been determined that there is no desired reaction in the consumer, 4) images of soup have become more vivid and warmer (www.neurosciencemarketing.com).

5. CONCLUSION

By exploring activities in the human brain through a variety of methods and procedures, neuromarketing provides new insights into consumer preferences regarding product choices, branding, advertising responses, and purchasing decisions. With neuromarketing, product concepts can be quickly tested, and those that do not seem promising are eliminated from the development process. This allows more efficient allocation of resources in order to develop only promising products. In this way, neuromarketing contributes to increasing efficiency in management processes, time savings, costs and other resources, giving companies the opportunity to reinvest into product innovations and meet future market trends in a better way.

Neuromarketing analyses of brain activity have enabled a better understanding of human behavior and decision-making processes, which have created the basis for companies to offer products to be more in accordance with customer needs (Madan, 2010). Knowledge of customers, acquired through neuromarketing, can be used primarily in the later stages of the innovation process, where the focus is on innovative design. Neuromarketing can primarily contribute to product development, in situations where the product is made, but undergoes through some design or communication campaign considerations. In these later stages, prototype testing is performed, whereby the customer is provided with an item intended to represent the product that is being developed. Information about the customer's attention, thoughts, reactions, or emotions are studied while the customer is using that product prototype.

Considering the influence of neuromarketing on the product creation process, it can be said that, on the one hand, its effective application in this sphere is limited. According to Ariely and Berns, neuromarketing techniques are more appropriate in evaluating a product when it is used than in the product creation process. In this case, neuromarketing is considered to be unable to deliver the right results, but rather to apply alternative methods (Ariely & Berns, 2010). Authors Calvert and Brammer, on the other hand, point out that fMRI as a neuromarketing method can provide adequate information for these purposes (Calvert & Brammer, 2012). Considering both of these approaches, it can be said that neuromarketing has limited application in the initial stage of product creation process, while its implementation is far greater and more useful in the final testing of a product intended for possible corrections prior to its launch or commercialization.

However, what marketing professionals always need to keep in mind is that it can only be used as a complement to traditional marketing research methods, not as a complete replacement of them.

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MARKET POSITIONING OF THE AI CHATBOT WEAVER IN BANKING

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Abstract: *In this paper we present the business case of the modern artificial intelligence chatbot solution Weaver developed by Saga New Frontier Group, a leading IT company in the region. The Weaver chatbot is a unique chatbot solution that provides companies with cost savings and sales increases by providing chatbot-based services to their users. We present how Saga, a member of New Frontier Group, created REA (Raiffeisen Electronic Assistant) together with Raiffeisen Bank, using the Weaver platform, a service powered by artificial intelligence that banking users interact with via text and video chat interface. REA is available on Viber and Facebook Messenger and it represents digital innovation in the banking sector in Serbia. The paper explains the importance of the market positioning strategy of the Weaver AI chatbot solution in the banking industry.*

Keywords*: market positioning, Weaver, AI chatbot, REA (Raiffeisen Electronic Assistant), banking*

1. INTRODUCTION

Recently, there has been growing interest in artificial intelligence applications and modern technology solutions in marketing. Davenport, Guha, Grewal and Bressgott (2019) discuss the impact of artificial intelligence on marketing by focusing on how marketing strategies will change and how user behaviour will change, and by highlighting issues related to data privacy. Furthermore, Mogaji, Soetan and Kieu (2020) emphasize that artificial intelligence (AI) is changing business theory and practices, especially in digital marketing. According to Shankar (2018), AI "refers to programmes, algorithms, systems and machines that demonstrate intelligence". Accordingly, there are different approaches to AI, and in this paper, we take the approach of Mogaji et al. (2020).

AI helps companies to provide better user experience and customer satisfaction (Campbell, Sands, Ferraro, Tsao & Mavrommatis, 2020) as well as develop operational efficiencies and reduce the cost of operations (Singh & Singh, 2019). Banks in Serbia are adopting the latest emerging technologies such as big data, machine learning, artificial intelligence (AI) and Internet of things (IoT). Marketing and communication in the banking sector face major challenges arising from digital consumer interaction (Okuda & Shoda, 2018) and digital service consumer experiences (Hoyer, Kroschke, Schmitt, Kraume, & Shankar, 2020), supported by new technologies, artificial intelligence in particular. The AI chatbot has become a favourite and progressive practice among various stakeholders: scientists, researchers, and marketers (Conick, 2017; Gupta & Sharma, 2019).

Previous research in this field has focused on analysing chatbot theoretical frameworks. Chatbot is defined as an artificially conversational agent, intelligent enough to initiate and simulate human-like conversation. According to Heo & Lee (2018), "chatbot is a program that talks in voice or text. It is equipped with artificial intelligence (AI) technology and is developed in a way to combine with messenger, offering companies new opportunities for business communication". In the retail business, advanced features of AI are developed through the analysis of four types of data: numeric, text, voice and visual/image/video data. These data and available marketing content can make it easier for managers to take decisions (Shankar, 2018). In banking, a banking chatbot project is built using artificial intelligence algorithms that analyse the user's queries and understand the user's message. Chatbots are a popular interactive tool; they are available to answer questions and provide information to users 24/7. People, especially the younger generations, have been using finance apps for personal banking for years. The apps allow them to perform banking tasks on their mobile devices without personal interactions (Chandra, 2020), and by using such apps, people have been interacting with chatbots in a variety of situations.

It would seem, therefore, that further research is needed to better understand the success story of the Weaver AI chatbot solution as a digital banking service by focusing on a real example of the Raiffeisen Bank in Serbia. The aim of this paper is to present the market positioning strategy for the Weaver AI chatbot solution. In the banking sector, the chatbot Weaver has the potential providing information about their balance and special bank offers. Users can get the benefit of chatbot conversation and no need of waiting in long queues to deposit money. Banks could use chatbots in their marketing efforts to improve their customer retention rate, increase brand loyalty and personalize the user experience.

2. WEAVER CHATBOT ACROSS INDUSTRY

A powerful AI chatbot solution can be beneficial to many different industries, from helping users to find products on an ecommerce site, to giving bank customers options of new bank loan. A recent study by Gartner report (2018) shows that by the year 2020, 85% of user interaction in retail will be managed by AI. Having in mind the types of industries where chatbots can be implemented, a study by Grand View Research (2019) identified that the market can be divided as follows: BFSI (Banking, Financial services and Insurance), media and entertainment, healthcare, e-commerce, retail, travel and tourism, and other industries.

Here are processes that Weaver AI platform takes care of with ease, across variety of industries:

- Providing information about previous transactions, account balance, nearest bank branches and the best offers regarding bank's services (banking industry)
- Handling payments and paperwork, tracking orders, providing information about procurements and overall supply chain costs (supply chain)
- Finding nearest hospitals and medical centres, providing an insight of available services, their prices and available doctors who will properly take care of patients (healthcare)
- Providing online assistance to customers during their search and perfect items or pushing targeted promotion offers according to the customer preferences (retailer)
- Answering repetitive questions about available rooms, prices, check-in and check-out times, attractions near the accommodation and FAQ's (hospitality)
- Connecting several departments in order to respond to given inquires, it cuts down the waiting time and resolves customer's issues with ease (telco)
- Guiding customers thought the website while discovering their preferences, simultaneously collecting data points for targeted offers (automotive)

It is also possible to extend additional features for Weaver AI solution responding to the special requirement of business clients.

3. ABOUT THE WEAVER AI-BASED ENTERPRISE CHATBOT PLATFORM

Weaver is a notification platform developed by Saga's engineers in the division for software solution development. AI based enterprise platform, with the ability of chatting forms of communication, while exchanging rich content and talking to the end-users. Saga's advanced communication engine supported by NLP/NLU (natural language processing) usage completely simulates human-to-human communication — the chatbot run by Weaver platform is able to support interactive communication with leaps through different stories, or jumps from step to step depending on the natural conversational flow. The communication automation and enrichment are the main purposes, simultaneously spreading the current customer pool and making existing customers more satisfied. The chatbot module has services exposed across multiple channels with the same user experience (UX).

To position the Weaver AI platform on the market, a brochure was designed to present the benefits to clients using the Weaver platform. The Weaver brochure consists of three parts. In the first part, the title, Boost your Business with Artificial Intelligence, connects the Problem section with the Solution section which explains in detail why a business client should use the AI chatbot solution, see Figure 1.

The second part provides a brief description of the AI solution and the potential industries in which Weaver could be implemented. The third part of the brochure, at the bottom of the page, presents the basic and advanced benefits of Weaver. There is also a "Find Out More" section in this part of the brochure, the main objective of which is to further engage users with the AI chatbot solution by integrating all marketing communication digital tools: YouTube presentation, Web presentation and successful story references.

Figure 1: AI chatbot Weaver platform brochure

There are six features that provide important relevant insights into market positioning with regard to the competitive advantage of the Weaver chatbot (Weaverbot.ai, 2019):

- *Intelligent talk*: The use of artificially intelligent systems is on the rise, but the concern about the genuine simulation of human conversation still exists. The Weaver chatbot module solves this issue by understanding the flow of the human mind, giving it the ability to keep up when the user spontaneously changes their mind, and seamlessly and intelligently continue the conversation.
- *Omnichannel experience*: In an era of total information accessibility, users tend to prefer the channels they use in their everyday lives. Most companies think they can't possibly be present on every channel out there without major expenses. Weaver chatbot solves this by being present and collecting data across all of them, and storing it in one place. This allows for information availability at the clients' fingertips.
- *Deep integration*: Complex software solutions often come with several components that must be compatible and up to date, which is not always the case, leading to issues during runtime, and dissatisfied clients. Weaver offers the opposite: a single solution easily integrated in all core systems of any company's software, full coverage of processes deliverable to the end users, all in one place.
- *Multi-intent*: Customer service agents can often be overbooked by numerous inquiries and cannot manage to immediately answer to all of them. The Weaver chatbot is capable of handling numerous pieces of different types of information all at once. Be it meaning or context, Weaver can easily comprehend end users' statements that have more than one intention.
- *Multilingualism*: Weaver AI chatbot platform is fluent in most of the world's languages. Once the selected language scheme is fully implemented, Weaver understands the most common international languages (English, Chinese, German, etc.) equally as well as the less common ones (Serbian, Armenian, Greek, etc.), allowing for a friendlier and more personal user experience.
- *Voice ready*: Research has shown that 51% of people who shop using the auditory method use it to research products and services. This was a green light for an additional feature to extend the customer service experience - voice-activated assistance. This enables the Weaver chatbot to interact and communicate through voice, accept commands in oral or written form, and respond vocally.

The Weaver chatbot solution has a price range from USD 30,000 to USD 100,000+, depending on the number of cases expected from clients. The pricing model should include maintenance costs upon implementation. This type of chatbot significantly differs from out-of-the-box simplified chatbot solutions, both in business domain and in price range (USD 1,000 – 20,000).

3.1. Market positioning of the Weaver chatbot

Global chatbot market segmentation can be done based on size of business clients which are large enterprises, medium enterprises, and small enterprises. Several large enterprises have developed chatbots with a specific set of rules; however, they are expected to optimize their chatbots in future in a bid to achieve advanced and sophisticated operations. Even though the large enterprise segment still accounts for the largest proportion of chatbot implementation across industries, the medium enterprise segment is expected to grow at the highest CAGR of 24.8% by 2025.

To position the Weaver AI chatbot solution, it was important to present the solution at business conferences focused on chatbot and artificial intelligence. Accordingly, the Weaver team presented the solution at Chatbot Summit in Berlin in October 2018 and at Web Summit, the world's largest tech conference, in Lisbon in November 2018. An effective event-marketing strategy was developed. In addition to participating in such business events, it was also important to use the sales and marketing funnel strategy to reach and convert potential leads into closed deals.

3.2. Weaver chatbot event-marketing strategy

Saga management decided to organized the first global presentation of Weaver and Raiffeisen Electronic Assistant (REA) In October 2018 in Berlin, at Chatbot Summit. It is the world's leading international conferences connecting professionals and organizations who believe that artificial intelligence will play crucial roles in the next decades in digital user experiences. Saga and Raiffeisen Bank jointly presented the successful REA case study at the conference. At the Summit, visitors were able to experience Weaver on a whole different level during a panel held by Saga representatives that was sponsored by Weaver as a Gold sponsor. So far, the Summit has been held three times, in Berlin (Germany) and Tel Aviv (Israel). Event marketing strategy is important part of market positioning for Weaver solutions among the biggest international companies, top level decision markers, tech leaders and start-ups on the rise, which are joining together to build and share the best conversational A.I., chat, and voice experiences. The Chatbot Summit had more than 1500 visitors, 100 speakers and over 50 exhibitors. This event is the right place for networking, finding potential clients and presenting solutions (Chatbot Summit, 2018).

3.3. Customer acquisition marketing & sales funnel

In order to convert potential business clients, it is crucial to understand how to use the marketing and sales funnel for AI chatbot solutions (Power, 2017). B2B businesses are different comparing sales and marketing strategy to end users. Sales and marketing process consist of identifying ideal customer profile (target persona) and setting the tailored offer. The second step is lead generation process, identifying potential leads for chatbot offer, negotiation and close the sales deal with contract. The specific characteristic of chatbot solutions is that provider needs to organize special internal team from the company for business client, to be part of preparation stage, education, implementation and maintenance. Some of these stages are also potential revenue drivers for chatbot solution.

Using digital sales and marketing channels, the most difficult part is how to convert potential leads to real users. The model that a lot of companies use for this conversion is marketing and sales funnel, see Figure 2. The marketing and sales funnel of companies consists of a few major stages (Kotler, Rackhan & Krishnaswamy, 2006).

The first step of the Top of the funnel is creating awareness about chatbot service offer through reaching target groups to be aware of the Weaver AI chatbot solution. Before this stage potential clients are unfamiliar with the brand. After reaching large numbers of potential clients, some of them will have interest to know more about the desired chatbot offer. The main opportunity for the company is to engage with them.

At the Top of the Funnel, the company gathers information about visitor behaviour and actions on different channels by tracking clickstream data on the website, social media and blogs. Companies usually used cold emails and cold calling. In traditional marketing they also collect client's data at the point of sales touch point, showrooms, public lists and recommendations from satisfied clients. They could become leads – visitors that show specific interest for chatbot. Based on these data, companies could create a target persona and save it in their CRM system. Many businesses deploy chatbots within their websites or mobile applications, where they can initiate conversations with customers and help with raising awareness and developing an interest in the company's offering.

The Middle of the Funnel represents the stage for educating customers about the service digital portfolio. Companies tend to use digital communication tools such as: forums, webinars, FAQ pages, references (successful case studies from previous clients), blog post, gamification and other light-touch service, as for example, live chat. The most important part for this stage is creating relevant content and user interactions. Based on digital user engagement provides user unique digital experience and activation in the field where they are the best. Some research showed that users will buy 30-40% more if they are the part of some forum organize by the company. Also, feedback from the users will give new ideas for company and generate innovative offer created from user insights and that will increase conversion by 2.3 times more than without user activations. With chatbot solution and sales presentation it is possible to ask question, to interact and in this way, users will have a more personalized approach.

Figure 2: Customer Acquisition Process for Weaver chatbot: marketing & sales funnel

At the Bottom of the Funnel, customers interact with direct front line sales teams and capitalize on marketing investments. Company usually develop remarketing strategy and email automatization to ensure relevance at closing stage with qualified leads having high chances of making a purchase. For software offer it is important to provide a live demo of the software to support trials. After trial and user experience, the customer can perceive how the software or AI chatbot solution could be used in their case and how it can make an impact on their business. Moreover, the customer is given information personalized chatbot offer consists of business benefits, technical specifications, price range based on their business needs, characteristics of the industry, key success factors and financial limitations.

After the purchase is done, these clients should be further developed, and a relationship should be maintained, which could result in customer retention in the future. Cross selling and up selling sales techniques are two major tactics of customer retention strategy and long-term profitability (Damnjanovic, 2019).

4. REA EXAMPLES OF THE WEAVER CHATBOT SUCCESS STORY

Raiffeisen bank is a top universal bank in the Serbian market, providing a comprehensive range of products and services to businesses, as well as to private individuals. The bank makes every effort possible to make itself available to its clients. However, the bank's employees receive a high volume of simple queries, which creates an overload and results in long response times.

On the forefront of new technologies, Raiffeisen bank was the first bank in the Serbian market to introduce REA, the Raiffeisen Electronic Assistant – a business chatbot – in January 2018. REA (Raiffeisen Electronic Assistant) is a chatbot built on a Weaver platform; see Figure 3.

REA it is currently present on two messaging platforms: Facebook Messenger and Viber. Unlike other communication solutions that already exist in Serbian market, and which are based on the "menu guided communication" (decision tree), Raiffeisen Bank's solution is an enterprise bot that operates on the basis of artificial intelligence and is based on a complete understanding of natural language. The conversation between REA's service and the client takes place in Serbian or English - interactively, resembling communication between two people.

Conversation between REA and a client is interactive and very similar to human to human conversation. Examples of using REA: if user asks: Hi, I would like a cash loan 10.000€ with repayment period of 36 months, REA automatically responds to message: Here is your offer: Monthly instalment is 290€, Interest is 5%.

Its success is evident in the fact that within the first six months of its implementation, REA has carried out over 500,000 conversations, many of which actually had nothing to do with finances, although 76% of them were bank-related. Throughout this platform, users are given a chance to find answers to their questions quickly and efficiently. After implementing this solution, Raiffeisen Bank has recorded a significant increase in interaction

with customers, a higher level of customer service efficiency and an overall increase in customer satisfaction. Once REA was implemented, the number of requests it received was up to 7 times higher than the number of requests made through the bank's other communication channels. And, up to 27% of users who use REA do not use other digital channels (Jovanović & Gaborović, 2019).

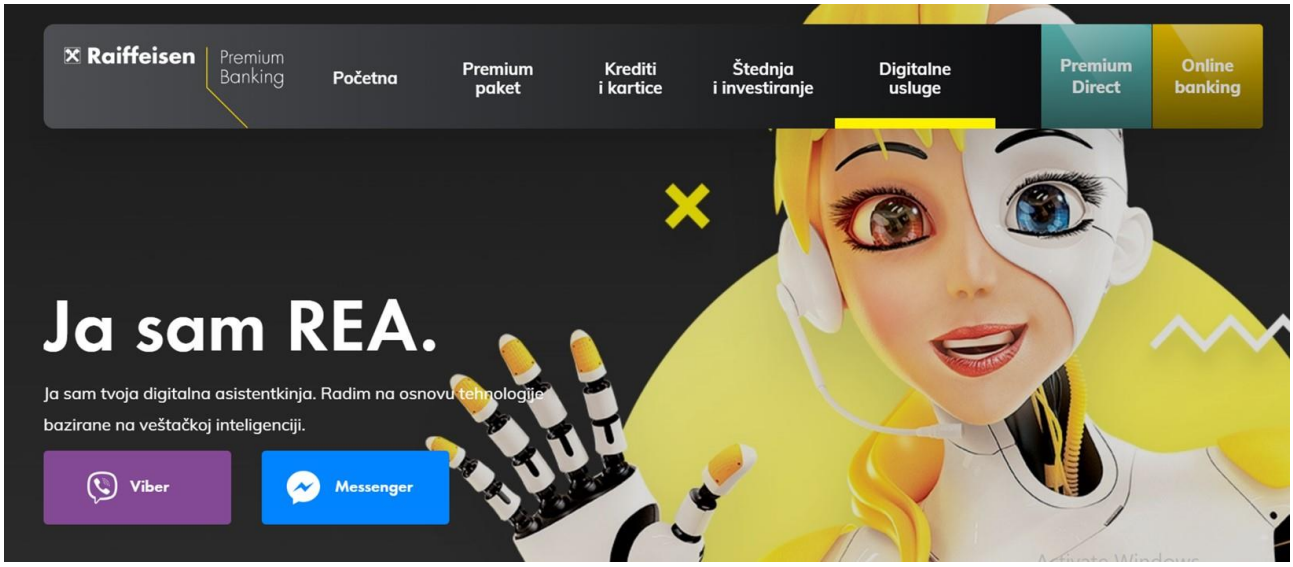

Figure 3: Raiffeisen Electronic Assistant: AI chatbot on a Weaver platform

The Saga management team has also developed additional features in REA, such as the full voice enabled communication complex transactions automation support in 2020. For example, consider a family: the daughter needs money so her father uses P2P communication to tell REA "send 2000 dinars to my daughter to withdraw". In the next step, REA creates a QR code that the daughter uses to withdraw the money from her father's account simply by scanning the code.

4.1. Innovative iKeš loan- the first online cash loan in Serbia

Understanding the dynamic habits and needs of banking clients is crucial in being successful and achieving long-term profitability. In today's banking sector it is imperative for marketing managers to provide superior client experiences and offerings that will stand out from those of competitors in the market. Many clients do not have the time to make repeat visits to a bank branch office. According to Raiffeisen Bank's research, what clients want is a cash loan from the bank in a short period time, without any papers delivered to the branch, and at a time and place that suits them.

Raiffeisen Bank used an integrated marketing communication strategy and an omnichannel approach to position the new iKeš loan on the market. They used both traditional and online marketing communication strategies, consisting of TV advertising, print, online magazines, web presentation, YouTube channel (see Figure 4), and social media presentation on their Facebook page. The campaign communication message was clear – iKeš loan is the first online cash loan in Serbia – and they used this unique selling proposition in order to position iKeš for its target group. Raiffeisen Bank continues its successful collaboration with the famous actor Jelena Gavrilovic, using celebrity advertising for its marketing communication campaign and the REA chatbot solution with innovative chat features.

Raiffeisen Bank launched its new digital service – iKeš loan for bank clients – in September 2019. The main benefits of iKeš loan are (Raiffeisen Bank Serbia, 2020):

- Short time for applying and getting a loan online: Money in the account in 30 minutes. The offer is ready for clients once they have submitted the required data and passed the credit check by the Bank's Credit Office.
- Minimum documentation: All that is needed is a personal document and the last 3 monthly statements in PDF format from the bank where you receive your salary. It is possible to get an iKeš loan if you are the client of another bank in Serbia.
- 100% online: Video chat with a bank agent and electronic signature, or one visit to the branch if you wish.

"iKeš" loan is available to citizens, without coming to the bank, in the amount of up to 600,000 dinars, with a maximum repayment period of up to 5 years and a fixed interest rate throughout the repayment period. Transfer of earnings to Raiffeisen Bank is not mandatory (Bizlife, 2019).

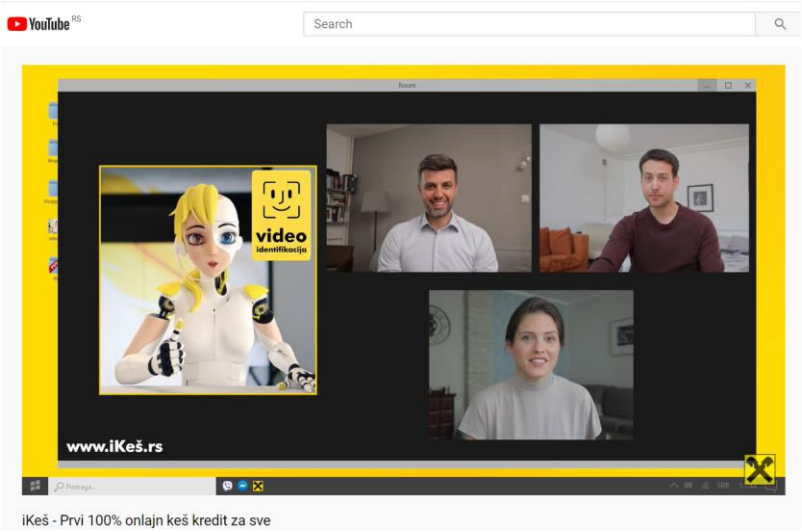

Figure 4: Innovative iKeš loan- the first online cash loan in Serbia, YouTube marketing campaign

5. CONCLUSION

The use of artificial intelligence applications to provide a better user experience, marketing communication strategy and customer care support is increasing globally, regionally and locally. This paper presents the opportunities SAGA has to offer the innovative Weaver AI chatbot solution to clients in the banking sector and other industries.

Digitalization trends, the omnichannel integrated approach of the sales and marketing funnel, and online banking services are becoming more attractive to modern banking users. This, however, requires re-thinking existing business strategies and value propositions for banks.

This paper presents the competitive advantage of the Weaver AI chatbot solution and market position strategy, and takes an in-depth look at the successful partnership strategy between Saga and Raiffeisen Bank Serbia. Together they have created the Raiffeisen Electronic Assistant (REA) based on the Weaver platform, a service powered by artificial intelligence that banking users interact with, via a chat interface as an additional communication channel with their bank. Thanks to the additional features of full voice enabled communication complex transactions automation support with QR scanning and voice chat with REA, they have gained a unique competitive advantage on the market.

ACKNOWLEDGEMENTS

This paper has been supported by the University of Rijeka under the project number Uniri-drustv-18-235-1399.

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THE INFLUENCE OF DIGITAL TECHNOLOGIES ON THE ECOLOGICAL AWARENESS OF THE Y AND Z GENERATION

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***Apstract**: The objective of this research is to establish whether the environmental awareness of the younger generations can be influenced through digital technologies. Digital technologies, especially through Digital Marketing, are in their early age. Generations Y and Z, with their knowledge and development, follow the development of such technologies. The future and saving the Planet through ecological disciplines, environmental protection and sustainable development, is possible only if the population becomes aware in this regard. The use of these channels can be utilized as the simplest means of sharing information with Generation Y and Z through gaining their awareness and mobilization in order to preserve a secure ecological future of these and all future generations.*

Keywords: *digital technologies, Generation Y, Generation Z, ecology knowledge*

1. INTRODUCTION

Global awareness, the first stage in the global education continuum, involves using technology resources such as Google Earth or the Jason Project (Jason Learning, 2012; 2014) to bring locations across the globe into the classroom learning environment. By authors Cook, Bell, Nugent, Smith (2016), global awareness is appropriate for educators without the connectivity needed for global communication or with a structured curriculum that allows little time for open-ended projects across time zones**.** This highlights the importance of digital technologies but also global awareness. Without digital technologies it would be impossible to share information and knowledge. In this day, the most important ecology knowledge and ecology information from all around the World.

By Arbuthnot & Lingg (1975) environmental knowledge has been found to be positively related to environmental behavior, but the literature also reports contradictory findings on the question of how ecological knowledge is related to environmental behavior. (Tanner & Kast, 2003) stands by the term factual knowledge refers to knowledge about definitions and causes/consequences of environmental problems, whereas action-related knowledge is used to refer to information about possible actions (e.g., which human behaviors are related to the greenhouse effect). Unlike factual knowledge, action-related knowledge is more likely to affect behavior.

For example, Joshua Barnett (2018) posits that Timothy Morton's concept of ecological awareness offers a challenge to the field's focus on crisis. Future research in environmental criticism might further engage this and other topics that have implications for rhetorical theory, criticism, and the role of the critic (Blom, Tine, 2019, pp. 1) very important is that, ecological awareness implies a relationship between nature and humans. We will say in globally, and digital technologies and all kind of technologies, too.

2. DIGITAL COMMUNICATION CHANNELS

Environmental problems are one of the most talked about in online communities. The environment is one of the concerns of the world community, which continues to be the subject of conversation throughout the world (Pinema et al., 2019).

Through digital marketing channels and the development of digital technologies, the population is encouraged to develop, progress and constant following of trends. New generations are educated in this

area from the very beginning. Those who are not, are forced to follow the growth trend of digital technologies. More and more people are holding digital technology devices, smart phones, tablets, computers, etc. in their hands. And they spend time on Digital Platforms and Social Networks.

It is clear that digital marketing has an increasing impact on the population. This was especially noticed during the Covid 19 pandemic, when the whole world was in quarantine to prevent its spread. The principal means of communication and information is actually the Internet and digital media, portals of public and other authorized institutions with the World Health Organization in the first place. Data monitoring, communication, advertising, development of online business "from home", providing food and other resources needed for the household during isolation, have enabled Internet platforms that have come closer to the target groups with their Digital Marketing or Internet Information Service.

Portals, digital media, independent writers and journalists research and publish articles with sensational headlines in order to attract the attention of readers, but there are also those who do not expose themselves, who serve their purpose by writing on Blogs and provide timely information that can be vital for the awareness of today's man. The population is still attracted to commercial issues, political issues, commercial products, but the topic of sustainable development and environmental protection is still in its infancy.

3. GENERATION Y AND Z AND LEARNING ABOUT ECOLOGY

We consider these two generations important for environmental awareness and by investing in their knowledge, through digital communication channels, being their biggest users, we can ensure a step towards enhancing environmental protection.

(Kassim, Awang, Ahmad & Ahmad, 2019) state that from a technological perspective, generations in this era are more advanced and distant, as part of the current pace of development of technologies that have a profound impact on the students' 'learning style. As many students initially referred to teachers and books, students now use the Internet more as their main reference source . (Kassim, Awang, Ahmad, & Ahmad 2019, pp. 167-170) founded "From technology perspective, generations in this era are advanced and more distant as the pace of technology now has a profound impact on students' learning style. If in early days many students refer to teachers and books, students are now more using the internet as a major reference source."

In his "Human Hierarchy of Needs", Maslov said that by satisfying their basic needs, people strive for further improvement and satisfaction of other needs. They strive for beauty, creativity and knowledge which all together makes perfection. Under knowledge in our research, we emphasize the attitude of the inhabitants and the environmental awareness and care for the planet Earth (Smith, Brower, 2012, 535-551). New generations strive for further knowledge and technological improvement.

Generation X, which preceded Generation Y and even later Z, grew up during economic restructuring and globalization, had a formal education and did not encounter the mandatory use of digital technologies, the manner of learning, awareness and the then state of the environment and it quite differs from today's generation.

Generation Y includes those born in the period from 1980 to 1995. This is a generation of hardworking and advanced people, prone to job changes, development, progress, who are middle aged (among older members) had their first contact with technology that interested them in part, and in part were forced to accept its development and to master it. Today they are mostly regular users. Those born later became technologically literate very quickly.

The generation born after 1995, the so-called Generation Z, is characterized by birth in a developed technological age and complete digital-technological awareness. In their time, issues of global warming are topical, and social concerns about the environment have been conveyed to them from previous generations. Importantly, they have a developed cultural awareness. They prefer virtual contact and staying indoors. This is a clear indication that further investment in this generation and their awareness can have a significant impact on future generations, as well as on the current and future environmental protection.

Kassim, Awang, Ahmad & Ahmad (2019) founded by observing this generation and the study of ecology, Darla Rothman said in her study that Generation Z prefers to see a colored picture and only reads less than 20% of the text. Forty-three percent of teenagers within Generation Z who want to learn use the Internet and by 38% are more likely to mix methods while 16% are more likely to use books to learn**. (**Kassim, Awang, Ahmad & Ahmad, 2019) founded looking at this generation learning ecology, Darla Rothman in his study says the generation of Z prefers to see a colored image and only read less than 20% of the text. Forty three

percent of teenagers in generation Z wanting to learn to use the Internet, 38% is more likely towards a mixed method while 16% is more likely to use books for learning.“ This is a great advantage for the approach and change of education that has been applied so far.

Social media and computers and other technologically advanced devices are extremely present with this generation. Outdated curricula must be modified and adapted to new generations. Awareness of the environmental changes that have befallen this generation have certainly had an impact on the environmental awareness of Generation Z in relation to the previous ones.

“The learning style of many individuals affects the environmental factor, and that is the ecology of each individual. The differences in the environment experienced by each generation will certainly affect the ecological learning of the generation”, founded Kassim et al. (2019). The learning styles of many individuals are influenced by the environmental factor, which is the ecology of each individual.

There is a need for different adaptations of learning approaches to these different generations because the focus on learning is different. Generation Z quickly becomes bored with learning using standard methods, so it is necessary to apply a new approach.

Kassim et al. (2019**)** states that, in addition to everything, the use of social media can also be one of the ways of learning for the new generation. Social media tools such as YouTube, WhatsApp and Telegram can be platforms for teaching lessons online. They also founded that according to other authors, students have a positive perception about the application of Youtube in teaching.

When we talk about consumer characteristics, those born after 1995, in relation to previous generations have the attitude to choose ecological products when buying, as well as to have an insight into the manufacturer of the product, depending on whether the producer operates in accordance with environmental care. This generation dedicates importance to social responsibility as well as to the collective awakening of awareness on the living environment and its protection. These consumers are willing to pay a higher price to buy a secure, environmentally safe product for their health but also for the environment they live in. They especially choose organic products that have grown in a healthy environment and where there was no use of pesticides that cause harm to the environment in which they were grown. By the (Smith, Brower, 2012) his consumer "image" contributes to the overall well-being of society and future generations.

4. SUBJECT OF THE RESEARCH

The objective of the research is to find out whether Generations Y and Z follow the information presented to them through Digital Communication Channels, specifically whether they follow topics in the field of environmental protection and care for the environment in order to determine whether this manner of work can be utilized for gaining their environmental awareness, and whether they are know if such information makes them aware.

5. METHOD

The research was conducted using an exploratory method through a closed Questionnaire with answers offered. It was posted on the Internet during quarantine during the Covid 19 pandemic after the state of emergency had ended. The questionnaire was posted on Facebook and Instagram, in various groups, Citizens' Associations, environmental movements, mountaineering associations, student associations, the Student City in Novi Beograd, Novi Sad, Kragujevac, science society student groups throughout Serbia, whose further mutual sharing via networks among members was approved. Different populations, age structures in different parts of the Republic of Serbia, different seasons, different structures of education and interests are included. A total of 480 respondents were surveyed. 40% of Generation Y members, 39% of Generation Z, 17.1% of Generation X and a small portion of Baby boomers with a total of 3.5% were surveyed. The research was found to be successfully completed.

6. DISCUSSION OF THE RESEARCH RESULTS

New technologies create an abundance of new knowledge, new opportunities for the younger generations, as well as their work positions. The rapid growth of the economy is accompanied by the quick growth of technology. With this growth, the needs of the population also increase. By increasing such needs, the natural balance of the environment is disturbed. The curriculum in schools must be changed and adjusted, but that takes time, and consequently the results which are expected from such changes in the syllabus for future generations. Digital technologies enable quick responses and access to Generations Y and Z and may be utilized in several ways. The proper way we are interested in, is the approach towards gaining environmental awareness.

The increase in the use of the Internet and the network channels provided by the Internet has been monitored for years. It is almost unthinkable to imagine a household without an Internet connection. Rich and varied content is available to everyone. The materials and topics that can be found provide a wide range of knowledge and information, both in the service and educational sense. Social networks are now at their peak. The so-called "Influencers" or "influential people" have the status of people who can influence the decisions and tastes of their network followers. They can make an enviable profit for their reputation and positioning on social networks. This topic is basically realized by digital marketing. One of the simplest types of income, when we talk about business and product sales through digital marketing, are "Influencers". The question arises as to whether this influence can be used for other, educational and long-term cost-effective purposes for the entire population and the Planet. Through a change of opinion and gaining awareness, we shall also attempt to discover this for a start with one such research.

There is an increasingly present topic and knowledge that Planet Earth is suffocating and fighting for its survival: 20 degrees Celsius in Antarctica, ozone depletion, fires, floods, earthquakes that are increasingly shaking the earth with great force, large amounts of debris in the oceans, the surrounding nature, the extinction of indigenous species of animals and plants, climate change, are just some of the problems we are facing and becoming just a little aware of. Even less, that it is our future, our responsibility and our defeat and an expression of ingratitude to the planet we live on. The question is: can digital technologies help solve this problem?

6.1. The research results

Most of the respondents were born between 1981-1995, which corresponds to generation Y, where 193 respondents were surveyed, while the population born after 1995 with 187 respondents is in second place, which corresponds to generation Z, which makes a total of 380 respondents of these two generations.

When asked, “Are you concerned about the future of the environment we live in?”, 377 Generation Y and Z respondents answered. They were offered 3 answers: “No, I don’t think about it”. 25 answered, “I think more and more about that topic ”175 answered: “ I have always had a developed awareness of the environment ”, where 177 respondents gave this offered answer.

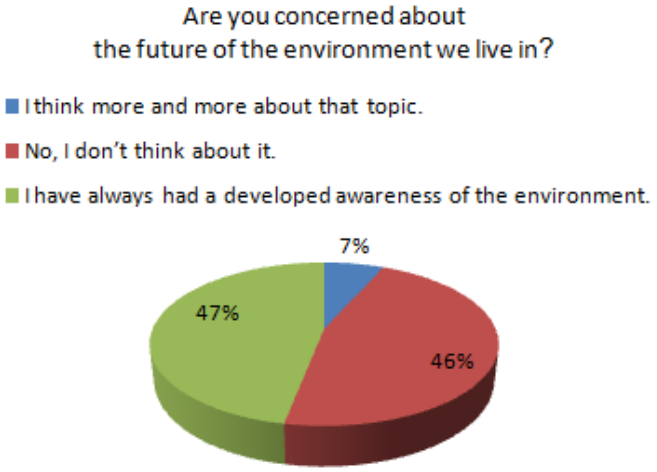

Figure 1: Answer the question: ”Are you concerned about the future of the environment we live in?”

When asked "Does the information you receive on the Internet affect your change of environmental awareness?" 290 out of 380 respondents answered positively : “Yes, it does have an impact and I'm researching the topic more and more” (77%), while the remaining 87 (23%) answered the opposite “No, I'm not interested”.

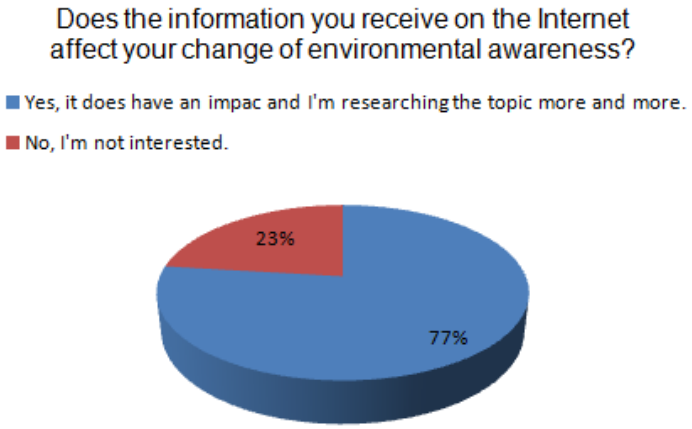

Figure 2: Answer the question: „ Does the information you get on the Internet affect your change of awareness regarding environmental protection?

When asked: "Do you find the news on the Internet, articles, various information useful lately?", 376 respondents answered. They answered: "Yes, I regularly follow them, I try to choose the best for myself.", 223 (59%), while 153 (41%) consider it a waste of time.

Figure 3: Answer the question: “Do you find the news on the Internet, articles, various information useful lately?“

Respondents who are members of Generation Y and Z stated that they follow the material available to them on the Internet and that it affects their environmental awareness, but when we talk about the quality of the material, they do not consider it completely useful and see it as a waste of time. By creating appropriate content, a drastic enhancement of awareness and enrichment of knowledge of these populations can be significantly initiated. This can also be achieved by creating platforms where everything should be included.

The way to approach Generation Z more effectively, when we talk about the way of learning, specifically about environmental protection, is by creating an Online platform for learning, interaction and information. Through such learning, Generation Z can be approached by an enhanced learning interaction and by improving and creating new technology platforms, YouTube channels rich in video content.

7. CONCLUSION

This research concluded that Generations Y, with an indication of Generation Z, are open to digital communication channels and are technologically aware. They use digital technologies and the information provided to them through such content. Communicating with them in this way is facilitated. They have a developed ecological awareness to a sufficient extent to have a great interest in further improvement and development of their knowledge in order to improve and preserve the environment. At the moment, they do not find completely quality content, which opens new research questions for creating quality, adequate content that would be placed before them. Further research will work on creating an educational program that will be used specifically for these generations, especially for Generation Z. The research will work and monitor further progress of knowledge and possible and overall improvements in our environment. One of the programs could be new technological, communication channels, with graphically designed attractive

content, for disseminating information through digital channels using Digital Marketing for proper, precise targeting of the target group.

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SUSTAINABLE CORPORATE BRAND

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Abstract: *For the last couple of decades, a significant part of market value structure of an organization has been composed of intangible assets. Taking into account their dominant participation in the value structure, it is evident that intangibles represent the image of the effectiveness and efficiency of an organization. Brand is one of the best-known intangible assets that is used for specifying a successful concept, in most cases a successful trademark. A corporate brand is a complex concept that consists of numerous larger or smaller interconnected units and is one of the strategic company resources. A strong corporate brand can symbolize a significant protection of an organization during financial or organizational hardships. Corporate identity is part of corporate brand and, by adding sustainability, a new concept, sustainable corporate brand, is obtained. The concept itself implements the elements of corporate social responsibility into the development of relations among various stakeholders with the goal of the corporate brand growth and improvement. The development of a corporate brand requires continuous work, tangible and intangible investment, as well as the participation of employees at all organizational levels. Corporate rebranding is one of organizational changes that is being conducted in order to increase the value of intangible assets or to heal the consequences that have emerged following numerous crises.*

Keywords*: sustainable corporate brand, corporate brand, corporate identity, corporate social responsibility*

1. INTRODUCTION

The intangible asset participation in the total value of an organization has rapidly increased over the last few decades. The creation and development of intangibles imply tangible investments, but also numerous other "invisible" elements. The combination of various types of intangible assets, with the combination sustainability, may be a significant source of competitive advantage. Sustainability itself becomes integral, even inseparable element of many contemporary business concepts and enterprises – if something is not sustainable, it generally implies that its value is not great either.

Numerous ecological and social crises (climate changes, great social differences, child labor, etc.) have resulted in the rise of public awareness regarding the environmental and social issues. The public pressure on companies has altered the method in which they approach the issues. Consequently, the sustainability has become the main concept that most companies aspire to (Broman, 2017). According to Olawumi and Chan (2018), *sustainability* is defined as the process and mechanism for achieving the planned sustainable development. Globalization has caused many changes in business activities, including, among others, the changes in the field of marketing, where the significance of *corporate brand* has been constantly increasing, instead of *product brand*. During 1990s, a number of papers were published (King, 1991; Balmer, 1995; Ind, 1997; Urde, 1999; Leitch, 1999 etc.) analyzing the approach to brand, not only in the context of products and services, but also in a wider context – at a company level. The term *company brand* was first adopted, but soon it was renamed into *corporate brand*, the term that is nowadays also being used (Villagra & Lopez, 2013). *Corporate branding* is a comprehensive approach to brand management that companies have adopted with the goal of a unique *corporate identity* development (Balmer, Powel, Kernstock, & Brexendorf, 2017). In practice, organizations often use the advantages of the company brand separation from the product brand, e.g. upon a new product launch, so as to protect the corporate brand in case of the product failure. And vice versa, in case of the product success, companies tend to implement the success in the process of corporate brand reinforcement. Yet another example of various product brand development are various target groups, when an organization tends to affect a greater market share.

The development of technology brings changes in the way of doing business for all organizations around the world. Over the last few decades, the development of information and communication technologies (ICT) has introduced new technologies such as the Internet and social networks (Boes, Buhalis, & Inversini, 2015). New technologies (social networks, blogs, internet, smart devices) enable constant interaction between users regardless of time and location. These changes have affected not only the daily life of the individual but also the connection of different cultures and people around the world. As a result, the conventional business system has begun to change rapidly. Thus, the question arises as to whether companies in a changing modern

environment will be able to provide differentiated value by presenting more interesting and useful functions. The new business (smart) environment enables interaction with consumers regardless of time and location and significantly affects marketing and brand (Yong, Hyung, & Bong, 2016) due to the possibility of constant exchange of content, monitoring a large amount of information, sharing consumer experiences, electronic systems to manage customer relationships and create interactive sites to communicate with consumers (Kocic & Radakovic, 2018).

Below, corporate brand and corporate identity are explained, not as new concepts, but their structure and the development method have been significantly improved due to the need for their adjustment to complex economic, social, ecologic and other challenges.

2. CORPORATE BRAND CONCEPT AND ITS CONNECTION TO CORPORATE IDENTITY

Corporate brand has the same goal as *product brand* in terms of identification, product differentiation and creating competitive advantage, but it represents a much wider concept than the relation between the product and consumer itself. The corporate brand focuses not solely on customers, but is also oriented to all stakeholders (employee, investors, suppliers, local community, etc.) (Roper & Davies, 2007).

Hatch and Schultz (2001) state the corporate brand basic functions:

- The means for ownership emphasis – the corporate brand basic function is to emphasize ownership. In simple terms, it represents the company name, logo and trademark.
- Its connection with the company basic values – corporate brand presents exactly these values to stakeholders, such as clients, media, shareholders and general public.
- Building the image – when using a product or service, stakeholders also “buy” the company values that are reflected through a certain product. Corporate brand is the sum of the company values. Through them, corporate brand guarantees the quality of a product and safety against bad business or financial risks. Therefore, a strong corporate brand contributes to achieving and/or maintaining the competitive advantage.
- The way in which consumers identify themselves with a company – the relationship between the company and its brand is an important aspect in the field of market research. The concept of identifying the consumer with the brand represents the consumer’s psychological state, in which the consumer perceives, feels and values his/her belonging to the brand.

Corporate brand does not only imply the company logo and name, but it also conveys the *corporate identity* in the company communication with both external and internal stakeholders, i.e. corporate brand conveys all those characteristics that differentiate the company itself form its competitors (Meierer, 2011). Corporate brand expresses corporate identity, in other words, the company values, vision and corporate culture (Hatch & Schultz, 2008), meaning that corporate brand is the means that help companies achieve the desired positioning and image on the market (Bawa & Saha, 2016). Aaker (2004) states that the corporate brand defines the company that will deliver its products and services and stand behind the offer that a customer will buy and use. The term corporate brand has been conceptualized as a multidisciplinary entity that brings together a number of company characteristics (Bawa & Saha, 2016).

Corporate brand has often been emphasized as one the most valuable intangible organizational assets. There are a number of factors that affect the greater or smaller corporate brand value (organizational culture, product design and quality, the innovations of products and processes, etc.). In fast changing industries, innovation is one of the most significant corporate brand value elements. For instance, Apple, Samsung, Toyota and Coca-Cola are being referred to as examples of the organizations that have managed over the last couple of years to maintain the corporate brand value, as opposed to the organizations such as Kodak and General Motors. The values of the above-mentioned corporate brands are being measured in dozens of billions of dollars (Gehani, 2016). It should be pointed out here that the participation of intangibles in the market value of S&P 500 companies was entirely changed in the period between 1975 and 2015 (from 17% in 1975 to 84% in 2015) (Monfort, Sebastian, & Lopez, 2015).

Brand identity is the basic brand component that reflects the behavior and corporate communication. *Corporate identity* is defined as an essential company characteristic that underlines its dynamic and changeable character. Balmer (2012) states that corporate brand identity can also significantly shape corporate identity. In the brand development process, it is of great importance that the corporate identity is based on principles and solid values, since those values themselves will lead all corporate activities and, as such, will be the subject of constant evaluation by stakeholders that demand the information on vision, principles and values (Villagra & Lopez, 2013). *Corporate identity* is also defined as a group of company characteristics that contribute to its recognition and uniqueness. Corporate brand essentially reflects corporate brand character and creates an emotional bond among consumers by it being presented on the market (Jobber & Fahy, 2006).

Corporate identity and corporate brand are in most cases being used as the same concepts, however Balmer (2012) states that there are significant differences between the two of them. Corporate identity refers to different organizational elements that deal with the questions: Who are we? What are we? and they also refer to all types of organizations (e.g. they would not be necessary in case of monopoly). The organizations that wish to build strong corporate brands need to harmonize their internal communication activities and human resource management practices with the brand values. The main goal of corporate branding is shaping the company value system and it contributes to its promotion and also to developing the reputation (Urde, 2013). Maintaining corporate identity is of great significance for all organizations and the senior management task is to ensure that corporate identity is strategically reliable, that it reflects corporate goals and fulfills the stakeholders' needs. Corporate brand significance is also being reflected in cases of change management processes (Balmer, 2017).

Balmer (1995) states that corporate brand management is essential for a company, that management strategies are constantly being changed and that successful management depends on the following factors:

- Clear corporate mission and philosophy
- Developed corporate identity
- Information on company perception by its stakeholders

Hatch and Schultz (2003) suggest the corporate brand management model that begins with corporate identity and the relation between the identity and: strategic company vision, corporate culture (the aspects associated with internal stakeholders) and corporate image and its perception by stakeholders. These authors also state that the brand management is based on the harmonization of the above-mentioned components in order to avoid the issues that could affect the entire brand image and reputation. De Chernatony and Harris (2001) agree that corporate identity is the basis for developing a differentiated and coherent corporate brand.

Over the last couple of years, companies have defined new strategies for brand management so as to harmonize the company demands with the needs of a society and, as a consequence, they have included corporate social responsibility into their activities. The new direction in business need to be integrated into a branding strategy in the following way (Villagra & Lopez, 2013):

- Identity of corporate brand and product brand need to be harmonized with the new business direction
- All interested parties need to be included into the strategy change processes.

3. CORPORATE SOCIAL RESPONSIBILITY AND SUSTAINABLE DEVELOPMENT

The activities within corporate social responsibility (CSR) contribute to the improvement of both internal (corporate culture) and external (corporate reputation) business aspects. CSR is being regarded as means used to develop the trust between an organization and its consumers in order to reduce their skepticism (Hur, Kim, & Woo, 2013). CSR is a corporate brand characteristic and, according to certain authors, CSR itself is something that *makes the difference* between corporate brand and product brand (Bawa & Saha, 2016).

The success of CSR largely depends on identifying real social issues that need to be resolved. Sometimes, these issued have already been identified by a country, but due to a number of reasons, it is not capable of solving them (e.g. wrong issues have been identified, wrong solutions have been applied, etc.). Organizations, particularly the large ones, due to their significant analytic knowledge and experience, are more likely to identify various social issues much more easily and to offer different creative and innovative solutions. Continuous activities regarding identifying and solving social issues can help achieve great results, and organizations themselves may significantly improve their public image. Naturally, this is not always the case – certain organizations invest substantial funds into solving the social issues, but still cannot entirely alter their public image (e.g. Monsanto).

Companies worldwide have been increasingly recognizing the need for CSR promoting with the aim to create sustainable competitive advantage and to improve corporate reputation that all stakeholders focus on. Corporate reputation is formed through the company activities and it represents an intangible asset. In addition to this, a number of academic surveys have been devoted to the CSR concept itself (Caroll, 1991; Roper & Davies, 2007; Mallin, 2009; Porter & Kramer, 2009; Idowu & Louche, 2011; etc.), its influence and benefits. The companies wishing to attract potential stakeholders deal with promoting corporate social responsibility. By means of investing into those activities, they are being able to ensure competitive advantage on the market and profit, to develop brand awareness, to create brand legitimacy and consequently to reinforce the relation between stakeholders and corporate brand (Pratihari & Uzma, 2017). Furthermore, the advantages that stem from adopting the CSR concept are as follows: the effect on the market (the effect on corporate image and reputation, the effect on brand perception, differentiation and the improvement of competitiveness, attracting new customers, the effect on loyalty and retaining the existing customers); the effect on working environment

(the effect on attracting quality employees, the effect on employees' motivation and commitment, reduced absenteeism and work-related injuries, increased productivity, the effect on retaining quality employees); the effect on business (the reduction of operational business costs, risk reduction, income increase due to sales growth and/or market share, product and service quality improvement, better financial performance, share value increase, positive influence on access to capital – responsible investment, the improvement of waste management efficacy) (Vlastelica Bakic, Krstovic, i Cicvaric Kostic, 2012, p.196).

Corporate reputation is one of the strongest organizational sustainability determiner. Business strategies are being changed, but a company must not allow for its reputation to be impaired, since it is very hard to recover from it. The companies with good reputation attract positive stakeholders' engagement. Good corporate reputation is one of the mechanisms that enables maintaining competitive advantage, contributes to retaining the customers as well as to their satisfaction and leads to the company positive media image in public (Makasi, Govender, & Munyoro, 2014). The integration of CSR with corporate brand contributes to reputation improvement, which is particularly noticeable in financial and oil industries. In addition to it, customers also focus on social aspects of corporate brand, and not only on its technical and functional characteristics. Taking into account all that has been mentioned above, it can be concluded that corporate social responsibility is becoming increasingly significant as the topic in the domain of corporate brand research (Pratihari & Uzma, 2017).

The relation between corporate identity, brand and reputation is illustrated below.

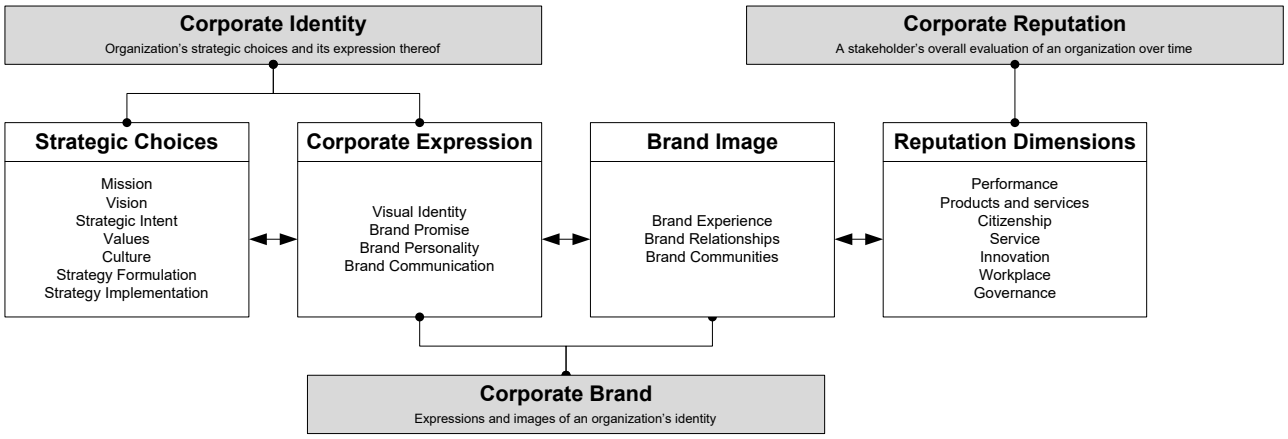

Figure 1: Corporate identity, brand and reputation integration (Abratt & Kleyn, 2012)

It ought to be emphasized that the functional sources of product differentiation are easy to be imitated, therefore the question arises as to whether CSR can really bring long-term and sustainable differentiation. In cases when companies declare to be socially responsible, they attract the attention of public and stakeholders, and thus, providing they offer empty promises and inaccurate information, i.e. providing their activities are not in harmony with CSR, it can lead to distrust. Therefore, the CSR strategy formulation as an integral part of the strategies at a corporate level and the conduct in harmony with it results in competitive advantage and confidence in corporate brand (Pratihari & Uzma, 2017).

4. SUSTAINABLE CORPORATE BRAND

A number of companies deal with creating their own sustainable brands. The author Stuart (2011) defines *sustainable corporate brand* as a corporate brand whose main characteristic is its sustainability. In case the sustainable development principles are integrated into business, organizations attract the consumers interested in sustainability, which contributes to achieving competitive advantage. Consumers are not the only group of stakeholders attracted by the sustainable corporate branding idea. Other stakeholders as well (e.g. the investors who are oriented towards sustainable business) will be more ready to cooperate with the companies with sustainable brand than with other companies. The companies that have created sustainable public image by means of corporate branding reduce their bad impact on environment. Therefore, sustainable corporate brand is effective means in ecological management risks (Broman, 2017). Villagra and Lopez (2013) state that the sustainable corporate brand is the one that includes ethical, social and ecological values to the same degree as economic in accordance with stakeholders' expectations. If a corporate brand indicates corporate identity, attitudes and behavior of a company and thus bonding the company with the stakeholders, then sustainable brand is the one that represents the companies with ethical and socially responsible management. The corporate brands that include the CSR aspects imply the transfer of excellence in social and ecological aspect management on their stakeholders.

The creation of a strong corporate brand has become a very important field for many companies. CSR is considered as one of the most important factors in the process of developing a strong corporate brand (Pratihari & Uzma, 2017). As it has already been stated, a growing number of consumers has started to pay attention to the corporate brand social aspects, implying that they do not only focus on technical and functional brand characteristics.

The creation of a strong corporate brand is of great significance, since the company can thus define its identity, but not the image or the reputation that are shaped by external and internal stakeholders. Since a brand creates certain expectations with its consumers, the organizations that carry on fulfilling the stakeholders' expectations will contribute to creating a positive image and thus a positive reputation. Good corporate reputation and a strong and sustainable corporate brand are some of the most important characteristics for creating a positive image and reputation and they largely influence the value creation and represent one of the main sources of competitive advantage. Sustainable corporate brand is the means by which competitive advantage is additionally reinforced, since the consumers tend to select the products and services of the companies that are applying the CSR practice in their business activities. The ethical dimension of CSR create with buyers the conviction that the company tends to achieve high ethical standards and that it takes into account the influence on society when making business decisions (Lu , Ren, He, Lin, & Streimikis, 2019).

The positioning of sustainable corporate brand is not applicable to all companies and should be applied only in those cases when the company has something else to offer. In any other case, it is more desired to develop the positioning of corporate brand with other characteristics that distinguish the brand from other brands. Therefore, not all brands should use CSR as the basis for positioning, but only in those cases where CSR represents a differential element, where it is clearly integrated into identity and strategic projects (Villagra & Lopez, 2013).

Sustainable branding does not give advantage only to individual companies, but it also contributes to corporate sustainability in a broader sense. Corporate branding and sustainable brand provide clients with information that helps them identify sustainable companies (Broman, 2017). Sustainable corporate brand stems from corporate identity whose main characteristic is sustainability itself. The positioning of sustainable corporate brand implies including the CSR principles into the organizational culture and developing the processes that support those values. According to certain authors, the inclusion of the CSR principles into a corporate brand is regarded as corporate rebranding, which implies balancing the current corporate brand characteristics and its improvement and changes towards the contemporary conditions that include sustainability as their basic characteristic, which requires an integrated approach (Stuart, 2013).

On the basis of the conducted research, Makasi, Govender, and Munyoro (2014) state that the sustainable corporate branding has the following benefits: it has a positive effect on corporate reputation and attracts new employees (i.e. increases the organizational attraction), then it has a positive effect on the existing employees, their performance, innovativeness and the sense of belonging to the company. Likewise, it has a positive effect on corporate image development and the perception of the company by its stakeholders. Vallaster, Lindgreen, and Maon (2012) claim that the adoption of the CSR principles within the corporate brand development urges companies to examine and improve business characteristics (organizational structure, management method and values possessed by both the management and the employees). Corporate brand management that is based on the CSR principles requires the adjustments of corporate identity, which contributes to differentiation and the creation of competitive advantage. Sustainable corporate brand affects positively corporate values, corporate mission and business strategies. Likewise, it has a positive influence on company financial performance and the creation of economic and social values.

5. SUSTAINABLE CORPORATE BRAND IMPLEMENTATION

For the last couple of decades, the society demonstrates an increasing interest in social issues and socially responsible management. Likewise, the application of ethical criteria when rating the company performance has increased. The basis for developing the sustainable corporate brand is its identity and values. The basic values of sustainable corporate brand are trust, honesty and integrity. Companies have been increasingly attempting to upgrade the identity characteristics and to define new strategies for brand management in order to harmonize the company interests with the ones of the society (Villagra & Lopez, 2013).

From the aspect of branding, the implementation of sustainable corporate brand implies corporate rebranding and it depends on an organization, i.e. on the current positioning of an organization in terms of sustainability. Corporate rebranding is aimed at balancing the need for satisfying the essential corporate brand characteristics and for further brand improvements in the context of implementing the CSR principles. Every company will deal with the question as to how this ought to be achieved and, eventually, how to implement a sustainable

corporate brand. Companies will most likely alter their visual identity and slogan in order to express sustainable corporate brand (Stuart & Muzellec, 2004).

Upon implementing sustainable corporate brand, according to author Stuart (2011), the following should be taken into account:

- Sustainable corporate identity, meaning that the company management and board of directors ought to consider the real identity, and then to research and come up with the desired and ideal sustainable corporate identity, which results in sustainability as the basic corporate brand value;
- Sustainable corporate brand implementation ought to be conducted through corporate rebranding, which results in the alteration of visual identity and slogan so as to support sustainable corporate brand;
- Upon the implementation of sustainable corporate brand, sustainable corporate identity is given the language which is understood by the organization members and which is reflected in the corporate story;
- When implementing a corporate brand, there are certain changes as to the accounting procedures. Something which was regarded as a cost before, now can bring profit and vice versa;
- The identification of organization members with sustainable corporate identity is of great importance. Some members will find it harder, and some will find it easier, to understand corporate story and to identify themselves with sustainable corporate brand;
- The members that participate in the supply chain need to be selected and engaged on the grounds of their capability and readiness as to the delivery of material in accordance with sustainable corporate identity;
- The inclusion of sustainable product design in the mix;
- Internal stakeholders will differ as regards their readiness and capability in terms of conveying a sustainable corporate brand message in their daily duties and interactions;
- External communication with stakeholders ought to be based on the facts that their interest regarding the sustainable corporate brand message shall differ;
- The premature conveyance of sustainable corporate brand information can cause more harm to the corporate brand than the failure to convey it in the first place.

6. CONCLUSION

The harmonization of the interests of an organization and a society requires a thorough analysis of social needs and issues and the methods and possibilities for their settlement. The result of such analysis ought to be defining a clear strategy for solving the identified issues and establishing partner relations with the aim to create a common value.

Corporate brand, corporate identity and product brand are all equally important concepts that need to be given equal attention. The improvement of one element should lead to the improvement of other elements, whereas the weakening of one such element should bring minimal harm to all other elements. With regard to the significant increase of the participation of intangibles in the organization market value, it is evident that it represents the image of the business activities of an organization. Corporate brand does not refer to the assets provided with no income whatsoever, but it demands continuous activity as well as the investment in terms of both tangible and intangible funds. Sustainable corporate brand conveys the sustainability principles to stakeholders. Sustainable brand refers to more than solely corporate brand attributes, thus it can be stated that sustainable corporate brand is a “hybrid” concept that originated by merging the related concept with the goal of obtaining a synergetic effect that is beneficial for both the organization and its stakeholders. The business activities which are in accordance with the CSR principles are by all means the precondition for sustainable corporate brand development.

The development of information and communication technologies has enabled significant improvement of business processes by reducing the number of participants, replacing manual work with computers or machines, shortening processing time in most steps, centralizing data, reporting and real-time planning, better relationships with external participants (business partners, manufacturers, distributors, end users, etc.), better availability, better and faster communication, etc. One of the key improvements that ICT has brought is the ability to learn and solve once unsolvable problems (eg GO games). All these improvements are certainly acceptable from the point of view of a sustainable corporate brand. In addition to this, a smart environment represents a compatible concept to the concept of a sustainable corporate brand. A significant part of modern ICT concepts has the word smart (smart cities, smart houses, smart production) in its name, which indicates optimality (or optimization) as their key element.

In future research, the development models, time periods and its costs, the sustainable corporate brand renewal (rebranding) as well as possibilities of applying the elements of the smart environment concept ought to be analyzed. Yet one more research direction could be the analysis of the latest crisis effects emerged as the consequence of the virus COVID-19 epidemic on the development and restructure of a corporate brand. Like in any crisis, the consequences are (or will be) numerous, but new possibilities for the concept

improvement are being opened, either through adding new dimensions, or changing the existing dimensions, or developing the subconcepts, etc.

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RELATIONSHIP MARKETING IN CULTURE AND ARTS

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Abstract: *The paper presents theoretical and practical aspects of relationship marketing in culture and arts. Relationship marketing is part of holistic marketing approach in culture and arts. Relationship marketing has active, project and functional models. The paper presents new ways for building smart environment for communication with target groups, through social media, Instagram, Facebook, Twitter and Zoom platform. Relationship marketing could be operational, functional and strategic. In the smart environment, relationship marketing could develop in the way of excellent communication through social media and Zoom platform or Instagram television. In the paper has developed theoretical and practical aspects of relationship marketing in culture and arts. In, second part of the paper, the focus group with seven managers of cultural and arts institutions gives opinion about impact of relationship marketing in culture and arts, in smart environment. The focus group has organized on Zoom platform. The results of the focus group presents public audience's satisfaction and experiences with cultural and arts events. The results of empirical research will be base for future theoretical and practical research in the field of implementation of relationship marketing in culture and arts in smart environment. Analysis of relationship marketing in culture and arts is important, as new concept of marketing conception in smart environment. The paper improve modern ways of social communications, in smart environment, by social media, in order to develop relationship marketing and experience marketing in culture and arts. Social media platforms give opportunities for raising cultural and arts experiences. Social media gives opportunities for interactive conversation with public audience in smart environment. Public audience could comment cultural and arts events. Public audience become inspire with cultural and arts events, what lead in develop of new cultural and arts experiences. It is very important for young generations to improve cultural and art's experiences, because the biggest influence global world changes have education, culture and arts.*

Keywords*:* Relationship marketing, smart environment, culture, arts, experience marketing.

1. INTRODUCTION

The smart environment gives opportunity for communication through social media, Instagram, Instagram television, Facebook, or Zoom platform. The smart environment is modern way of communication and easy way to be in contact with target groups. Zoom platform is excellent online place, where people can share ideas, organized meetings, cultural and arts events, educational events. Relationship marketing have to change approach according to smart environment. Smart environment, also, gives opportunity for audio, podcast cultural and arts events, educational forums and exchange of ideas. The world is involved in artificial intelligence and the world is in process of acceptance of modern, online way of communications. Smart environment is future environment, where people will learn and share ideas, knowledge (Janicic, 2019).

Cultural organizations have challenges: on the one hand, they are responsible for preserving, protecting, promoting and enhancing the heritage of an immensely precious past, a ‘legacy’ from which to learn and which the largest number of people must be allowed to enjoy, according to the ‘heritage’ concept. On the other hand, cultural organizations must turn this industry into an economic asset to all intents and purposes, integrated in territorial marketing logics and improve communication with target groups in smart environment (Battaglia, Santagostino, & Bargauan, 2017).

In today’s smart environment, the sheer variety and quality of offerings vying for consumers’ attention have forced arts organizations to invest in other aspects of the customer experience. For example, the success of the Tessitura database illustrates how arts and cultural organizations can improve the customer experience and build a stronger relationship with consumers. The development of new audiences also relies on a deeper understanding of their expectations and behaviors (Colbert, 2019).

In smart environment, museum play a cultural and important role in collecting, protecting and managing social and cultural wealth. Cultural collections belong to society, and are not intended to satisfy the interests of individuals or specific social groups. Museums are entrusted with the mission and purpose of collecting and maintaining important objects of art, science and history. More importantly, they have a major role in providing access to humanities, art, history, collections and education (Huang, 2019).

Digital technologies, in smart environment, may potentially stimulate positive feelings and emotions in visitors of cultural and arts events. Particularly, the storytelling of digital personalization of cultural heritage sites can effectively personalize visitors' experience and uplifts the visit toward an authentic and unique experience (Rialti, Zollo, Ciappei, & Laudano, 2016).

Relationship marketing in culture and arts, as element of holistic marketing approach in culture and arts, is subject of this paper. Implementation of relationship marketing in culture and arts in new field of research in marketing theory and practice. It is interdisciplinary approach (Belch, 2012).

By the interdisciplinary approach in implementation of relationship marketing in culture and arts, hypothesis of the paper is that relationship marketing has impact on development of culture and arts. Marketing strategies in culture and arts have to be sophisticate, simply and focus on target audience. Relationship marketing gives opportunities to improve experiences on cultural and arts events (Chong, 2002) .

In the first part of the paper is present literature overview of relationship marketing in culture and arts. In the second part of the paper is present focus group with managers of cultural and arts institutions about impact of relationship marketing in culture and arts. Results of the focus group is present in discussion and present base for future research about impact of relationship marketing in culture and arts. The managers in focus group emphasizes that implementation of relationship marketing strategies improve experience of cultural and arts performance. The research has based on qualitative tools.

Relationship marketing strategies are deeply explain in the paper. Relationship marketing exist only if exist two-way communication between cultural and arts institutions with public audiences. If exist only one way communication, it is direct marketing, situation when cultural and arts institutions send messages from cultural and arts company to public audience in one way. When communication become two way, it is relationship marketing approach in cultural and arts institutions.

Implementation of relationship marketing in culture and arts, on global market place, is present through the examples in practice.

The research in the paper has based on case studies of good examples of relationship marketing in the development of implementation of relationship marketing in culture and arts. The research, in the second part, is based on the focus group realized with seven managers of cultural and arts organizations, described in case studies. The focus group has been done with seven managers of cultural and arts institutions on smart environment, Zoom platform. The research has based on qualitative tools.

2. RELATIONSHIP MARKETING IN CULTURE AND ARTS

Relationship marketing, as element of holistic marketing approach, is two-way communications between company, customers, consumers and business partners, in order to develop business, positioning company on market place and creating corporate brand (Kotler, 2016).

Relationship marketing could be active, when company actively is communication with business partners, customers and consumers. Relationship marketing could be trans-active, when company work with business collaborates on some projects in period. Relationship marketing could be passive, when consumers and customers are interesting on work of company, but communication is not activate. Relationship marketing could be operative, functional and strategically, according to goals. Relationship marketing could be operative, functional and strategically, according to goals (Kotler, 2016).

Relationship marketing is important for publishing institutions, as well as, literature workers, authors, writers and public audience. Modern, social media give opportunities for two-way communications with public audience. In that way well define relationship marketing strategies are important for good communications, creating corporate, publishing brand and for making connection with readers. For business partners publishing institutions have to create customer relationship database, which is platform for business communications with business partners. For integrated marketing communication, relationship marketing is platform for sending clear, simply messages, that make corporate, publishing brand (Blakeman, 2006).

Relationship marketing implement strategies by relationship tools, such as traditional marketing strategies and modern social media approach. Communications have based on database of all stakeholders of publishing institutions. Communication has based on reader's experiences and information about behavior of target groups, present in Figure 1.

Figure 1: Key elements of Relationship marketing
Source: (Kotler, 2016)

Relationship marketing has communication tools, such as social media, customer services, word of mouth, and events, present in Figure 2.

Figure 2: Key tools of Relationship marketing
Source: (Kotler, 2016)

Relationship marketing include elements present in Figure 3.

Figure 3: Creating brand by Relationship marketing
Source: (Kotler, 2016)

Relationship marketing in culture and arts is synergy of all elements of marketing mix. Employees are advocates for cultural and arts institutions. It is important that employees have skills for good communications with target groups. Good atmosphere between employees is create element for brand building of cultural and arts institutions. Integrated marketing strategies have to send consistent and clear message for public audience about cultural and arts institutions and projects. Visitors of cultural and arts projects are the best advocate for cultural and arts institutions. Cultural and arts events, through relationship marketing approach, make atmosphere of connection, opportunity for conversation and discussion. Relationship marketing is key element for communications with public audience. Social media are source of excellent two-way communication. In that way, synergy of all elements of holistic marketing approach is necessary for development of culture and arts and building brand of these institutions (Larry, 2008).

3. EXPERIENCE MARKETING IN CULTURE AND ARTS

Cultural and artistic projects have impact on experiences of public audience. History facts prove that literature arts improve culture of the world. Modern society needs cultural and arts content (Janicic, 2018).

Experience marketing has challenge in improving planning process of cultural and arts events, development of world is cultural, and arts market place. Experience marketing has based on thoughts and feelings of public audience about cultural and arts projects. Cultural and arts projects describe life moments that influence on experiences in public audience. That experiences influence creating of cultural and arts brand institutions (Kotler, 2016).

Culture and arts are "moments of life". They are expression of life. In that way culture and arts is drive by experiences. Relationship marketing have impact on development of culture and arts (Janicic, 2018).

The Figure 4. presents model of experience marketing and experiential tools.

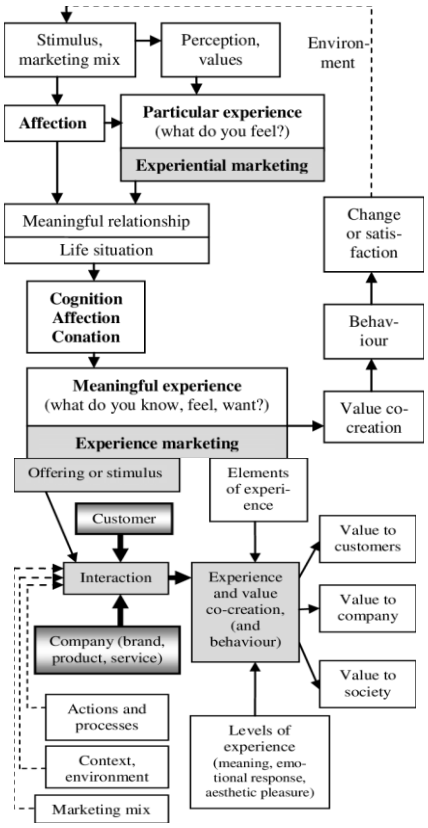

Figure 4: Experience Marketing and Experiential Tools Approach
Source: (Same, 2011)

4. THE EXAMPLES OF RELATION MARKETING IN CULTURE AND ARTS

Brilliant example of relationship marketing in culture and arts is the *Booka Store* in Belgrade. Every day in center of Belgrade, books public have opportunity to buy books, enjoy literature events, exhibitions of books, philosophical discussions, or just sit in the store and read books.

The *Book Store* is surround by old part of Belgrade, where readers could buy books and enjoy in beautiful literature events. The *Booka Store* presents old book, but core of business is publishing new book's titles written by popular authors in Serbian the region and the world. Public in Serbia is introduces, for the first time, some of the brilliant authors by from the world. Some literature projects and events are traditional, but some other literature projects are interactive, so visitors can take part in events.

The *Booka Store* is brand in opinion of public audience in Serbia and region. Brand of *Booka Store* has based on excellent book's names, writers, and brilliant artistic environment. Internal marketing in *Booka Store* has based on educated, young people that work in store, with brilliant communication skills. Atmosphere in store is peacefully, artistically and literature. Integrated marketing has based on clear message that *Booka Store* send to public audience, as place where people enjoy in literature.

The *Booka Stor*e has communication with public audience on social media, such as Instagram and Facebook, as well as web page. On the social media, readers have opportunities to be inform about old and new book's title, about literature events, about open discussion forums. The readers have opportunities to write about their opinions about books and create communities on some topics.

The storytelling of the *Booka Store* has based on open, free, cosmopolitan and artistically approach and stories, where in the focus is book and written words. When someone buy book in store or by online book store, there is opportunity to give e-mail address, so *Booka Store*, continually could inform about new book's titles, literature events, literature projects, or social responsible campaigns.

Public had opportunity to enjoy in literature services in *Booka Store*, as well as, to enjoy in literature events. Especially touchable is literature events with brilliant writers, present in Figure 5.

After literature events, visitors could write comments in the yellow book in *Booka Stor*e, or online, on web site, on Instagram, or Facebook pages. The comments are that visitors enjoy in beautiful written words, books, stories and literature events. The literature events had attention of media, televisions, radio stations, as well as, social media. The number of people in Serbia and region that love books from *Booka Stor*e rise every year and *Booka Store* become regional brand.

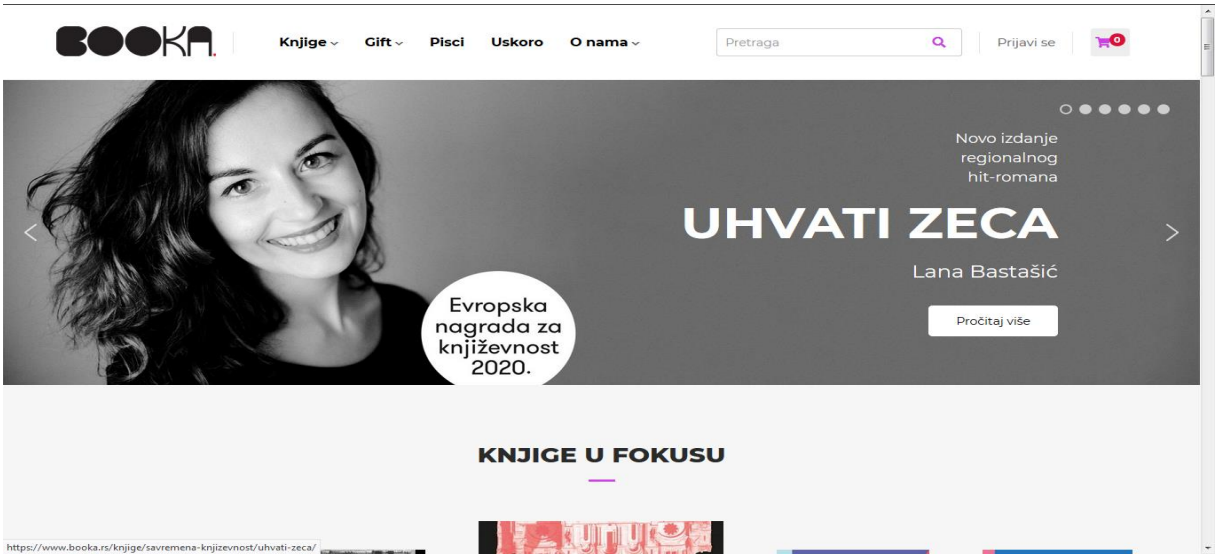

Figure 5: *Booka Store*
Source: (booka.rs)

Good example of implementation holistic marketing approach and experience marketing in literature arts is English the bookstore *Waterstones*. Visitors of the *Waterstones* adore walking around several flours of store and looking for new and old book's titles in the fields of science, as well as, poetry, child books and making brilliant literature experiences. Visitors enjoy in atmosphere of literature arts and culture in beautiful environment, full of literature arts, present in Figure 7.

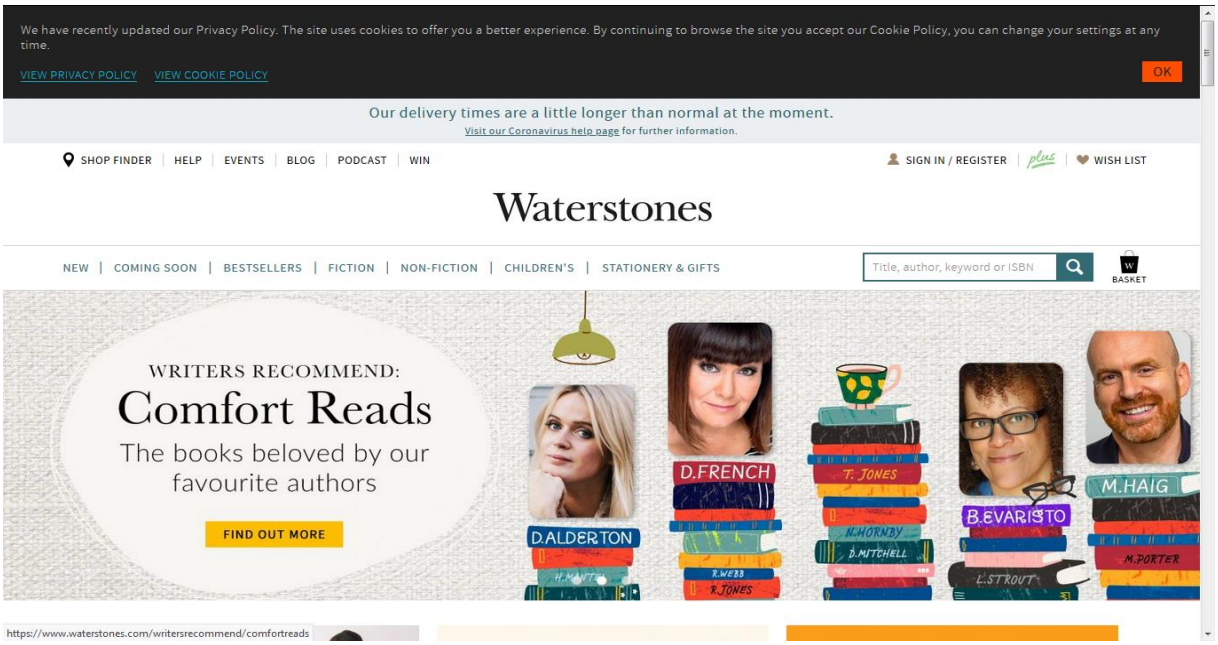

Figure 7: *Waterstones*
Source: (waterstones.com)

The good example of implementation of development of arts experiences, based on relationship marketing, is "Budva Theatre City". Every night in center of city Budva in Montenegro, during summer nights, tourists have

opportunity to enjoy some artistic presentation in "Budva Theatre City", in theatre events, in music events, literature events, exhibitions and philosophical discussions.

It is Theatre under the open sky, surrounding by old stone houses and in the center is stage where visitors could enjoy in arts, brilliant actors role, stories all-around of the world. Every nigh theatres around world present their theatre projects, literature events, music events, exhibitions, movie nights and philosophical discussions. Some projects are traditional, but some other projects are interactive, so visitors can take part in events. Visitors had opportunities to introduce beautiful theatre, literature and music events. Specially touchable is theatre events with stories of life of historical persons, music nights with brilliant musicians, writers, painters, photographers, present in Figures 8 and 9. After projections, visitors could write comments in the yellow book in theatre, or online, on web site of theatre, on Instagram, Facebook or Twitter pages. The comment was that visitors enjoy in beautiful artistically events. The theatre events had attention of media, televisions, radio stations, as well as, social media. The theatre events bring artistic experience to visitors.

Figure 8: Theatre City Budva, guest of evening is Bitef Theatre from Belgrade with "The King New Dress" (source: gradteatar.me)

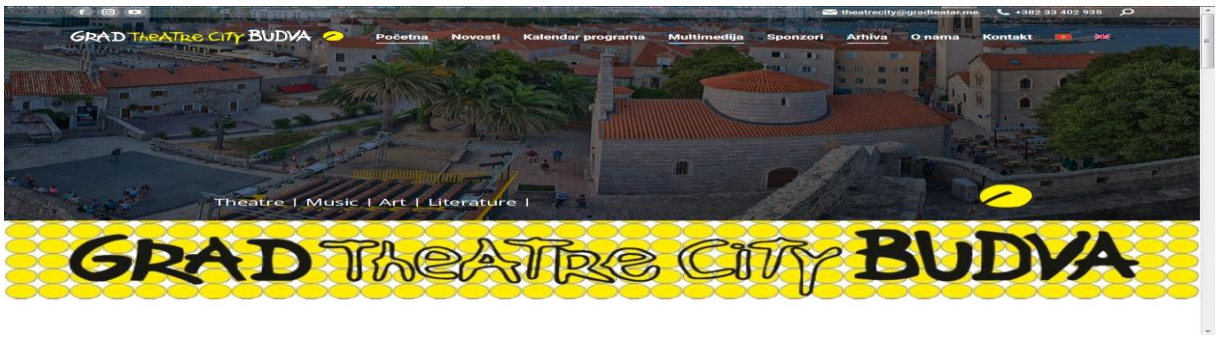

Figure 9: Theatre City Budva (source: gradteatar.me)

Author of this paper had opportunity to make focus group with managers in these cultural and arts institutions, organized on the Zoom platform. In focus group participated seven managers, four from Booka Store, and one from Waterstones and two from Theatre City Budva. Focus group organized on Zoom platform in October 2019. The focus group last one hour. The results of the focus group are important for cultural and arts institutions that whose managers participate in the focus group conversation. Author was moderator of the focus group. The key topic of focus group was impact of traditional and modern, social media relationship marketing in smart environment. The focus was on smart environment communication with target groups.

Managers of these cultural and arts institutions concluded that traditional and modern relationship marketing in smart environment have impact on development on culture and arts. Interesting is that they enlighten role of care about public audience needs and wishes. The key is to research public audience needs and wishes and to focus on development of cultural and arts events, according to their wishes. In the smart environment, it is easy to be in online communication with target groups, through social media, Instagram, Instagram television, Zoom platform.

All these cultural and arts institutions care about history of culture and arts, tradition of culture and arts, and, in that way, give brilliant, excellent experiences to public audience. They emphasize that in implementation of marketing in development of culture and arts, it is important to be passionate about culture and arts, be respectful and sophisticate in communication with public audience in traditional way and modern way in the smart environment, through social media and social platform.

The members of focus group, managers of of the cultural and arts institutions emphasized that it is important that offline and online media write in good way about their institutions, cultural and arts events. They concluded that media contents about cultural and arts institutions, culture and art's events have impact on development of cultural and arts institutions, as brand.

The members of focus group proved that relationship-marketing approach in culture and arts is synergy of sophisticate, passionate approach, based on marketing strategies. They emphasized that employees present culture of institutions. It is important that they have skills for good communications with public audience. Warm artistic atmosphere between employees is create element for brand building. The members of focus group proved that public is the best advocate for culture and arts projects. All members of focus group proved importance of social media in communication with public audience.

In the focus group, managers emphasized that in implementation of marketing in culture and arts, it is important to be passionate about culture and arts, respectful and sophisticate. Culture and arts open hearts and it is way to connect people and share messages.

5. CONCLUSION

The paper presents theoretical and empirical view on relationship marketing in development of culture and arts projects. Cultural and art's institutions could build brand, based on quality and commitment of public audience. In the paper are present case studies, from practice of cultural and arts institutions. The research in the paper has done by focus group with seven managers in the cultural and arts institutions that presented in case studies.

The paper proved that smart environment gives opportunity for communication through social media, Instagram, Instagram television, Facebook, or Zoom platform. The smart environment is modern way of communication and easy way to be in contact with target groups. Zoom platform is excellent online place, where people can share ideas, organized meetings, cultural and arts events, educational events. Relationship marketing have to change approach according to smart environment.

The paper presents the focus group with seven managers in cultural and arts institutions, presented in case studies. The focus group has organized on the Zoom platform. In the focus group participated seven managers, four from Booka Store, and one from Waterstones and two from Theatre City Budva. Focus group has organized on Zoom platform in October 2019. The results of the focus group are important for cultural and arts institutions whose managers participated in the focus group conversation. The key topic of focus group was impact of traditional and modern, social media relationship marketing in smart environment.

The paper proved that media contents, in smart environment, about culture and arts, have impact on development of cultural and arts institutions brand. Social media gives opportunities to share experiences about culture and arts, to write comments and create groups to describe beloved artistic projects. Specialized journals for culture and arts write about cultural and arts events and projects, but it is, also, important that daily newspaper write about cultural and arts information. Social media have the most important impact, because many vloggers have stories about experiences about cultural and arts events. Synergy of all these elements influences development of culture and arts.

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IMPLEMENTATION OF DIGITAL METRICS IN THE HOSPITALITY INDUSTRY

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Abstract: *In the past two decades, a large part of the scientific and professional public has been focused on the implementation of digital metrics systems which are gaining more significance with the constant expansion of the internet and the digitalization of business. A small number of papers deals with researching digital metrics in the hotel industry. Within this research, how certain factors such as the attitudes of managers and the size of the hotel affect digital metrics systems is analysed, as well as whether the levels of application of digital metrics affect the business performance. Also, the need to redesign traditional measurement systems based exclusively on financial metrics into contemporary measurement systems which equally value financial and non-financial metrics is emphasised. Within the research, hotel managers who operate in winter tourism centres of Bosnia and Herzegovina are surveyed with the aim of analysing the aforementioned factors.*

Keywords: *digital marketing, metrics, performance, hotels*

1. INTRODUCTION

The use of the internet is becoming increasingly present all over the world, and digital marketing is becoming an increasingly significant means of communication with existing and potential clients and a source of competitivenesss of companies (Leeflang, Verhoef, C., Dahlström & Freundt, 2014). Traditional methods of advertising are becoming passive for clients, so the primary position is taken up by digital marketing (Beckers, Doorn & Verhoef, 2017). The possibilities brought by digital marketing (global levels of communication with clients, lower implementation costs and the precise determining of the effiiency of digital marketing activities) and the limitations of traditional marketing have contributed to the expansion of digital marketing (Maddox, 2015). A large part of the scientific and professional public is focused on researching the possibilites offered by digital marketing (Leeflang et al., 2014; Järvinen & Karjaluoto, 2015). Digital marketing is an integral part of marketing strategies no matter the size and operations of companies. Companies, in line with the business objectives and the audience, create digital media content but the most important elements are: digital marketing objectives, pomotion channels, the content layout, frequency and measurement of digital marketing efficiency (Patrutiu Baltes, 2015).

Significant investments in digital marketing have conditioned the need for digital metrics systems development (Järvinen & Karjaluoto, 2015). Digital metrics are used by more than 60% of the most active web locations all over the world (Web Technology Surveys, 2014). Various authors highlight the significance of various digital metrics (Peterson, 2005; Bendle, Farris, Pfeifer & Reibstein, 2016). The most used digital metrics are: site visits, page displays, followers on social media, the rates of leaving the page and the time spent on the page (DeMers, 2014). The implementation of digital metrics is of extreme importance for hotels because it enables the analysis of the efficiency of digital marketing and determining the deficiencies in digital media content and the advancement of certain companies' offers (De Pelsmacker, Tilburg, & Holthof, 2018; Nakatani & Chuang, 2011).

2. LITERATURE REVIEW

The use of digital metrics dates back to the nineties, when the first web analytics tools were developed. Research shows that many do not use web metrics adequately and do not use their potential with the aim of advancing the quality of services (Chaffey & Patron, 2012). During the implementation of digital metrics, the focus should be on the choice of metrics, data processing and the organizational context of the use of measurement results (Järvinen & Karjaluoto, 2015). The precision of digital metrics is of the utmost importance for managing companies (Hennig-Thurau et al., 2010; Pickton, 2005; Wilson, 2010). Research has proved that the implementation of digital metrics has a positive effect on the financial performance of hotels (Phippen, Sheppard, & Furnell, 2004; Wilson, 2010).

The metrics which referred to the page views numbers directly influenced the number of hotel guests which was reflected on financial performance. A decrease in page views numbers and time spent on the page point to deficiencies in the hotel offer and was negatively reflected on business performance. Also, the aforementioned metrics could have helped the hotel managers in predicting the number of guests (Duverger, 2013). Hotel impressions are also reflected on the hotel performance (Viglia, Minazzi & Buhalis, 2016; Melián-González & Bulchand-Gidumal,, 2016). The number of positive reviews leads to business success (Viglia et al., 2016; Kim, Lim & Brymer, 2015; Zhu & Zhang, 2010). Viglia et al. (2016) state that the scope of page views and time spent on the website leads to positive performances. Authors often state that metrics are used as customer feedback in order to advance the offer and thus affect business performance (Wang, Miaoand Huang, 2013; Chen & Xie, 2008, Melián-González & Bulchand-Gidumal, 2016). The effect of digital marketing and determining its efficiency in the hotel business has received some attention in the literature (Cantallops & Salvi, 2014). Melo, Hernández-Maestro & Muñoz-Gallego (2017) suggest that hotel managers should establish a digital marketing plan which includes the mandatory implementation of a system for measuring digital performances.

Within various research, it is mentioned that the size of the hotels and the managers' attitudes affect the levels of metrics implementation (Hudson, Smart & Bourne, 2001; Garengo, Stefano & Bititci, 2005; Odar, Kavčič & Jerman, 2012; Wadongo, Odhuno, Kambona & Othuon, 2010). Large companies invest significant resources in digital marketing and use various metrics to determine the efficiency of digital advertising. Managers of small companies view digital marketing more as an expense rather than a generator of income. Managers and owners of small companies often often have a suspicious attidute towards the significance of digital marketing, and investments in digital marketing are kept to a minimum (Cole, DeNardin and Clow, 2017). Although small companies are a significant initiator of economic progress, the fact is that in the first five years of doing business, most small companies fail due to poor or insufficient marketing (Cronin-Gilmore, 2012). The use of digital media plays a significant role in the development of companies and helps small companies become more competitive, stable and permanent (Eid & El-Gohary, 2013). Logofatu and Alexandru (2012) claim that the use of digital media is significant for small and undeveloped companies, and companies that do business on small and underdeveloped markets because it enables the achieving of an international audience with fewer expenses, less effort and time. In order to save money, small hotels often do not used balanced digital marketing metrics systems and exclusively reduce measurement systems to financial analysis, due to which they cannot even perceive the significance of digital marketing (Cole, DeNardin & Clow, 2017; Pereira-Moliner Font, Tarí, Molina-Azorin, Lopez-Gamero & Pertusa-Ortega, 2015). In the case of large hotels, the situation is different. The application of non-financial digital metrics would be reflected on the more efficient management and improvement of service quality (Cole, DeNardin & Clow, 2017; Bohdanowicz, Zientara & Novotna, 2011). Small companies very often copy the digital campaign strategies of large companies, but what they lack is certainly analytical knowledge, skills and means for the use of digital metrics (Cole, DeNardin & Clow, 2017).

The authors underline that the successful implementation of measurement performance systems depends on the managers' attitudes (Wadongo, et al., 2010). Managers who have a positive attitude towards digital advertisement invest more significant resources and use metrics to determine the effects thereof. There are studies which indicate that managers' education has nothing to do with the attitudes of managers on the significance of digital marketing metrics. No matter the level of education, many marketing managers remain skeptical towards the use of digital metrics, using their own experience in bringing strategic decisions (Germann, Lilien, & Rangaswamy, 2013; Lilien, 2011). For a successful implementation of digital metrics, it is necessary for the company to possess: employee analytical skills, information technology quality and infrastructure, requirements for the implementation of digital metrics by the strategic management and an organizational culture (Cole, DeNardin & Clow, 2017).

3. RESEARCH

Within this paper, the part of the research related to the application of metrics in the hotel sector will be presented. Within the section which will be presented, the level of application of digital metrics of advertising, their relationship with the financial performance of business and the attitudes of managers on the usefulness of the application of digital metrics in the managementinf the hotel sector was analysed. The research was conducted on the territory of Bosnia and Herzegovina. 34 hotel managers who operate in the winter tourism centres of Bosnia and Herzegovina were surveyed, which comprises 71 percent of the hotels in winter tourism centres.

At the beginning of the research, through the analysis of the relevant literature (Peterson, 2005; Bendle et al., 2016) it was determined which digital metrics are the most used (18 metrics of digital marketing). In the interviews with the managers of the five biggest hotels, the list of metrics was refined and the metrics which

are used most often were chosen (ten metrics) and which mainly refer to digital advertising. After refining the list of digital metrics, the primary research was conducted. Within the questionnaire, three groups of questions were defined: the first group of questions was related to the financial results which hotels achieve (annual income), the second group of questions referred to the degree of application of select digital metrics and the third group of questions was related to the attitudes of managers on the usefullness of metrics of digital advertising during hotel management. In table 1, the characteristics of the hotel sample are shown.

Table 1: Hotel sample characteristics

Characteristics	Categories	N	%
Annual income	<500000 USD	15	44.1
	≥500000 USD	19	55.9
Sales growth in the past five years	≤1 %	13	38.24
	1%<, >3 %	13	38.24
	≥3 %	8	23.53
Ownership	privately-owned	22	64.7
	state owned	12	35.3

Of the 34 surveyed hotel managers, only one stated that he does not use digital metrics. Image 1 shows the frequency of digital metrics measurements. It can be seen on the graph that ten hotels meaure only one metric, and that three hotels measure all the offered metrics.

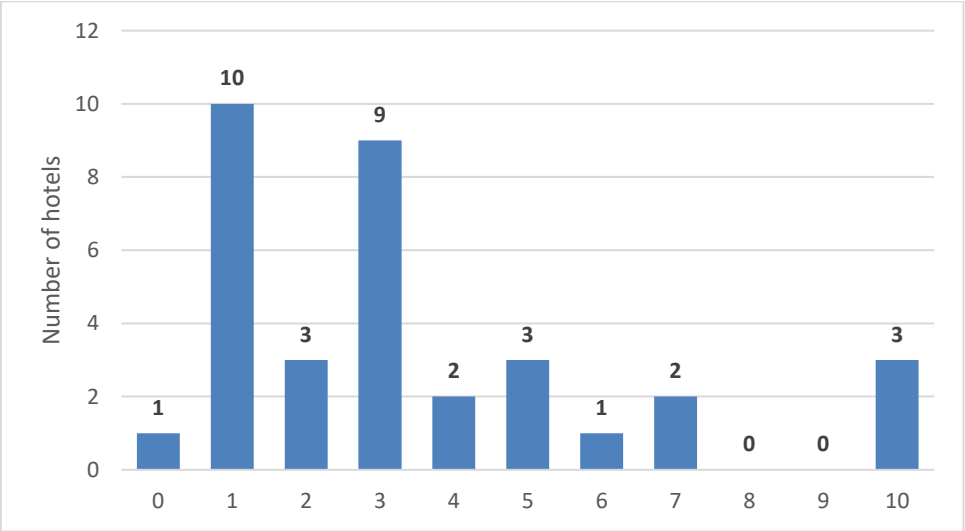

Figure 1: Frequency of digital metrics measurement

Table, 2 shows the frequency of application of the offered digital metrics. The biggest number of hotels use metrics related to financial values, and that is the profit achieved through digital marketing which is used by 32 hotels or, 27.6 %, followed by the click metric which is used by 18 hotels or 15.5 %. Digital metrics which are used the least are the conversion value and conversion price which is used by only 4 hotels or 3.4%.

Table, 2: Use of offered digital metrics

		Hotels	
		N	%
Digital metrics	Impression	15	44.1
	Click	18	52.9
	Click through Rate	10	29.4
	Cost per Click	9	26.5
	Cost per Mille	8	23.5
	Conversion	11	32.4
	Conversion value	4	11.8
	Conversion rate	5	14.7
	Conversion price	4	11.8
	Profit achieved through digital marketing	32	94.1

It was analysed whether there is a difference in the number of metrics which hotels measure compared to annual income, sales growth and ownership. The Mann-Whitney U Test and the Kruskal-Wallis Test were used. In tables 3, 4 and 5, the resuls of the testing are shown.

Table 3: Level of digital measurement differences between different annual income

Level of measurement	<500000 USD		≥500000 USD		U	Z	p
	Md	n	Md	n			
Digital marketing PI	2	15	3	19	211.5	2.45	0.015

Table 4: Level of digital measurement differences between different sales growths

Level of measurement	≤1 %		<1, 3> %		≥3 %		χ2 (2, 34)	P
	Md	n	Md	N	Md	n		
Digital marketing PI	2	13	3	13	3.5	8	3.90	0.142

Table 5: Level of digital measurement differences between different hotel ownership

Level of measurement	state-owned		privately-owned		U	Z	p
	Md	n	Md	n			
Digital marketing PI	2.5	12	3	22	143.5	0.42	0.683

Table 6 shows the mean value and the standard deviation of managers' attitudes on the usefulness of digital metrics during hotel management, which were marked on a scale from 1 to 5 (1- completely useless metrics, 5- absolutely useful metrics).

Table 6: Usefulness of digital metrics during hotel management

	N	Minimum	Maximum	Mean	Std. Deviation
Digital metrics mark	34	1	5	3.41	1.048

Based on the results achieved, the average mark of the usefullness of digital metrics is 3.41, which means that hotel managers consider digital metrics useful in the process of hotel management.

In the following section, it was analysed whether there are differences in the managers' attitudes compared to the annual income, sales growth and ownership. Tables 7, 8 and 9 show the test results obtained through the application of the t-test and ANOVA.

Table 7: Level of difference in attitudes of managers concerning the importance of measuring performance indicators between hotels with different annual income

Attitudes toward measurement	<500000 USD		≥500000 USD		t(32)	p
	M	SD	M	SD		
Digital marketing PI	3.07	1.16	3.68	0.89	-1.76	0.09

Table 8: Level of difference in attitudes of managers concerning the importance of measuring performance indicators between hotels with different sales growths

Attitudes toward measurement	Growth ≤1 %		<1, 3> %		≥3 %		F(2, 31)	P
	M	SD	M	SD	M	SD		
Digital marketing PI	2.62	0.87	3.77	0.83	4.13	0.84	9.73	0.001

Table 9. Level of difference in attitudes of managers concerning the importance of measuring performance indicators between hotels with different ownership

Attitudes toward measurement	State		Private		t(32)	p
	M	SD	M	SD		
Digital marketing PI	3.42	0.90	3.41	1.14	0.02	0.98

4. CONCLUSION

A number of positive effects on business achieved through the implementation of digital marketing have affected the managers of companies to invest significant resources into this field. The effect of digital marketing in the hotel industry is exceptional (De Pelsmacker, Tilburg, & Holthof,, 2018). In line with the levels of investment, the implementation of adequate systems for measuring the efficiency of digital

marketing is necessary (Sainaghi, 2010; Järvinen & Karjaluoto, 2015; Nakatani & Chuang, 2011). Digital metrics systems are used as a medium of control of results achieved but also as an instrumnent of managing in the function of advancing service quality (Llaci., Kume & Leskaj, 2002; Bendel et al., 2016; Järvinen & Karjaluoto, 2015).

The relevant literature in the field of performance measurement most often analyses three key areas. The first is the redesigning of traditional measurement systems which exclusively rely on financial analysis. Also, the implementation of contemporary measurement systems based on the equal application of financial and non-financial indicators. Various authors still express concern when it comes to the process of modernization of measurement systems in the hotel industry, highlighting the dominant effect of financial metrics, indicating the deficiencies of traditional systems and their negative effect on future business outcomes (Sainaghi, 2010; Louvieris et al., 2003; Haktanir & Harris, 2005; Gomes et al., 2007 Kaplan & Norton, 1992 Banker et al., 2004). The second group of research determines the effects of the implementation of a performance measurement system on the business outcome of companies. The aforementioned research points to the significance of the application of metrics in the function of advancing communication with clients, the advancement of the company's service quality which is also positively reflected on financial business results (Järvinen & Karjaluoto, 2015; Phippen, Sheppard, & Furnell, 2004; Wilson, 2010; Duverger, 2013, Viglia et al.,, 2016; Melián-González et al., 2013; Kim et al., 2015; Zhu & Zhang, 2010; Wang et al., 2013; Chen & Xie, 2008). The third group of research analyses the attitudes of the managers on performance measurement systems, indicating that positive attitudes of the strategic management of companies on metrics are a crucial factor for accepting and the quality of implementation of measurement systems (Germann, Lilien, & Rangaswamy, 2013; Lilien, 2011; Wadongo, et al., 2010). Also, it is stated that small hotel managers, due to a lack of resources and employee analytical skills, neglect the influence of the implementation of measurement systems or these systems are based exclusively on financial performances. On the other hand, managers of large hotels invest significant resources in measurement systems, introducing them as formal instruments of management. Based on this, it can be concluded that the size of the hotel has influence on the degree of implementation of performance measurement systems (Cole, DeNardin & Clow, 2017; Pereira-Moliner et al., 2015, Bohdanowicz, Zientara & Novotna, 2011).

The results of this research do not deviate from the results of relevant studies in this field. Within this research, it was proved that hotel managers most often rely on financial metrics, the profit achieved through digital advertisement, which is applied by 32 hotel managers, while other non-financial metrics are less represented. The aforementioned result is harmonised with the results shown in the relevant literaure, that the effect of financial metrics is still primary, and that the significance of non-financial metrics is still not sufficiently accepted. Such a way of operating may jeopardise future business performance, because companies cannot perceive the strategic initiators of development. Based on the European standard on hotel size, hotels which achieve an annual income of over $5 000 000 are considered large hotels (Statista – a web site for the hotel inudstry of Europe). Based on the aforementioned standards, mainly small and medium-sized hotels operate in the winter tourism destinations of Bosnia. In line with the conclusions of the relevant research, small hotels are faced with problems of a lack of employee analytical skills, information technologues and an organisational culture. Managers of hotels in Bosnia face the same problems as small hotels due to which they cannot adequately implement and completely assess the quality of the digital metrics system within the process of hotel management. In line with the aforementioned, hotel managers consider digital metrics useful and on a scale of 1 to 5, they give them a mark of 3.41. Based on the results of the analyses, it can be concluded that there is a difference in the levels of income achieved and levels of application of digital metrics. Such results are in line with what is presented in the relevant literature - that hotels which achieve better business results use a larger number of digital metrics compared to those hotels which use a smaller number of metrics. However, what is concerning is that there is a large difference in managers' attitudes concerning the usefulness of digital metrics. Analysis has shown that hotel managers who have a larger annual income and hotel managers who have a larger annual growth assess digital marketing metrics as more useful.

This research has a number of limitations. The first limitation is the small sample of 34 respondents. Considering that the respondents are hotel top managers, this sample is considered to be a VIP sample, and the literature justifies this sample as strategically significant (Melian-Gonzalez & Bulchand-Gidumal, 2016). Also, one of the limitations of this research is the insufficient questioning of the attitudes of the managers on the usefulness of digital marketing metrics. Within this research, managers have given a common mark for digital marketing metrics, and it would be more precise had the managers assessed each of these ten metrics individually. Within this paper, there is room for improving the quality of the research. One of the directions of future research would be the analysis of factors which influence the choice of digital marketing metrics. In future research, what is the number of optimal digital marketing metrics which managers use, and which would be the most efficient within the hotel management process could also be perceived.

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EXPLORING THE FACTORS WHICH IMPACT THE PROMOTION AND WOM IN THE MOVIE INDUSTRY: THE CASE OF MILLENNIALS

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Abstract: *The specificity of creative industries, and thus the film industry, is reflected in the fact that, if we strive to maximize profit from the final product, there is a requirement for significant investments in the production process. This is not mandatory and most often not the case in traditional industries. It is a well-known fact that the certainty of the movie's profitability and good reception by the audience can never be presented to a large enough audience. Knowing that, authors paid special attention to the influence of two very typical factors in movie industry - such as promotion and WOM (Word of Mouth). The authors will try to explore the factors which have an influence on the importance of these two aspects among millennials.In the first part of the paper, authors will present the importance of these factors through a review of the literature, while in the second part of the paper contains analysis of the results of the primary research that has been conducted for this paper.*

Keywords*: marketing, promotion, word of mouth, movie industry, millennials*

1. INTRODUCTION

This paper considers the importance of the factors which have an influence on the importance of promotion and WOM among millennials.The importance of WOM is emphasized by numerous studies pointing out that WOM has a stronger impact on customer behaviour in relation to other sources. In addition to behaviour, WOM also affects others cognitive states of consumers such as awareness, expectations, perceptions, attitudes and intentions (Buttle,1998). On the other hand, every movie needs some kind of promotion. Today, there are lot of promotional strategies that companies are looking for in movie industry. Every movie is a new product and each one is different one, as it has different content, is targeted at different audiences, and has different deal structures. There may be 5 or 6 or even more movies released every week, yet every campaign must hit the target on time. Additionally, the marketing of a movie is consumed fast, there is little or no time to test-market it before its release or before one source or another gets word of buzz on a movie and broadcasts it to the world at large (Lieberman & Esgate, 2002).

Certainly, there is ample evidence that generations are different. What may be important is the need to establish a level of understanding about millennials so environment can challenge them in relevant ways (Simons, 2010). Knowing that, understanding their habits, needs, perceptions and interests is useful for marketing activities in movie industry.

The paper is organized as follows: the second Section features a literature review on the importance of promotion and WOM in the movie industry. Section 3 sees the presentation of the proposed research approach and the conducted survey. The results of the statistical analysis are presented and elaborated in Section 4, while the concluding remarks of the study are given in the final chapter.

2. LITERATURE REVIEW: THE IMPORTANCE OF PROMOTION AND WOM IN THE MOVIE INDUSTRY

The movie industry is an entertainment industry that includes three different sectors: production, distribution and screening of movies. Final products of the movie industry are movies, whose production requires high monetary expenditures. The ultimate goal of the movie industry is to make profit, however, given that movies

are experiential services, it is difficult to predict the movie's earnings and success, since they depend on the tastes and preferences of consumers.

What characterizes the experiential services is the fact that the consumer/viewer can know their value, it results only after purchase and consumption (Mitra et. al, 1999). Movie industry has always promoted on a difficult way (Caves, 2011). But in recent years movie marketing budgets have been increasing fast. They have grown 50% between years 1999 and 2005 and hit 60% of the total production costs (Albert et. al, 2000). At the same time the industry is characterized by intensive WOM communication among (potential) consumers. This makes sharing of experience and influencing late-comers decisions an easy task.

According to Chintagunti (2017) WOM affects earnings from movie, but not the volume of online reviews. Movie marketing used to be an insular and backwater function in the Hollywood ferment. With movie promotion expenses soaring and competition for “moviegoers” are on the rise. Movie producers, movie creative executives and movie financiers want to understand how movies will be launched and at what price. Movie marketing directly has an impact on the other industries (Marich, 2013). The marketing of movie and of other entertainment differs from forms of promotion

Movies are also characterized by a relatively short market presence when compared with other goods and service offers. Hennig -Thurau (2001) found that on an average, a movie is available to audiences in cinemas for a period of 8 weeks before it is forced out of the market by a successor. Thus, movies are highly dynamic and constantly dominated by new ones.

The promotion of the movie includes various techniques and media, starting from television, radio, internet and print media, through billboards and posters. Advertising through television, radio, print media and the internet is unavoidable in film promotion. The form of promotion on television, internet and radio implies a short film advertisement, the so-called trailer, which usually lasts about 30 seconds, and shows selected scenes, which best reflect the quality of the movie. King (2007) states that over 40% of the budget for movie promotion is spent on television, where emphasis is placed on promotion two to three days before the movie’s premiere. Sometimes a site is created for the purpose of promoting the movie, and movie trailers are often posted on social networks such as YouTube, the Facebook pages of the production company, the actors or the director. The promotion of the movie also includes billboards and posters, which include a selection of a specific scenes from the movie and represent the main attraction of the movie, such as the actor, the title of the movie, visual information about the plot of the movie (Mehrabi, 2011). Social media marketing, also, plays an important role in the satisfactory promotion of creative industries, such as movie industry (Wawrowski & Otola, 2020). Promotion is the last element in determining the marketing mix, which is a logical sequence, since each marketing campaign previously requires information about what product is offered, at what price and where it will be available to consumers (Kolber, 2010).

Billboard advertising mainly represents the first phase of movie promotion, which begins a few weeks before the movie promotion (Caves, 2011). Also, what is important during the promotion of the movie and what greatly influences the way the movie will be received by the audience is the critique of the movie.

WOM can be defined as personal communication (positive or negative) between the recipient and the source that the recipient of the information perceives as non-commercial in terms of brand, product or service (Arndt, 1967). Buttle (1998) emphasizes how WOM affects a whole range of consumer conditions - awareness, expectations, attitudes, behavioral intentions and reality behavior, as well as the way the environment is experienced. The impact that WOM have on the consumer is stronger than the influence of other sources of information and one of the main reasons for such the situation lies in the fact that WOM comes from neutral sources, individuals who are not directly related to the product, service or brand and which consumers trust more than sellers and marketers (Buttle, 1998).

Characteristics of WOM are (Kotler, 2014):
1. **Impact** - Word of mouth can have a significant impact as people trust other people which they know and which they respect;
2. **Personality** - WOM reflects the opinions, attitudes and experiences of the individual;
3. **Timeliness** - WOM is happened when individuals want it and when they are interested for it.

WOM is a powerful force which can, through multiple exchanges, reach and influence large portion of the society (Babutsidze, 2011). Word-of-mouth augments advertising in diffusion of information across the potential customers. However, unlike advertising, which has a clear aim of inducing people to buy a product, word-of-mouth does not have an ultimate target as it is un-coordinated collective effort. The important implication of this difference is that it is possible, and in fact quite plausible, that negative sentiment about the product diffuses through peer-to-peer interaction. Due to fact that consumer interaction plays somewhat similar

but at the same time very different role from advertising, makes studying the interaction between these two forces interesting (Babutsidze, 2011).It is believed that negative word-of-mouth has effects of substantially larger size than its positive counterpart (Park et. al, 2009).
Also, electronic word-of mouth (eWOM) has attracted considerable interest from researchers in the past decade and it is definitely evolving (King et. al, 2014). Online WOM can impact consumers' product evaluations, purchase intentions, and their choices (Moore & Lafreniere, 2019).

WOM in movie industry have high importance and affect earnings in three ways (Liu, 2006):

- WOM create product awareness (awereness of movie),
- WOM influence the consumer's evaluation of the movie and
- affects decision of purchasing.

As Bansal and Voyer (2000) state that "although there exists much opinions regarding the power and usefulness of WOM, there is surprisingly little empirical research that examines the 'procedural' aspects." WOM plays a significant role in service activities due to the intangible nature of services which prevents pre-purchase testing and rehearsal that are possible with tangible goods. Therefore, a judgement about the quality of the product consumer is about to purchase can be imprecise.

As potential consumers are aware of this fact, their perceptions are susceptible to word-of-mouth coming from consumers that have already seen a movie. This is especially evident in complex services or services whose purchase and use carry a high level of perceived risk intangibility of services increases the perceived risk, which leads to an increase in the search for information by word of mouth surrenders, to reduce the risk. Due to the perceived risk, those sources do not have credibility associated with the service in question and which do not promote it (Sweeney et. al, 2006). Movies are experiential services, so WOM significantly affects movie success. The launch of a new movie, like the launch of new products, is followed by marketing campaign and ads to intrigue consumers and create certain expectations related for a product or service (Liu, 2006). Movie industry is characterized by extensive promotion and WOM among (potential) consumers. WOM that propagates through fixed social network is affected by the mismatch between consumer's expectations and realized quality of the movie. As a result, intensive promotion is running a risk of generating overly negative WOM, while moderate levels of advertising generate positive WOM that is complementary to promoting efforts. The most striking finding is that marginal returns to promoting can become negative high levels of promoting. This effectively means that for intensive advertising campaigns and additional commercials might result in the reduction of the audience (Babutsidze, 2011). WOM is a key factor for success to achieve high playability.

A picture's playability is the way it satisfies an audience interested in seeing it. The act of purchasing the movie ticket is already evidence of some level of interest in seeing the movie. A key component of playability is the level of satisfaction: How satisfying the movie is. If it is highly satisfying, then most likely audience members will encourage friends to go. This spreads WOM about the movie, a key factor for success, and allows the movie to grow and sustain itself in the marketplace. Popular movies such as Titanic, Forrest Gump and The Blair Witch Project have high playability – they are very satisfying to a broad audience. Highly positive WOM helped bring in returning viewers, allowing these pictures to become extremely profitable at the box office and beyond (Maltin, 2004). WOM is present before and after the movie premiere and in the pre-screening phase WOM can be minimal if movie critics 'reviews and advertising can meet the needs of consumers for information (Liu, 2006). Before the movie premiere, advertisements, promotional messages and often movie reviews, related to the movie are usually positive. From the above it is possible to conclude that the WOM before the screening of the movie is mostly positive and after screenings of the movie the actual experience of the viewer affect the valence of WOM (it grows negative WOM) (Maltin, 2004).

The experience of watching a movie is the main driver of WOM teaching in the audience (Anderson, 2006) indicating an increase in WOM teaching with an increase in the number of viewers. Positive word of mouth usually refers to a direct or indirect recommendation to watch a movie. Positive WOM increases the expected quality and the consumer's attitude towards the product / movie and negative WOM reduces the quality and attitude of customers, consumers are willing to accept the negative an opinion of a movie if it shows controversy rather than a bad product. Since it is verbal, the view of the movie generated by the viewer can be perceived as more reliable in the relationship to other forms of advertising and is considered to better reflect the taste of the audience compared to the taste movie critics (Holbrook, 2006). Rawal and Saavedra concluded that the volume of WOM has a significant impact on total movie earnings.The higher the WOM volume is, the higher will be the probability that potentially consumer will hear it, and greater awareness of the product / service generates more sales (Rawal & Saavedra, 2017). Liu (2006) showed that the valence of verbal teaching is more positive before showing a movie when expectations before the screening of the movie are higher. The author states how the valence of verbal tradition has no significant impact on movie earnings. Moon (2017)

concludes that there is a link between UP and movie revenue, more specifically to user reviews of critics and viewers significantly affect movie earnings.

3. RESEARCH METHODOLOGY

3.1 Proposed research approach

In the proposed study, we strived to determine which factors have an impact on the importance of different means of promotion and on WOM of different aspects of the movie. We observed two groups of characteristics: Demographic characteristics and Habits and attitudes reagrding movies. The demographic characteristics we took into account are gender, education, age, and income. In the other group of characteristics we placed self-perception as a fan of movies and the number of movies watched per month. The proposed research approach is given in Figure 1.

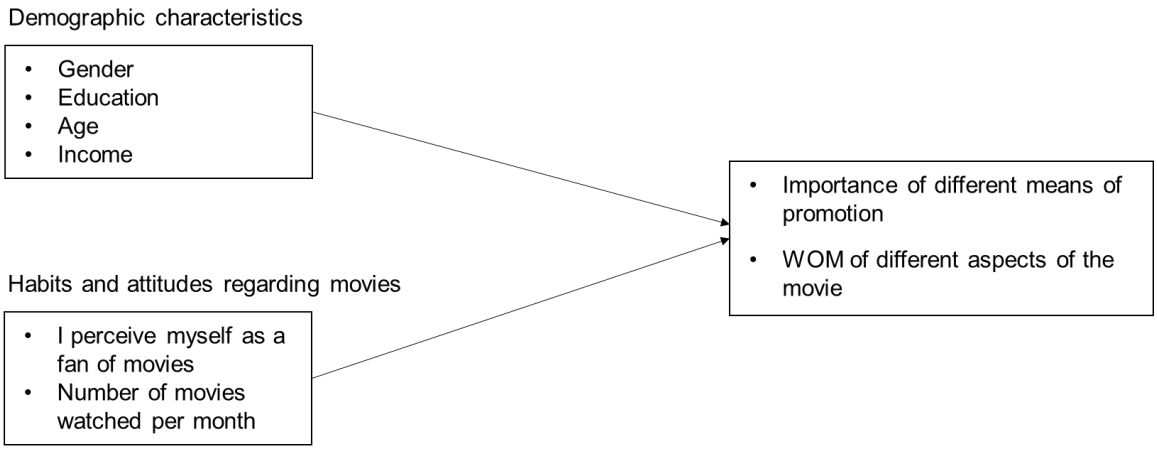

Figure 1: Proposed research approach

Accordingly, four reseach hypothesis emerge:
H1: Demographic characteristics have an impact on the effectiveness of WOM of different aspects of the movie
H2: Demographic characteristics have an impact on the importance of different means of promotion
H3: Habits and attitudes regarding movies consumption have an impact on the effectiveness of WOM of different aspects of the movie
H4: Habits and attitudes regarding movies consumption have an impact on the importance of different means of promotion

3.2 Conducted survey

In order to asses the reseach hypothesis we created a survey which was conducted online from April 1st until April 10th 2020. The survey was distributed on Facebook study groups of different faculties of the UB, on personal profiles of authors, and on groups and pages related to movie industry. Afterward, the statistical analysis was performed using SPSS 25. The survey consisted of questions covering four areas: demographic characteristics, habits related to watching movies, opinion on means of movies promotion, and word of mouth (WOM). The first section of the survey asked the respondents basic demographic information which included gender, age, income, and place of residence. The following section aimed at anaysing how of the respondents watch movies, who they watch it with, and where they most commonly watch it. The next section strived to observe how different means of promotion are important to respondents in persuading them to see a movie. Finally, we aimed to shed light on how WOM on different aspects of the movie impacts the respondents.

4. RESULTS

4.1. Sample characteristics

After closing the survey, 1728 responses were submitted. As the survey was opened to everybody with the link, the sample consisted of respondents who cannot be categorised as young millennials and old centennials. We strived to observe the younger generations who have finished higher education or are currently attending it. As millennials are observed as those born between 1981 and 1996 and centennials as those born between 1997 and 2012, we observed those born between 1990 and 2000. After the removal of respondents who were younger or older then defined, the sample consisted of 1023 respondents.

In the sample which we closely analysed we had 768 female respondents who make 75.1% of the sample, and 255 male respondents who make 24.9%. A disproportion in the respondent's gender can be noted. However, such a disproportion could have been expected having in mind that females are more prone to participating on online survey (Smith, 2008). When it comes to the age distribution of respondents, the mean age is 25.249 with the standard deviation of 2.735. When it comes to their heights level of educational attainment, none of them has only primary school, 40.4% of them has Bachelor's degree or equivalent, 34.7% has high school, 24.9% has a master's degree or PhD.

Taking a closer look on their personal income, we can say the following: most of the respondents (32.5%) has no personal income, followed by those who have between 20,000 and 50,000RSD (19.1%), those with 50,000 to 80,000RSD (18.5%), and those with income above 80,000 (11.2%). The rest refused to answer or have income below 20,000RSD. Most of the respondents are from Belgrade, 453 of them, while the rest are from cities in Serbia and region. The demographic structure indicates that we have covered a part of the younger generation who has high level of education attainment and has personal income around or above Serbia's average income.Next, we present the habits of our respondents related to watching movies. The mean number of movies the respondents watch on monthly basis is 3.009 with the standard deviation of 2.234. The median is 3, indicating that half of the respondents watches 3 or less movies per week.

Therefore, we can say that most of our sample are those who watch a lot of movies on weekly basis. Next, 69.5% of the respondents observes themselves as someone who likes and extremely likes to watch movies. Most of the respondents watches movies alone (54.6%), followed by watching movies with partner (28.0%). If they are watching a movie in the cinema, most of them will go to the cinema in their neighbourhood (44.6%) or in big cinema chains (32.3%). The rest goes to film estivals and culture centers.

4.2. The effect of gender on promotion and WOM

As presented above, a slight disproportion in the gender of respondents has been noted. However, the Mann Whitney (MW) test proved to be stable even when the samples are unequal (Zimmerman, 1987), which encouraged us to proceed with the comparisons using the MW test. The comparisons between male and female respondents and their importance of different means of promotion is given it Table 1. The MW test showed that there is statistically significant difference between males and females regarding the impact of promotion in print and marginally significant difference in case of billboard promotion. In both cases, the female respondents are more influenced by these channels of promotion. Interestingly, no difference was noted for the promotion on social networks. Also, this channel of promotion has the highest means per gender indicating that both genders are highly impacted by the promotion on social network.

Table 1: Mean and standard deviation per gender, Mann Whitney test statistics, absolute mean difference and the direction of the observed difference

Channel of promotion	Gender	Mean ± SD	MW test	Abs mean difference	Difference
Print	Male	1.67 ± 1.019	-2.844*	0.173	Male < Female
	Female	1.85 ± 1.069			
Bilboard	Male	2.02 ± 1.160	-1.934*	0.150	Male < Female
	Female	2.17 ± 1.187			

Note: * $p<0.05$

Next, we wanted to analyse do male and female respondents value the WOM the same on different aspects of the movie. We observed the WOM on acting performance, director, producer, scenario, movie as a whole, distribution channel, and scores on IMDB. The only case for which statistically significant difference was found was for the WOM on the director. Namely, female respondents place more significance on the WOM on the director than males ($m_{female}=1.85$, $m_{male}=1.67$, $Z=-4.152$, $p<0.01$).

4.3. The effect of educational attainment on promotion and WOM

The scale for measuring educational attainment had five levels. However, as the respondents were not equally distributed among them, several groups were merged, so as to obtain more reliable results. Such an approach to fusing the levels of the categorical variables is called level collapsing (Gertheiss & Tutz, 2010). Herein, we collapsed the levels master's and PhD. To compare groups, we used Kruskal Wallis test.

If statistically significant difference was found, we further employed Mann Whitney test to determine between which two groups there is statistically significant difference. Interestingly, no statistically significant difference

was found between the respondents with different educational attainment taking into account the impact of different channels of promotion on their decision to watch a movie.

Therefore, we can conclude that education attainment does not have an impact on the effectiveness of promotion on different channels. Next, we wanted to analyse do respondents with educational background value the WOM the same on different aspects of the movie. The only case for which statistically significant difference was found was for the WOM on the scenario ($m_{high\ school}$=3.11, $m_{bachelor}$=2.78, $m_{master\ and\ PhD}$ =2.75, Z=10.812, p<0.01). According to the MW test, the respondents with finished high school are the ones who are the most impacted with WOM.

4.4. The effect of age on promotion and WOM

To analyse the impact of age on the importance of promotion activities and WOM for the respondents we used the Spearman's correlation coefficient. The results indicate that age impacts the importance of two channels of promotion: billboard and social media, and two WOM: scenario and movie as a whole (Table 2). All obtained correlation coefficients are low, negative, but statistically significant. These results can be interpreted that the older respondents do not take into account the promotion of the movie on billboards and social media as a factor which will impact their decision to watch a particular movie.

Observing the impact of age on the importance of WOM the result is unexpected. Both correlation coefficients are low and negative indicating that the older respondents to do not pay attention on the recommendations on scenario and movie as a whole.

Table 2: Spearman's correlation coefficient between age and the impact of different channels of promotion and WOM on the decision to watch a movie

	Channel of promotion		**WOM**	
	Bilboard	Social media	Scenario	Movie as a whole
Age	-0.082**	-0.071**	-0.128**	-0.113**

Note: ** p<0.01

4.5. The effect of income on promotion and WOM

To analyse the impact of income on the importance of promotion activities and WOM for the respondents we used the Kruskal Wallis test. In order to obtain more reliable results, when conducting the test, we did not observe the 95 respondents who did not want to provide information on their income. The remaining five groups were more or less coherent, with the group of respondents with high school being the largest.The results indicate that there is statistically significant difference in the effect of promotion in print between different income groups (KW=10.541, p<0.05). The MW test showed that those with lower income (up to 20,000RSD) pay significantly more importance on this channel of promotion than those with income from 50,000RSD to 80,000RSD. Next, we found differences in the effect of the WOM on the scenario (KW=11.629, p<0.05). The MW test showed that those with lower income (up to 20,000RSD) pay significantly more importance on suggestion on the scenario than those with income from 20,000RSD to 50,000RSD. Also, differences were found for the WOM on distribution channel (KW=11.776, p<0.05). Interestingly, those with the highest income, above 80,000RSD, pay significantly more attention to this WOM than all other income groups.

4.6. The effect of self-perception of a movie fan on promotion and WOM

To analyse the impact of number of movies watched per week on the importance of promotion activities and WOM for the respondents we used the Kendall's tau correlation coefficient. The results indicate that there is no influence of the number of movies watched on any channel of promotion. Namely, all obtained correlation coefficients are low and not statistically significant. However, the results on the importance of WOM provide interesting insights (Table 3). Namely, the more the person perceives himself/herself as a movie fan, the more will they value the WOM on the director, producer, and the IMDB score. On the other hand, they will not value the suggestions on the movie as a whole and on the channel of distribution. The obtained correlation coefficients are low, but statistically significant.

Table 3: Kendall's tau correlation coefficient between self-perception as a movie fan and the impact of WOM on the decision to watch a movie

	Director	**Producer**	**Movie as a whole**	**Distribution channel**	**IMDB Score**
I perceive myself as a movie fan	0.121**	0.078**	-0.094**	-0.063**	0.058*

Note: ** p<0.01

4.7. The effect of number of movies watched on promotion and WOM

To analyse the impact of number of movies watched per week on the importance of promotion activities and WOM for the respondents we used the Spearman's correlation coefficient. The results indicate that there is no influence of the number of movies watched on any channel of promotion. Namely, all obtained correlation coefficients are low and not statistically significant. On the other hand, number of watched movies impacts the effect of WOM on acting performance, scenario, movie as a whole, and distribution channel impact (Table 4). All obtained correlation coefficients are low, negative, but statistically significant. These results can be interpreted as that the more movies the respondents watch and have seen, they have developed their own independent taste in movies, which is less susceptible to opinions and suggestions from others.

Table 4: Spearman's correlation coefficient between the number of watched movies per week and the impact of WOM on the decision to watch a movie

	Acting performance	Scenario	Movie as a whole	Distribution channel
Number of watched movies per week	-0.109**	-0.063*	-0.173**	-0.063**

Note: ** p<0.01

5. CONCLUSION

Creating specific environment in order to engage millennials is one of the biggest challenges nowadays. However, creating a suitable promotion in order to attract millennials and get positive WOM, in creative industries, should be a great challenge. It definitely requires a totally unique approach.

WOM not only informs but also influences the audience's choice. Additionally, from all the relevant factors, the only one that has stronger effect on the pre-release as well as post-release of a movie is the word of mouth communication about the movie. Rawal and Saavedra (2017) concluded that the volume of WOM has a significant impact on total movie earnings. The higher the WOM volume is, the higher will be the probability that potentially consumer will hear about it, and greater awareness of the product / service generates more sales.

After conducting the review of the literature, it is noticable that certain demografic characteristics and habits influence the effectiveness of movie promotion and WOM and that few information conducted by primary research takes a significant part in order to direct marketing activities. The results of the conducted reseach show that all hypothesis have been partially confirmed except H4. It is very important to emphasis that the both genders of millennials are highly impacted by the promotion on social network. The only case for which statistically significant difference was found was for the WOM on the scenario. The MW test showed that those with lower income (up to 20,000RSD) pay significantly more importance on suggestion on the scenario than those with income from 20,000RSD to 50,000RSD. Also, differences were found for the WOM on distribution channel (KW=11.776, p<0.05). Interestingly, those with the highest income, above 80,000RSD, pay significantly more attention to this WOM than all other income groups. Also, the more the person perceives himself/herself as a movie fan, the more will they value the WOM on the director, producer, and the IMDB score. On the other hand, they will not value the suggestions on the movie as a whole and on the channel of distribution. These results can be interpreted as that the more movies the respondents watch and have seen, they have developed their own independent taste in movies, which is less susceptible to opinions and suggestions from others. Those information can be crucial for forming creative basis in marketing activities and understanding the target market in movie industry.

During our reseach we could identify two possible future directions of the study. The first one encompasses the creation of a conceptual model which will explore the interrelations of different aspects of movies marketing mix and how can they impact the decision on consumption of the movie. Such an approach was taken by Elif, Ayse and Gulhayat (2018). On the other hand, the conducted survey could be replicated in the countries in the region thus enabling cross contry comparison. We hope that the proposed reseach will add to the existing literature on marketing in creative industries and will act as an impetus for further research on the topic.

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SMART ENVIRONMENT FOR COMMUNICATION IN FINANCIAL INDUSTRY

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Abstract: *The modern business environment in financial industry is very dynamic and subject to rapid changes as a result of technological innovations, increased awareness and increasingly sophisticated requirements of customers. The adoption of ICT by financial institutions has a positive effect on the communication effectiveness, as well as overall business performance. The relevance of big data technologies in today's business is huge since they are essential for data management, analytics and development of tailored financial products and services, as well as communication strategies. The application of artificial intelligence and other modern technologies has become increasingly popular in the financial industry, due to their potential to provide customers with efficient and personalized services at low costs, and create smart environment for the development of effective communication with target groups.*

Keywords*: financial industry, technological innovations, personalization, communication*

1. INTRODUCTION

Organizations in the financial industry operate in a complex and competitive environment characterized by changing market conditions and unpredictable economic climate. Modern market business in financial industry is characterized by increasing complexity of products and services, development of new communication systems based on the Internet and use of modern communication and information technologies (Kirakosyan & Dănăiaţă, 2014). Digitalization of communication processes has brought operationally more efficient communication models, greater possibilities to attract target groups of customers and penetrate to new markets, which, consequently, enables financial organizations to generate new sources of revenue (Krstić & Tešić, 2016). These changes have enabled the creation of smart environment that enables the development of effective communication strategies focused on target groups, their needs and preferences, which strengthen the relationships between financial organizations and their customers, corporate clients, stakeholders, employees and board of directors (Shrestha et al., 2019).

Information and communication technologies (ICT) play a key role in the business of modern financial organizations, as well as the case in other industries (Claessens, 2017). In line with modern market challenges, organizations which provide financial services strives to change the traditional operational practices and adopt the widespread usage of technology and integrate it into their business operations and communication strategies (Lata, 2017). Those financial institutions that have successfully integrated ICT into most of their operations have a greater potential to achieve market competitiveness and to develop long-term relations with customers and other target groups that are key for the successful business performances.

2. CONTEMPORARY APPLICATION OF ICT IN FINANCIAL INDUSTRY

The adoption of ICT by financial institutions has a positive effect on the communication effectiveness, as well as overall performance, as operational activities are now provided through a variety of ICT tools, so that many activities that previously required human input have been automated today (Bolt & Humphrey, 2015). The use of ICT has had a positive impact on the speed of delivery of financial services, productivity and profitability, as well as more efficient and effective communication with target groups. Financial institutions are now using a variety of technologies, processing systems, computer operating systems, database management systems, data planning and database tools, data security systems, intranet and extranet services and email systems which, used with synergy, provide environment for effective communication strategies (Shrestha et al., 2019). Technologies like wireless communication, speech and image processing and recognition, utilized in a variety

of displays and computational elements play a fundamental role in enabling smart environment (Russo & Stella, 2017).

The usage of ICT in financial sector has improved three critical areas in communication: efficiency, quality and transparency, which are continuously being challenged to a great extent by the quantity of communication needed on daily basis (Distaso, 2010). These technologies have facilitated more flexible communication and services, so that financial organizations now provide customers with flexibility and customized services in managing their customer relationships (Rahim & Mada, 2017). The development of communication strategies requires appropriate analysis to determine the type, nature and scope of ICT solutions needed for achievement of greater efficiency and effectiveness in relation to communication goals (Bucevska & Hadzi Misheva, 2017).

Technology progress have essential impact on changes in the banking industry. As the core of the financial sector, banks nowadays provide financial services based on electronic banking (e-Banking), virtual banking, PC banking and mobile banking and e-payment systems (Kirakosyan & Dănăiaţă, 2014; Shrestha et al., 2019). As one of the dominant areas of ICT implementation in financial sector, internet and mobile banking is developed to achieve ease and speed of business and reduce the number of necessary human resources, as well as to gain an advantage over competitors, homogenize service quality, provide heterogenized communication and overall, to increase market share and improve general business results. However, even though electronic services and communication is changing the banking industry and has the greatest impact on relations with customers, certain challenges still exist (Claessens, 2017). Joshi and Parihar (2017) conducted a study aimed at identifying a key cause of declining profits in internet banking and found that an insufficient understanding of customer behavior and preferences regarding the use of ICT technologies was the reason for that. Also, lack of trust and understanding of the usefulness of electronic system among bank customers is also identified as the barrier, which declined the overall effectiveness of communication via electronic channels (Adapa & Roy, 2017). This implies that there is a necessity to rise customer awareness and trust in electronic channels, also by strengthen the communication via these channels as well as traditional ones.

Financial organizations generate a vast amount of customer data such as: socio-demographic data, logs from their financial products, transaction data, as well as external data, like social media data and data from various websites, which are used as valuable inputs for decision-making and creation of communication content. This implies that the relevance of big data technologies in today's business in the financial sector is huge. Financial practitioners and analysts consider big data to be an emerging issue of the data management and analytics of various financial products and services, and essential for successful customer relationship management (Sun et al., 2019; Hasan et al., 2020). Sun et al. (2019) emphasized the 4 V features of big data: volume (large data scale), variety (different data formats), velocity (real-time data streaming), and veracity (data uncertainty). The modalities of applications of big data in the financial sector are many, among which: data mining, social media analysis, web analytics, risk management, fraud detection security intelligence and similar. One of the data mining techniques which is commonly used, is the text data mining, encompasses linguistic, statistical, and machine learning techniques, which is used to analyze textual documents, such as emails, reviews, plain texts, web pages, reports, and official documents, with the goal to extract the data, transform it into valuable information and make it useful for decision making (Pejic Bach et al., 2019).

The application of artificial intelligence (AI) is increasingly popular in the financial industry, due to its potential to provide customers with efficient and personalized services at low costs. Wolter & Kirsch (2017) claim that AI based technologies are key factors for realising a smart environment. Bredt (2019) forecasts that the financial sector "will be transformed by AI, offering the opportunity for better and more tailor-made services, cost reduction, and the development of new business models". Artificial intelligence technologies in the forms of machine learning, voice recognition and predictive analysis, enable the function of robots and chatbots in provision of financial advices, making risks analyses, manage customer accounts and engage in algorithmic trading (Lui & Lamb, 2018).

Further application of different technological options in financial industry leads to the development of models of virtual organizations that seek to position themselves within specialized market segments. In addition, the application of these technologies enables other non-financial organizations, such as telecommunication companies, to appear in the financial market and offer, through existing internet platforms, various banking services or centralized management of the entire customer finances. Fintech is fast becoming a global phenomenon, and it represents an umbrella term for innovative technology-enabled financial services and business models. Fintech companies combine financial services with modern, innovative technologies. They generally aim to attract customers with products and services that are more useful, efficient, transparent and automated than those currently available by traditional financial institutions (Alt et al., 2018; Mention, 2019).

3. PERSONALIZED OMNICHANNEL COMMUNICATION OF FINANCIAL ORGANIZATIONS WITH CUSTOMERS

With the digital transformation of business operations, financial institutions are able to employ communication strategies that use new tools and channels to reach customers and to personalize communication and services in a multi-channel banking environment. By migrating customers to digital channels, financial organizations have begun to realize significant cost savings by reducing physical interactions with customers and maximizing the benefits generated in digital channels. Today, there are many touchpoints between financial organizations and customers. The devices such as: smartphones, tablets, computers, smartwatches, through which content can be spread and various communication platforms are used for this purpose. An effective communication strategy needs to integrate available touchpoint, channels, and platforms, so that the customer needs and preferences are taken into consideration (Abdollahpouri & Abdollahpouri, 2013). Customers are increasingly expecting to get in touch with bank staff through digital "chats", video calls or other real-time options, instead of visiting the bank's physical space or calling the contact center. These allows financial organization to provide the customer “with an innovative experience by offering sophisticated services that are perceived as emotionally more engaging” (Kirakosyan & Dănăiaţă, 2014). Additionally, an omnichannel communication strategy allows financial organization to make the best use of every available touch point, and to revitalize the traditional ones, such as local branch offices. Such communication has significant impact on customer satisfaction with organizations, through customers’ perceptions of overall service quality (Frimpong, 2014).

One of the key features of effective communication is personalization. Personalization represents the process of collecting and processing information about customer behavior and linking this information to demographic, sociological, and other customer information. Collecting data on consumers, their transactions and preferences, enables a deeper understanding of customer needs and the use of information technology for advanced analysis of customer information and personalization of products and services offered to them. It represents the basis for effective customer relationship management in financial industry (Cvijović et al., 2017). In financial sector, the use of information and communication technologies in the process of personalization of activities and the development of long-term and profitable relationships with customers is widespread (Albashrawi & Motiwalla, 2019). Communication with customers can be personalized in several ways; for example, by changing the content, frequency and schedule of broadcasting messages, using different types of greeting messages, sending custom e-mails, including images or videos suitable for the customer, etc. For example, the electronic user interface, thanks to personalization, can address the customer by name, offer an overview of previous transactions and suggest products that may currently be of interest to the customer. For the purpose of personalization, various methods are used, such as: data mining, user profiling and filtering. The content of messages can be based on the interests and needs of customers that are inferred from their previous behavior (so-called preferential personalization) or may include the name of the recipient or reference to products and services previously used by the customer (so-called self-reference personalization) (Adeosun, 2009). Personalization can bring numerous advantages for financial institutions. For example, Pikkarainen et al. (2006) presented the example of Finnish bank, which increased the average rates of consumer response to the bank's offer and reduction in direct marketing costs through the implementation of a program of personalized communication in real time through multiple channels. For example, if a customer searches for "low deposit rates" in a search engine, a personalized banner will appear on the bank's website that relates to the bank's best deposit rates.

In e-Banking, communication plays an important role and it can have a significant influence on the increase of customer loyalty/retention and achieving greater customer satisfaction (Kirakosyan & Dănăiaţă, 2014). Internet banking, as well as mobile banking are gaining importance on the global level. Financial organizations around the world have improved their mobile applications and optimized their websites for their customers' smartphones and tablets. Mobile channels are more likely to generate customer satisfaction because they require far less effort than physically coming to bank branches or calling the contact center, which leads to increased loyalty and greater customer retention, repeat purchases and recommendations. Customers continue to adopt mobile banking in most markets, encouraged by the simplicity and convenience of mobile channels, although the pace of progress in encouraging users to migrate from physical to digital channels varies dramatically from country to country. Certainly, developed countries dominate in this respect, while this process is slower in less developed markets. Research results indicate that the following factors significantly influence the willingness of customers to adopt mobile banking: perceived usefulness and relative advantage, perceived ease of use, compatibility, competence and integrity, perceived risk, perceived cost, perceived credibility and trust were examined (Lin, 2011; Hanafizadeh et al., 2014).

Various Internet-based platforms are efficiently used for communication with customers. Direct Email Marketing can be very useful for providing customers with personalized content built based on their characteristics, needs and phase they are along the customer journey. Social networks are essential for creation of communication paths with customers. Social media allows financial organizations to reach

consumers at significantly low cost and higher level of efficiency, with the potential to develop dialogue and receive valuable feedback in real time (Kirakosyana & Dănăiaţă, 2014).

Technologies based on artificial intelligence (AI), such are robots and chatbots, can be efficient means for communication with customers (Lui & Lamb, 2018). Chatbots create an illusion of conversation with a human and are used in various areas, for example, as automated online assistants which complement or even replace human facilitated services in a call center (McTear et al., 2016). The architecture of chatbots have two different models, rule based and artificial intelligence-based models. A rule based chatbots have the predefined input patterns and responses and use certain type of heuristic approach to select the appropriate response. The architecture of rule based based chatbot can be seen in Figure 1.

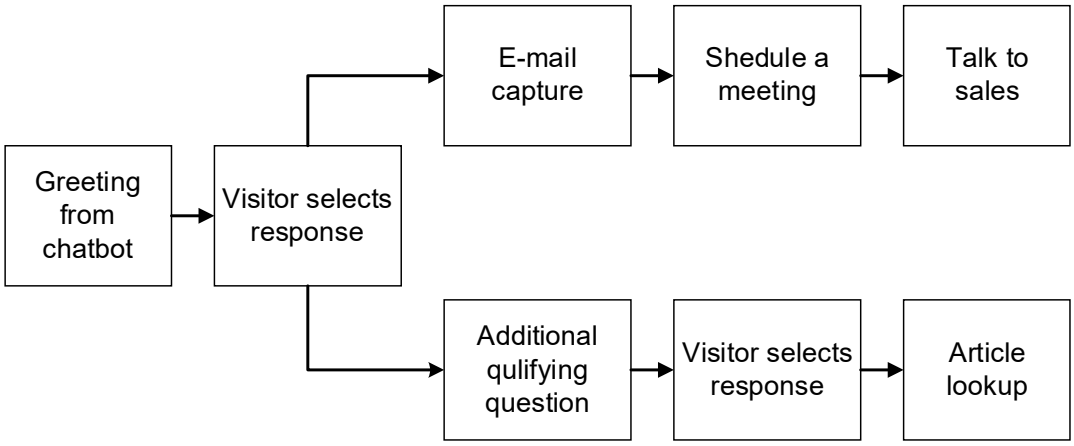

Figure 1: The architecture of rule based chatbot (Singh & Singh, 2019)

On the other hand, artificial intelligence models are not based on some predefined responses, but instead use text classifiers, algorithms, artificial neural networks and natural language understanding to make an understanding of customers response, as well as to produce right answer (Singh & Singh, 2019). The architecture of AI based chatbot can be seen in Figure 2.

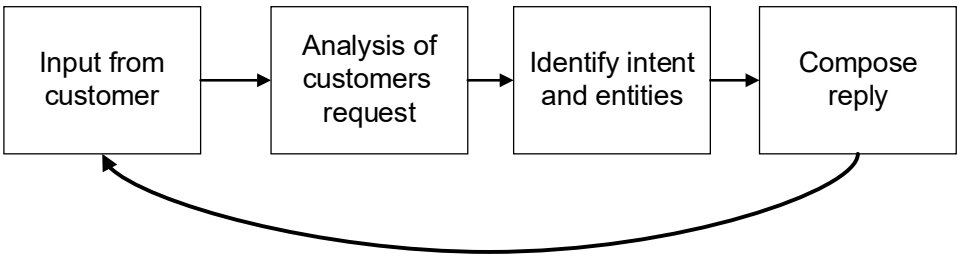

Figure 2: The architecture of AI based chatbot (Singh & Singh, 2019)

Spreading use of various technologies by financial organizations will enable further improvement of models of personalized communication, managed through various channels. Advanced channels of personalized communication will enable the strengthening of competitive strengths and improve business performance of financial institutions.

4. CONCLUSION

Digital transformation has provided traditional financial organizations with innovative communication strategies that have the potential for effectively reaching target customers. The financial industry has, on a global level, been continuously affected by changes related to the development of ICT over the years. The revolution in the field of ICT has enabled the transformation of the financial sector from the traditional way of conducting operations to more efficient ways. The creation of smart environment for effective communication has become a subject of basic importance and concern for all banks and a prerequisite for achieving local and global competitiveness. These technologies have continued to change the way financial organizations and their corporate relationships are organized around the world by providing the opportunity to increase the speed and

quality of service delivery, and to raise customer satisfaction. Efforts to survive in the market, maintain existing market share and invest in sustainable development, require the use of contemporary technologies and develop automated devices and personalized communication strategies. Personalization enables the adjustment to customers' characteristics and requirements and reduction of the necessity for personal contacts in electronic communication channels and the achievement of beneficial and long-term relationships with customers based on higher levels of satisfaction with financial services.

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ARTIFICIAL INTELLIGENCE IN MARKETING

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Abstract: *Until recently, marketing was practiced by people – they were conducting it themselves, or by using different channels and traditional media such as newspaper and television, graphic media or billboards. That trend has drastically changed with the introduction of Internet. As a result of the development of informational technologies which have simplified and modernized the communication between vendors, buyers, investors and advertisers, regardless their geographical location, Internet has become the center of world economy. However, an even bigger revolution in marketing is the implementation of Artificial Intelligence (AI) technologies. AI technologies have made a revolutionary transformation of the concept of marketing, starting from sales, marketing research, and going all the way to the promotion. Therefore, the aim of this paper is to present a review of possibilities and current practice of AI implementation in marketing, while analyzing trends in this field and examples of good practice.*

Keywords*: marketing, AI technologies, interaction*

1. INTRODUCTION

The concept of marketing includes a whole scope of activities - from generic ones, such as product advertising, gaining publicity, and attracting a larger number of buyers/consumers, to those more complexed, such as satisfying the needs of a customer/client. Without the use of the marketing concept, it would be impossible to imagine the business of any organization. Companies that lead their business policy, based on the marketing principles, invest their innovation efforts into expanding the portfolio of products and services, improving the existing ones, or searching for new consumer groups that haven't used the exsting products or services. The traditional marketing concept has been significantly changed by the introduction of the Internet and the expansion of Information Technologies, which has enabled companies to diversify their distribution channels towards new markets which haven't been available before. That is enabled by using a set of new marketing tools and communication channels. However, the technology development hasn't been standing still ever since the Internet was introduced. The most contemporary technologies have presented an innovative challenge to the marketing experts – artificial intelligence (AI).

Artificial Intelligence (AI) is a growing technology, industry and a research area. Even though the interest for the use of AI in marketing is still not at an extremely high level, the AI has a large potential to make big changes of the way contemporary marketing works. As such, AI in markeing is a key research topic. By analyzing the current use of AI in marketing, its potential to further apply in marketing in the near future and the areas of application and improvement, we can establish the grounds for understanding long-term implications of AI in marketing. All of the above has defined the research area of this paper to be the characteristics and possibilities of using the AI in marketing, while analyzing current trends regarding the implementation of AI in marketing practice.

2. A BRIEF REVIEW OF ARTIFICIAL INTELLIGENCE

Simply said by the founder and CEO of *Google's* AI company *DeepMind*, aritificial intelligence is a „science which makes machines smart" (Ahmed, 2015). Even though this deffinition has been set broadly, it can be considered adequate, having in mind that artificial intelligence is broad in its nature, including a wide spectre of different technological manifestations. The term AI involves a large number of subcategories, such as machine learning and deep learning, but also materialised AI products in real world, such as voice recognition, picture recognition, virtual assistants and search recommendations. These subcategories of AI can be defined as a more precise understanding of artificial intelligence, while artificial intelligence itself or even super artificial intelligence, can be considered as AI categories that are not yet close to being implemented in marketing. Therefore, this paper will treat the term of artificial intelligence as a more precise understanding of AI, since this domain has already found its use in the field of marketing.

Artificial intellingence, as was formerly mentioned, covers a lot of different technologies which use similar principles to do various cognitive tasks equally or even better than humans. For example, *Gmail* is now using artificial intelligence in order to anticipate the next word that the user will type in e-mail messages and offer an automatic suggestion which will enable the user to type faster.The software assistants, such as *Grammarly*, use artificial intelligence to offer recommendations of more accurate text writing when it comes to grammar. Given the different technologies that it includes, AI can be understood as a „portfolio of technologies“ which rely on the principle of computerised system that receives data for carrying out cognitive tasks in a manner of maximizing chances of succesful probem solving (Kaput, 2016). Given the number and diversity of AI technologies, we will not be presenting or defining each of these technologies. Instead, the following part of the paper will focus on key AI technologies that have been applied in marketing so far, with a brief analysis of the examples of good practice.

3. THE POSSIBILITES AND CURRENT USE OF AI TECHNOLOGY IN MARKETING

Untill recently, marketing was an activity conducted by people – personally or through different channels and traditional media such as newspaper and television, graphic media, billboards, etc., but this trend has drastically changed with the introduction of the Internet. Internet has become the center of world economy and that was enabled by informational technologies who have simplified and modernized the communication between vendors, buyers, investors and advertisers, regardless their geographical location. However, an even bigger revolution in marketing is the use of Artificial Intelligence (AI) technologies. AI technologies have started their era of transforming the concept of marketing in almost all of its dimensions, starting from sales, marketing research, and all the way to promotion.

One of AI technologies which was among the first to be used is the machine learning which, by its simplest definition, is a capability to learn without special programming (Kamarinou et. al., 2016), and which is based on congitive basis. The key feature of machine learning, which enables its use in marketing, is the possibility to interact with the consumer in order to simplify consuming of services of contents for him. Typical examples of machine learning are special platforms which understand human language aside form software language, so they can behave according to the humans voice orders. This is called natural language processing, whose basic function is to enable the human to talk to the smart machine same as with another human. One of the examples are the popular chatbots, who have recently become very frequent in the world of digital marketing, and which have been implemented into communication platforms and messaging applications in order to provide conversation between the company and/or the brand with the consumer.

Sentiment analysis also has a meaningful use in marketing – it was developed for simple, automatic data processing, based on which a typology of dominant consumer sentiments is deducted. For example, posts on social networks such as *Twitter* can be analyzed, and the sentiments are being classified by simple criteria such as positive, neutral and negative – the result is the most frequent sentiment. This type of analysis enables the companies and brands to learn about general consumer opinions on certain products or brands in a fast and simple way.

Image recognition and processing technology is also one of the AI technologies that are being frequently used in marketing. For example, the *KFC* company has been using the technology of face recognition as a payment method, while the Japanese cosmetics company *Shiseido* is using this technology in order to recognise the skin type, followed by an individual recommendation of skincare products based on the analysis of a persons photo and personal data (Jarek & Mazurek, 2019).

AI technologies find their purpose in achieving differet marketing goals, from attracting new customers, keeping the existing ones, all the way to influencing the purchase desicion. The stated example of company *Shiseido* interprets a successful implementation of AI technology in all of the goals above. In a similar way, it can be used to increase customer experience satisfaction in stores. The author of the book *Artificial Intelligence for Marketing*, *Jim Sterne*, explains that, when the consumer enters a store, the sales person has a set of information about him, such as his age, gender, style. However, if these information are enriched by the information gathered with an application using AI, such as previous purchase history, previous network search, affinities towards brands and products, price range of bought or searched products, the advantages of a sales person using AI and his probability to meet the needs of the customer efficiently are evidently much higher.

The use of voice, face and image recognition in marketing has lead to the development of a new marketing branch – interactive marketing. Interactive marketing uses AI technology of face recognition by loading the biometrical customer data and enabling the reading of customers sentiment data, ofering a unique experience for the consumer. One of the good interactive marketing examples is the campaign of *Expedia* company, named *Discover Your Aloha* campaign. This campaign was designed so that the customer can turn on his cellphone, tablet or PC camera, which enables him to travel to the tropical heaven of Hawaii. By face

recognition technology, the company receives data on which part of the experience has triggered the most positive reactions from the visitor, and after they have left the campaign website, they receive a coupon with an offer for Hawaii vacation, located exactly in the part of Hawaii that they have enjoyed the most during their virtual travel (Duran, 2016). This smart usage of face recognition technology has enabled the *Expedia* company not only to create an interactive marketing experience campaign, but also to add more value by offering personalised discounts for their customers to see their favourite part of Hawaii in real life, based on gathered data.

Jarek and Mazurek (2019) also include automatic robots and machines as the implementation of AI in marketing. These authors give the example of Service-free shops (*Ford & Alibaba, Amazon Go, Zaitt Brasil*) as well as autonome shops that offer basic products and magazines, where the whole sale and packing process is automatized. The store was tested in Shanghai (*Mobi Mart*).

3.1. The review of the use of AI in marketing prevalence and the areas with the largest influence

According to the data from year 2017, the largest number of companies (98% of them) have just been taking the first step towards the usage of AI in marketing, while only 20% of them have already had implemented some of the AI components into their marketing processes (Bughin, McCarthy & Chui, 2017). These data indicate that the companies worldwide clearly recognize the possibilities and the inevitability of implementing AI technologies in marketing, and they also point out the ongoing process of introducing artificial intelligence into marketing. Marketing is currently listed as the fourth industry when it comes to the implementation of AI, and measured by the investments so far, as the sixth industry that implements AI with a share of around 2,55% in total AI investments of all industries (Naimat, 2016).

Table 1 shows the review of marketing mix components that are currently the most influenced by AI technologies. More precisely, the table presents those marketing mix components in which the AI technologies have already demonstrated their benefits.

Table 1: Most significant areas of AI influence on the marketing mix

Product	Price	Promotion	Point of sale
Development of a new product	Price managment and dynamical adjusting the prices according to the buyers' profile	Creating a unique experience	Practical buy
Automatic recommendation		Personalized communication	Faster and simplified sales process
Creating added value		Creating the „wow-factor"	24/7 customer service (chatbot)
Hyperpersonalization		Eliminating the process of learning about product subcategories	Shopping automatization
Additional solutions apart from the product category		Positive influence on the consumer	Stores without service
		Minimal dissapointment	Customer support without the consultants
			New distribution channels
			Sales automatization

Source: Jarek, K., & Mazurek, G. (2019). Marketing and artificial intelligence. Central European Business Review, 8(2), p.52

Based on the data presented in Table 1, it can be easily deducted that the companies that have already implemented AI technologies into their marketing strategies have had significant benefits. AI is a revolutionary change of the way brands approach marketing, and the way marketing experts do their job. The advantages of this technology are perceived even if AI technologies are at the low level of implementation. For example, hyperpersonalization will allow companies to significantly raise their advantages. According to the research of the *Boston Consulting Group*, the personalization efforts can increase corporate revenues from 6% to 10%, and it is forecasted that hyperpersonalization will result in up to 15% revenue increase for companies who manage to implement it successfully in the next five years (Abraham et al., 2017).

It is very important to have in mind the fact that the digital marketing of today couldn't be successful without AI technologies. Data shows that 75,7% of smartphone advertising expenses and 71,8% of Internet advertising expenses are conducted through platforms that use artificial intelligence or machine learning (Barker, 2017). Therefore, it can be stated that AI is already present in marketing and that is represents the future of marketing development. Among many benefits for companies and marketing experts, AI technologies have the ability to create added value to customers lifestyle. By providing pleasant experiences, improving highly-relevant content and creating interesting brand interactions, AI can improve the connection between companies and consumers.

4. ARTIFICIAL INTELLIGENCE IN MARKETING – EXAMPLES OF GOOD PRACTICE

Although the potential of artificial intelligence is still not exploited to the fullest and there are many more areas of its implementation that remain to be explored, there are many companies who have already incorporated it into their everyday business. This part of the paper will elaborate some of the successful AI implementations in brands' and corporate marketing strategies.

4.1. Sephora's successful implementation of various AI technologies

Sephora is one of the leading brands in the beauty industry. Founded in 1970, *Sephora* has always been setting an example when it comes to innovation and customer relations – they have pioneered the concept of try-before-you-buy for cosmetics, which has then been implemented across beauty retail (CB Insights, 2017). Over the years, Sephora has been constantly innovating, and today they bravely use forms of artificial intelligence such as voice recognition and chatbots as a vital part of their marketing strategy.

While many cosmetic companies rely on department store sales, Sephora offers customers tech options that allow them to personalize their shopping experience (Rayome, 2018). One of these tech options is the use of voice assistants. In November 2017, Sephora launched an application on Google Assistant with features to book beauty services, take quizzes and listen to influencer-curated beauty podcasts. Apart from providing a unique experience for their customers, Sephora has been able to gather data on consumer preferences, which provided valuable insights for the company (CB Insights, 2017).

One of their most successful AI implementations is a chatbot Messenger, and it is one of the leading examples of chatbot implementation – *Sephora* was one of the first in the retail sector to use them (*Digital Marketing Institute*). Sephora's bot acts like a digital advisor, allowing users to take a variety of actions without having to leave Messenger – they can browse for products, book appointments, try on makeup using augmented reality, and more. This way, Sephora is creating an unforgettable online experience for customers, while also improving brick-and-mortar sales, because the bot is able to recommend available bookings and products based on the customers' location (Barnhart, 2019). Sephora has launched two services – *Sephora Reservation Assistant* and *Sephora Color Match*, which cover the key areas of customer experience. The Reservation Assistant enables customers to make appointments with beauty specialists, while the second one uses augmented reality – the user holds a camera to an image or a face, and a makeup shade is identified using an algorithm for Sephora's line of products. It can also be used to match cosmetics with an outfit (*Digital Marketing Institute*).

This way, Sephora has managed to create personalized customer experiences and provide real time communication between the brand and its consumers. By embracing the ongoing trends and technology development, Sephora is modernizing and improving traditional retail.

4.2. Hello Barbie – natural language processing and big data

Since its release in 1959, *Barbie* has become the most sold doll of all time. Even though it is considered classic and timeless, *Mattel*, the manufacturing company, has decided to follow the trends and improve Barbie by using artificial intelligence. *Mattel* has identified that the most common request from consumers was to have a conversation with *Barbie*, so they have decided to enable that by partnering with a startup *ToyTalk*. They have designed a Hello Barbie doll based on artificial intelligence and natural language processing (*Akenzua*, 2019).

By launching the *Hello Barbie* doll in 2015, *Mattel* has created a completely new experience for children. Hello Barbie has a microphone concealed in her necklace, that allows conversation. Every one of Barbie's potential conversations is identified, creating a base of more than 8.000 lines of possible responses. Barbie also remembers child's responses, which she can then use in some of the further conversations (Marr, 2019).

In order to initiate conversation, the child has to press the button on the dolls belt, which then starts recording in order to provide a response. The recording is parsed, analyzed, and after the correct response is selected, it is being sent back for Barbie to deliver. This process has been optimized to last less a second. All the conversations are sent back to the ToyTalk's cloud-based servers for analysis, creating a large data storage.

Hello Barbie is a great example of how artificial intelligence is easy to implement in every industry, including the toy industry. In this example, the company has responded to customers' needs and the artificial intelligence was implemented into the product itself, adding another dimension to provide extraordinary consumer experience.

4.3. Walgreens – using facial analysis for advertisement targeting

Facial analysis and recognition is another AI technology that has been frequently implemented by brands and companies. It is used in mobile banking, online stores, payment methods, smartphones and many other areas. One of the interesting implementations of AI based facial analysis solutions in marketing was made by Walgreens, a pharmacy store chain from the United States. They have developed a new technology in order to create smart displays which target ads to individual customers. These displays are integrated into cooler doors, creating a personalized advertising space adjustable in real time (Kuligowski, 2019). Instead of seeing through the glass, customers are presented with digital representations of products inside the cooler, which is adjusted to the customer itself (Ryan, 2019).

These screens are equipped with sensors and cameras which are connected to face recognition technology that can approximately identify customer's age, gender and emotional response to what they are seeing, but also external factors like the weather (Kuligowski, 2019). Although the technology involves scanning customers' faces to analyze their age and gender, they are not individually recognized and stored as data, but only analyzed demographically in order to determine the shopping trends for different customer categories (Fussell, 2019). The cooler also tracks the products that are chosen by the customer, suggesting complementary products to increase the sale. Apart from creating personalized advertisement, these coolers provide stock information in real time for the company (Kuligowski, 2019).

These coolers were created as a combination of digital advertising and brick-and-mortar stores, with a goal to implement AI driven technologies as a creator of advertisement and database which will enhance in-store sales.

4.4. Artificial intelligence implementation in automotive industry

The automotive industry is highly competitive which causes the manufacturers to constantly invest in innovative solutions that will differentiate their products and attract new customers. Over the past few years, these innovative solutions often included the implementation of artificial intelligence, and this case study shows its successful implementation by some of the industry leaders.

Volvo, a vehicle brand best known for its safety, launched its first car with internet connectivity in 1998 – ever since they have been working to evolve their data strategy. Today, the company is using data to predict car failure, service requirement, but also to uphold its impressive safety reputation. Volvo has carried out a pilot project from 2015 to 2017, where a thousand cars were equipped with sensors to detect vehicles' performance in hazardous situations, while the gathered data was uploaded to the Volvo Cloud. Apart from that, Volvo has focused also on improving driver and passenger convenience by offering their customers connection with streaming media services, GPS, traffic incident reporting, parking space location, weather location, and more. The company was monitoring the use of applications and features to determine what features are most valuable to their customers and what suits them best (Marr, 2019).

Apart from these significant innovations, Volvo is taking another step further in the implementation of AI in their industry, by developing self-driving vehicles. The idea behind autonomous vehicles is to provide computerized vehicle steering which will minimize driving hazards and maintain Volvo's safety reputation. On this occasion, they have partnered with *Uber* to develop AI technologies for these vehicles, and in 2019, they have launched the latest version of autonomous cars, XC90. The car still has human controls, but it also offers factory-installed steering and braking systems designed for computer control. By continuing to develop self-driving vehicles, Volvo expects that by the middle of the next decade, one-third of all cars will be fully autonomous (Shepardson, 2019).

However, Volvo is not the only company pursuing the idea of autonomous vehicles. BMW, also known for its high-tech vehicles on the market, is working on developing a complete "level 5" autonomy vehicle by 2021, which is the highest level of autonomy, meaning that the car is completely able to drive itself, without human supervision. BMW has acquired a location data service provider *Here*, in order to get data from existing cars that will be used to inform the self-driving cars. This data includes braking force, wiper and headlight use, GPS and video data. BMW has also partnered with *Parkmobile*, in order to provide technology that allows drivers to find and pay for parking before starting their journey. The car will also have voice recognition, enabling the driver to give basic voice commands, by integrating Amazon's *Alexa*. Lastly, this vehicle will be based on computer vision technology, which teaches machines to see as humans, using cameras instead of eyes, and to interpret what they are seeing in a way that's similar to a human brain (Marr, 2017).
Many other automotive manufacturers follow these examples, so this industry is inevitably making progress towards a new generation of AI driven vehicles, creating added value and an innovative experience for the customers.

5. CONCLUSION

The theoretical research results in this paper have manifested that AI is an important marketing tool for any kind of business in the 21st century. The most significant feature of AI technology is the possibility of direct and interactive communication with the consumers, which creates a large advantage compared to classic digital marketing. This enables businesses and companies to build sustainable consumer relations, and it can be said that AI in marketing has created a completely new basis for customer relations with a goal to improve the satisfaction and loyalty of the consumer.

A modern, efficient marketing strategy has to create terms for the company's success in the area of digital marketing. In order to achieve a successful marketing strategy, it is necessary to follow new social trends and to keep the interaction with the consumer. The power and possibilities of artificial intelligence in digital marketing strategy are indisputably helping marketing to place its products or services, and to achieve business goals. Simply said, the big change that is happening today in marketing is the artificial intelligence and machine learning. These technologies have created new possibilities for storytelling and products and services marketing, and they are changing the way that people communicate with brands and companies from the ground. Therefore, marketing experts have to adjust and start incorporating the artificial intelligence systems into their marketing strategies in order to be successful in the new era of digital marketing.

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UNDERSTANDING SHIFTS IN MARKETING EVOLUTION AS A PREREQUISITE FOR IMPLEMENTATION OF MARKETING 4.0

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Abstract: *Business systems are competing in the economy that is awash in hyper-competition, and the markets are changing faster than marketing. Innovations in digital technologies have created more connected marketing environment that is more engaging and consequently more difficult for organisations to comprehend and achieve their goals. The motivation for this paper arises from the idea to understand and explore existing marketing theories in order to understand the importance of adapting marketing to the rapidly changing business conditions. The core idea of this paper was to analyse how to incorporate marketing into the complexity of contemporary markets and modern business environment, with a particular focus on Marketing 4.0. The qualitative literature review was conducted using data obtained by a comprehensive examination of articles from the leading journals, respectable and state-of-art analyses and groundbreaking researches. The results of this paper can be used for further, more complex investigations and exploration of different marketing theories and its utilisation in the present conditions. This paper expands exiting research related to the evolution of marketing and its implementation, primarily focusing on the application of Marketing 4.0. The study also contributes to existing literature, and the findings may be useful to scholars, marketers, social influencers, and the general public.*

Keywords*: Marketing evolution, Marketing 4.0, contemporary markets, Web 2.0*

1. INTRODUCTION

The contemporary world is more engaging and more connected than ever due to the innovation in digital technologies (Kotler & Armstrong, 2018). Industry 4.0, or the digital industrial revolution, is essentially changing all aspects of the business (Cicvarić Kostić & Gavrilović Šarenac, 2020). The modern business environment is hypercompetitive, and markets were changing faster than marketing, so modern markets are very different from markets of the 1990s, let alone the 1950s (Kotler, 2010). If the functioning of an organization is perceived from the aspect of relationship marketing, then it is observed through the interaction of various stakeholders and organization (Cicvarić, 2006). Cicvarić Kostić et al. (2011) point out that the term integrated communications consolidate all messages that are sent by an organization, as well as all channels and places of communication, and they are directed to create a dialogue with stakeholders. MacInnis et al. (2020) show that consumer research regarding marketing that is boundary-breaking can influence relevant stakeholders, such as business organizations and environment, policymakers, scholars and media. Adoption of the marketing concept and the understanding of a customer has been an exciting theme for authors, and there are numerous researches conducted in this area (Day, 1994).

Besides the work of marketing scholars, marketing is also influenced by many factors. New digital technologies have shaped marketing in a fundamental way (Kaplan, 2016). In the early days of new technologies and social media, they only had an impact on companies (Kaplan & Haenlein, 2010) and later on the entertainment industry (Kaplan & Haenlein, 2012; Kaplan, 2015). Nowadays, technologies are rapidly developing, and social networks have become an indispensable part of a modern person. Even thou goals of marketing communications, differentiate, remind, inform, and persuade, as Fill (1999) stated, remain unchanged, the nature of marketing communications have to adapt to the contemporary digital world. One of the most important ways for brands to engage with clients is digital communications (Lamberton & Stephen, 2016; Wedel & Kannan, 2016; Colicev et al., 2018; Kanuri et al., 2018). The relevance of communications is even more significant in the age of the Internet, social media, and social network sites (Okanović et al., 2013). New generations use internet and social networks more than older generations. Sharma & Verma (2018) point out

that social media and other web 2.0 technologies have added the element of real-time interactivity, so the traditional time and distance restrictions are removed.

Brands are competing in hypercompetitive markets and have many challenges upon them, so the marketing goals of brands also changed. Due to hyperconnectivity, new brands are further stretching the branding space, and existing brands expanded their territorial reach and societal roles and new brands (Swaminathan et al., 2020). Embracing modern trends and the role of innovation became vital for the marketing success of a brand, both for the survival of businesses and finding new clients.

Goal of the paper is to understand evolution of marketing and modern marketing approaches to fulfill goals in modern marketing environment. The ultimate contemporary marketing goal is not only to keep clients or motivate them to act and act again; it is to motivate customers to advocate products or services of a brand and become their ambassador. Kotler et al. (2017) underline that the ultimate goal of Marketing 4.0 is to drive customers from awareness or noticing brand, product or service to advocacy. To cope with the modern market and marketing challenges, brands should consider the evolution of marketing before the implementation of Marketing 4.0. *Marketing 4.0 is a marketing approach that combines online and offline interaction between companies and customers, blends style with substance in building brands, and ultimately complements machine-to-machine connectivity with human-to-human touch to strengthen customer engagement* (Kolter et al., 2017, p. 53).

Paper is structured as follows: section 2 elaborates evolution of marketing and introduce Marketing 4.0, section 3 examines customers in the contemporary marketing environment and their specifies and preferences, section 4 describes rising of Marketing 4.0, and its characteristics, section 5 analyses challenges of advocacy phase as a marketing phase characteristic for Marketing 4.0, and sector 6 concludes with sublimising of importance for understanding marketing evolution and implementation of Marketing and proposes recommendations for future research.

2. THE CONSIDERATION OF MARKETING EVOLUTION

The first social science to reach the quantitative sophistication of the natural sciences is economics. The stream of literature from 1800 to 1920 is related to classical and neoclassical economics, and the first formal studies focused on the distribution and exchange of commodities and manufactured products and featured a foundation in economics (Say, 1821; Smith, 1904; Shaw, 1912; Marshall, 1927).

Commodities exchange (Copeland, 1923), institutions that made goods available and arranged for possession (Nystrom, 1915; Weld, 1916), and marketing functions (Weld, 1917; Cherington, 1920) determined early marketing thought. Commodity school examined characteristics of goods, institutional school analysed the role of marketing institutions in the value-embedding process, and functional school studied functions that marketers perform.

In the 1950s, the functional school began to morph into the marketing management school. The only purpose of the firm is to produce a satisfied customer, and the main focus was on the client (Drucker, 1954; McKitterick, 1957; Levitt, 1960). McCarthy (1960) and Kotler (1967) characterised marketing as a decision-making activity directed at satisfying the customer at a profit by targeting a market and then making optimal decisions on the marketing mix. In his later work, Kotler (1972, p. 42) stated that “marketing management seeks to determine the settings of the company’s marketing decision variables that will maximise the company’s objective(s) in the light of the expected behaviour of noncontrollable demand variables.”

In the 1980s, many new observations of marketing, different to 4 P’s and mostly independent of the conventional microeconomic paradigm began to develop. Lusch & Vargo (2015) noted that the *most notable was the emergence of services marketing as a subdiscipline, following scholars’ challenges to “break free”* (Shostack, 1977) *from product marketing and recognize the inadequacies of the dominant logic for dealing with services marketing’s subject matter* (Dixon, 1990). Marketing began to be observed as a continuous social and economic process. Studies of the leading scholars have advocated that a market orientation is central to organizational success (Peters & Waterman, 1982).

In the marketing literature from this period, there are separate lines of thought that observed marketing as a social and economic process, such as relationship marketing (Berry, 1983; Gummesson, 1994, 2002; Duncan & Moriarty, 1998; Sheth & Parvatiyar, 2000), services marketing (Zeithaml et al., 1985; Grönroos, 1994), quality management (Hauser & Clausing, 1988; Parasuraman et al., 1988), market orientation (Kohli & Jaworski, 1990; Narver & Slater, 1990), value and supply chain management (Normann & Ramirez, 1993; Srivastava et al., 1999), resource management (Dickson, 1992; Constantin & Lusch, 1994; Day, 1994; Hunt & Morgan, 1995; Hunt, 2000), and networks (Achrol, 1991; Webster, 1992; Achrol & Kotler, 1999).

Considering and expanding the research conduced by Lusch & Vargo (2015), Table 1 shows the sublimation of marketing discipline development and the stream of the literature by the most influencing authors.

Table 1: Stream of marketing literature from 1800 to 2000

Timeline	Stream of literature	Authors
1800–1920	Classical and Neoclassical Economics	• Say (1821); Marshall (1927) • Smith (1904); Shaw (1912)
1900–1950	Early/Formative Marketing	
	• Commodities	• Copeland (1923)
	• Institutions	• Nystrom (1915); Weld (1916)
	• Functional	• Weld (1917); Cherington (1920)
1950–1980	Marketing Management	
	• Business should be customer focused	• Drucker (1954); McKitterick (1957)
	• Value "determined" in marketplace	• Levitt (1960)
	• Decision-making activity	• McCarthy (1960); Kotler (1967)
	• Company's marketing decision variables	• Kotler (1972)
1980–2000	Marketing as a Social and Economic Process	
	• Relationship marketing	• Berry (1983); Gummesson (1994, 2002); Duncan & Moriarty (1998); Sheth & Parvatiyar (2000)
	• Services marketing	• Zeithaml, Parasuraman & Berry (1985); Grönroos (1994);
	• Quality management	• Hauser & Clausing (1988); Parasuraman, Zeithaml & Berry (1988)
	• Market orientation	• Kohli & Jaworski (1990); Narver & Slater (1990)
	• Value and supply chain management	• Normann & Ramirez (1993); Srivastava, Shervani & Fahey (1999)
	• Resource management	• Dickson (1992); Constantin & Lusch (1994); Day (1994); Hunt & Morgan (1995); Hunt (2000)
	• Network analysis	• Achrol (1991); Webster (1992); Achrol & Kotler (1999)

Sheth & Parvatiyar (2000, p. 140) advised that *an alternative paradigm of marketing is needed, a paradigm that can account for the continuous nature of relationships among marketing actors*. Rust (1998) emphasised the need for convergence among seemingly different views.

Reibstein et al. (2009) and Lehmann et al. (2011) emphasize that marketing as a discipline is at a crossroads. There is a development of the sharing economy and the increase of a distinct array of examination on this topic both inside and outside the marketing discipline in the last decade (Eckhardt et al., 2019). MacInnis et al. (2020) enunciate that impact on marketing stakeholders is limited because consumer scholars have followed a set of implicit limits regarding what they, when and how they study it, and same authors point out what scholars can do to breach limitations and improve the impact of their studies.

Kotler et al. (2010) described changes from Marketing 1.0, product-centric marketing to Marketing 3.0, the concept of human-centric marketing what was the natural outgrowth of the previous customer-centric marketing, Marketing 2.0. Due to the challenges of the transitional era, Kotler et al. (2017) underlined the need for the new marketing approach, and they introduced Marketing 4.0. In Marketing 4.0, customers are still important, but the approach is different, brands should adapt to the dynamic nature of customer paths in the digital market.

3. CONTEMPORARY MARKETING ENVIRONMENT

Marketing as a discipline is evolving and developing, and theoretical advances are critical to the development (MacInnis, 2011). White, Habib & Hardisty (2019) highlight the vital function of marketing in stimulating sustainable consumption. Drucker (1973, p. 61) articulated the marketing concept as we recognize it today: "There is only one valid definition of business purpose: to create a customer. The customer is the foundation of a business." Aforementioned concept has become the central concept of marketing, and it has moved beyond its operative boundaries to become increasingly necessary as a fundamental concept of management

(Kotler & Keller, 2003). Marketing process consists of several segments that can be fragmented into two main parts: Creating the value for the customers and building relationships with them; and (2) Capturing the value from the customers (Kotler & Armstrong, 2018).

When creating value for the customers, brands should understand the market and needs of customers. Based on gathered information, brands design a value-driven marketing strategy and then construct an integrated marketing program that delivers superior value to the customer, that should engage customers, build beneficial relationships with customers and make them satisfied. After these four segments, brands should work on capturing the value from customers and create profits and customer equity.

Melumad & Meyer (2020) underline two trends that have been particularly transformative in the consumer markets. The first trend is the change in the interaction between companies and customers, so online communication becomes the main instrument. The second trend is increasing in smartphone usage for communication. This emergence is observed through the share of web traffic by device, mobile phone share in December 2019 was 53.3%, which increased by 8.6% since December 2018, and laptops and desktop computers share in the same period was 44.0%, which decreased by 6.8% since December 2018 (We Are Social, 2020). People use smartphones for browsing the Internet more than computers, and there is a tendency to use smartphones more and computers less in the future. As smartphone penetration continues to rise, the number of smartphone subscriptions is forecast to reach 7.4 billion in 2025 (Ericsson Mobility Report, 2019, p. 7). Companies should analyse contemporary user-generated content and incorporate two mentioned trends into their marketing strategy, enabling customers to browse their content and establish communication via their smartphones.

Because customers have positive and personal associations with mobile devices, they have a feeling of comfort while using them (Melumad & Pham, 2020). Some authors (Skierkowski & Wood, 2012; Panova & Carbonell, 2018) point out that people usually associate computers with work, and smartphones with personal activities that give them mostly positive feelings, such as texting, social media or watching videos. Smartphones became a personal space for their owners, they know that they can rely on them to engage in mentioned activities any time and in any place Cheever et al. (2014), therefore they accept them as a source of security and comfort (Melumad & Pham, 2020).

New generations use social media also for brand and product research. About 85% of Generations Y and Z learn about new products on social media platforms, and 59% of them are more likely to even connect with the brand than older generations (Obradović et al., 2017). Brands adjusted communications with customers due to the expansion of the usage of social networks (Cicvarić Kostić et al., 2018).

Today's consumer is exposed to the marketing messages in different ways, from traditional and online media (Danaher et al., 2020) and some authors compared the effectiveness of traditional and online media (Naik & Peters, 2009; Danaher & Dagger, 2013; Dinner et al., 2014; Kumar et al., 2016; Sridhar et al., 2016; Srinivasan et al., 2016) and consumers preferring the online purchase channel (Ansari et al., 2008; Verhoef et al., 2015). Batra & Keller (2016) remind that TV advertising remains an important channel of marketing communications, despite the emergence of online media. Therefore, it is still not unusual for brands to have large budgets for TV advertising. Unilever spent almost $8.1 billion on ads in 2018 (Unilever, 2019) and Procter & Gamble (Procter & Gamble, 2019) spent $7.1 billion in the same year, and the most of their marketing activities were TV advertising (Pellikan, 2017). Sethuraman et al. (2011) highlight the significance of measuring the impact of advertising on sales, based on advertising elasticity or return on investment. In the most recent study, Bruce et al. (2020) explored how marketing messages or hints set in TV advertising impact the outcomes of ad spending on brand sales and their methods and findings for developing brand communication within advertisements can yield 2.3% increase in sales, on average.

The modern marketing environment consists of many challenges. Recent analyses of digital marketing literature show a fragmentation in the discipline (Yadav & Pavlou, 2014; Lamberton & Stephen, 2016) and Busca & Bertrandias (2020) point out that digital marketing is facing growing fragmentation. With the development of informational technologies and uprise of innovations, brands should maintain good relations with customers, both instore and online. Recent studies analyze influence media on sales, sometimes in both the instore and online environments (Danaher & Dagger, 2013; Dinner et al., 2014; Kumar et al., 2016; Srinivasan et al., 2016).

Marketing communications are crucial in the age of the Internet, social media, and social network sites (Okanović et al., 2013). One of the most important ways for brands to engage with customers are digital communications (Colicev et al., 2018; Kanuri et al., 2018; Lamberton & Stephen, 2016; Wedel & Kannan, 2016). The rising impact of social media such as Instagram, Facebook, YouTube, Twitter, and others is influencing tasks of a marketing function and making it more challenging. There are many factors brands

should consider to develop an effective marketing strategy and have an adequate implementation of marketing activities. Outsourcing of marketing activities is also one of the methods brands use to make more significant marketing impact, and that is a complex process which demands professionalism, planning and being systematic (Lazić et al., 2019).

Industry 4.0 is fundamentally transforming all areas of business (Cicvarić Kostić & Gavrilović Šarenac, 2020). In the connected era we live in, many of peoples' daily activities are conducted online. Choi & Mela (2019) point out that online marketplaces are also considered for monetization. Lin (2020) pointed out that numerous digital and media networks developed premium services that provide paid subscribers with fewer or even no advertisements. The most recent researches examine social media actions that are composed and executed in real-time proximal to an external event (Borah et al., 2020) and even understudied analysis of gender differences in how market behaviour shrinks moral identity discrepancy (Shang et al., 2020). Sharma & Verma (2018) point out that social media offers a valuable possibility to build sustainable relations with customers and to create and facilitate brand advocacy by fostering positive communications regarding brand among consumers.

4. RISING OF MARKETING 4.0 AND ITS IMPLEMENTATION

Many different marketing models developed over time, but lately, one of the most interesting marketing approaches is Marketing 4.0. The core roots of Marketing 4.0 can be found in the marketing literature of the nineteenth century. Doyle (2016) described the AIDA model as one of the models that analyse and measure the customer's journey from ignorance to purchase. St Elmo Lewis developed this model in 1898 in an attempt to explain personal selling. There are four sequences in the process that salesperson must lead a potential customer through. The sequences are following: (1) Attention; (2) Interest; (3) Desire; and (4) Action. Similar to 4P's, mentioned before, AIDA model has also developed and expanded in time.

One of the modifications of the AIDA model is offered by Derek Rucker of the Kellogg School of Management. This modification is called the four A's, and it also has four sequences. The stages are the following: (1) Aware; (2) Attitude; (3) Act; and (4) Act again. New framework simplified interest and desire stages into attitude and added a new segment, act again. First, potential clients become aware of some brand, then they form a particular attitude towards it, liking or disliking it. After that, they decide whether to act in a way brand desired, for example, to purchase something or pay for services. After they gain experience regarding that product or service, they form an opinion and decide whether the brand is worth to act again, to repeat purchase or pay again for services. The number of customers declines as they move from the first to the last stage of the process.

In the modern, hyperconnected business environment, a new customer path must be determined to accommodate changes formed by connectivity. Kotler et al. (2017) recommended rewriting the customer path as the five A's: (1) Aware, (2) Appeal, (3) Ask, (4) Act, and (5) Advocate. Brands should implement marketing strategies to drive customers from awareness to advocacy, which is the ultimate goal of Marketing 4.0. Three significant shifts determine the change from the customer path in the Pre-Connectivity Era and Connectivity Era (Figure 3).

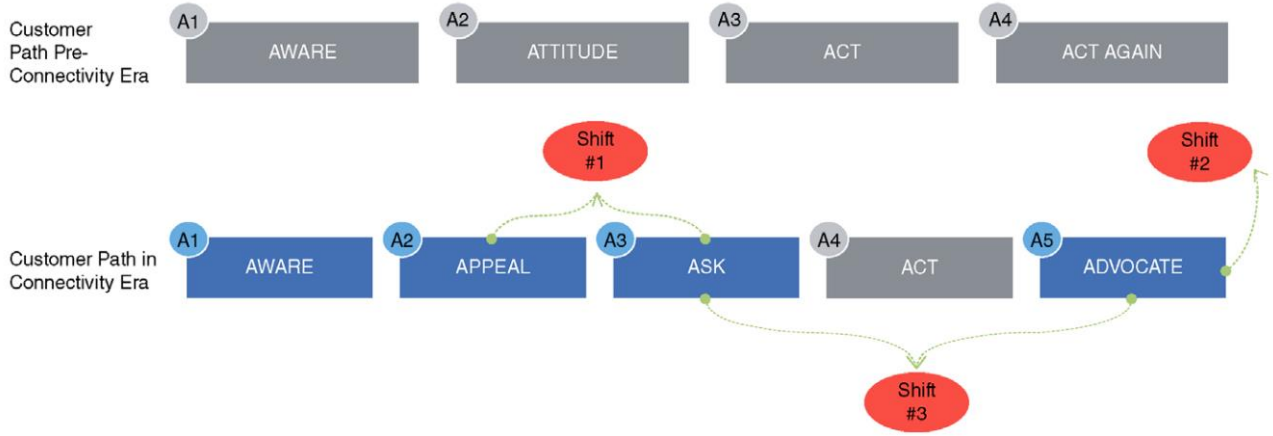

Figure 1: Shifts of a Customer Path in a Connected World
Source: Kotler et al. (2017)

The first shift represents a change from the attitude toward a brand determined by an individual to the primary appeal of a brand formed by the community. The client determines the final attitude. The second shift observe variations in the comprehension of loyalty. In the pre-connectivity era, loyalty is recognised as retention and

repurchase, but in the connectivity era, loyalty is determined as a willingness to advocate a brand. The third shift describes the understanding of brands. In the contemporary marketing environment, customers actively connect with other customers, building the new, ask-and-advocate relationship. The mentioned connection can either strengthen or weaken the brand appeal, depending on the preference during the conversation.

New customer path in a connected world can be observed as a funnel that drives potential customers from being aware of the existence of some brand to the clients that are advocating and promoting the brand, either online or offline. At first, potential customers learn about the brand from others. If they are getting to know with the brand online, they will be considering the website and pages of social networks of a brand, online reports and even comments about a brand on official and unofficial brand pages. In this phase, potential customers are exposed to the marketing communication messages and advertisements of a brand. Desired customer impression is awareness regarding brand is knowing about its existence.

Successful ads should build awareness, and that gives consumers reasons to choose and buy that brand. (Aaker, 1991; Keller, 2007; Teixera et al., 2010). Bakator et al. (2019, p. 483) described brand awareness as a strong influential construct and market factor in a marketing environment.

In the following, the appeal phase, brands seek to attract customers to the brand. Customers process many marketing messages that are emitted by brands, and because more frequently consumers receive messages or think about the brand the more prominent it becomes in their memory, they create short-term and long-term memory regarding a particular product, service or brand itself (Elliot & Percy, 2007). Desired customer impression is to get customers to like some brand more than others.

When customers are interested in a specific brand, they actively research it by searching for brand review online, asking friends and family, reading about products online, but also by contacting the call centre, asking questions in person and online, examining prices and trying products if possible. The goal of the brand in this stage is to convince the customer.

If convinced, customers decided to act and purchase a product or service of a particular brand. Customers make deeper interactions with a brand through purchase, using or trying the product and also complaining. Brands should observe complaint responses as an opportunity to reframe and explain the failure of a particular product or service to customers (Weiner, 1986; Tomlinson & Mryer, 2009). An effective complaint reply can change the perceived stability of the service failure by transforming customers' original attribution (Chatterjee, 2001). Desired customer activity in this phase is to buy the product or do what brand was intending to achieve. Trusting brand is very important, and when customers do not trust some brand, it distinctly decreases their purchase intention (McKnight & Choudhury, 2006).

The final phase of the customer path in a connected era is advocating. In this stage, some customers are using the product or services of a brand, and they may develop a loyal and robust connection to the brand. Their loyalty is indicated by retention, repurchase and advocacy to others. Customers keep using the same brand, they try new products or services of the same brand with ease, and they also repurchase it and recommend it to others. Consumer-generated content and complaints are regarded as highly credible, and consumers pay notable attention to that content (Filieri, 2016). Advocacy can be conducted any time in any place, and it probably will be conducted using smartphone.

5. CHALLENGES OF ADVOCACY PHASE IN MARKETING 4.0

There are various challenges in the advocacy stage. If a customer is not satisfied due to a service or product failure or any other reason, it could be demotivated for both current and potential customer if there are negative comments or complaints regarding a particular brand or its services or products. Scholars investigated service failure in various online contexts (Guo et al., 2016), such as online retailing (Holloway & Beatty, 2003; Lin et al., 2011), hospitality (Sparks et al., 2016), and social media contexts (van Noort & Willemsen, 2012; Schaefers & Schamari, 2016; Hogreve et al., 2019), and in offline contexts (Maxham III, 2001) and observers' reactions to complaints managed on social media (Mattila et al., 2014; Bacile et al., 2018; Hogreve et al., 2019).

A major source of information on the quality of brands and their products and services are online reviews of current clients that are easily accessible because of the internet accessibility (Raval, 2019). Visitors of social media pages, potential customers, can observe complaints of dissatisfied customers on mentioned pages (Javornik et al., 2020). The public nature of online customer reviews aggravates the effects of negative reviews, as prospective customers commonly read these public complaints when making buying decisions (Standifird, 2001; Mudambi & Schuff, 2010; Kuehn, 2015; Schaefers & Schamari, 2015), which can cause distrust of the seller (Moody et al., 2014). Perceptions of justice or injustice in the complaint-handling process of some brand affect the customers' future trust and loyalty (Tax et al., 1998; Homburg & Fürst, 2005). Potential customers

will base their perception regarding a particular brand on the communication exchange that is visible online (Einwiller & Steilen, 2015; Hogreve et al., 2019).

Regardless of the type of complaint, an instant response to a customers' complaints is critical (Seeger, 2006). Brands should have prepared an effective communication strategy for resolving problems. Marketers can analyse and use various textual data that can be gathered, such as online reviews, customer service calls, press releases, marketing communications, and other online communications and interactions (Berger et al., 2020). An effective strategy for managing customer complaints can facilitate forgiveness and assist in restoring customers' patronage after correspondence (Harris et al., 2006; Xie & Peng, 2009; Del Río-Lanza et al., 2009; Gelbrich et al., 2016). Cicvarić Kostić et al. (2014) confirm that the efficiency and effectiveness of the operation are affected by market orientation, and marketing strategies and tools affect. A brand can use different response strategies when managing an online complaint about a failed service (Davidow, 2003; Gelbrich & Roschk, 2011). Effective response strategies can be an apology, defending the reputation of a brand, excuse, and compensation (Kim et al., 2004; Seeger, 2006; Jin, 2009). Kim et al. (2004) point out that an apology is more effective when the benefits exceed the costs of accepting liability for the failure. Zhao et al. (2020) in their study found that apology is more efficient when the alleged cause is relatively unstable and when the seller has a high capacity to change and that defending the reputation is better when the alleged cause is relatively stable or when the seller has a low ability. The most recent research proposes appreciation rather than an examined apology; therefore it is more likely to increase consumers' self-esteem if the company is saying "thank you" to their unsatisfied customers than "sorry" (You et al., 2020).

6. CONCLUSION

The contemporary business environment is rapidly changing. A comprehensive examination and qualitative analysis of articles from the leading journals, respectable and state-of-art analyses and groundbreaking researches it can be observed that, during past decades, marketing adapted to different trends of the business environment. Since the existence of marketing, there were numerous market changes, and some authors emphasise that markets were changing faster than marketing. Modern marketing is definitely in the evolutive phase of advocacy. Brands should ask themselves are they able to answer to the moment 4.0, when marketing online is happening, and customers are the most influential advocates of brands. Industry 4.0 is essentially transforming marketing, and modern technologies are still developing with many more expected innovations in the future. Marketers should analyse and use various textual data that can be gathered from customers online to predict customer behaviour and prepare effective marketing communication strategies.

Modern brands have different challenges upon them. Most of the internet activities are conducted using smartphones, so the advocacy will also be handled using a smartphone, and because of that, it can happen regardless of time or geographical boundaries. Besides the fact that almost everything is online, the traditional marketing channels must not be forgotten. Innovations, the uprise of technical and technological innovation, more frequent usage of internet in all spheres of private and business life should not be observed as a threat; they should be considered as a chance. If brands seek to be successful in the future, they have to incorporate marketing doctrine into the complexity of modern markets and contemporary business environment, with a focus on each phase of Marketing 4.0, particularly advocacy. The paper also proposes analysing challenges in advocacy phase in Marketing 4.0 and handling negative comments as a recommendation for future research.

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MULTI CRITERIA ANALYSES OF IMPACT OF WWW SOCIAL NETWORKS TO BEHAVIOR IN CYBERSPACE

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Abstract: *World Wide Web (WWW) is a colloquial synonym for the Internet and presents an open window for first and fast information in a contemporary global society. In the paper, we observe the four influence social networks (Facebook, Youtube, Wikipedia u Twitter) and its positional influence on social behavior in cyberspace. Research is based upon an online questionnaire which results were used for AHP analyses. The hierarchy of impact and influential ranking was conducted through the contribution of five experts in the domain field in "Super Decision 2.6.0 – RC1 "software. The efficiency of WWW domains of influence in social behavior was conducted according to the chosen criteria and described in the paper. Identification of such WWW domains contributes to technological development and recognition of the model for the prevention, misuse, and protection of infrastructure and resources in defense and security.*

Keywords*: Internet, www, social network, social behavior, psychological manipulation, impact operation.*

1. INTRODUCTION

The current global society is linked by intensive and dynamic connections, especially in the field of communications. Transformation in the field of communications with the introduction of new technologies is taking the form of a continuous digital revolution. Modern humanity is in a direct and almost uninterrupted connection through social networks. In addition to the positive effects (information, time-saving, improvement of living standards), there is a danger of malicious influence. Namely, social networks are often seen as unreservedly open and well-intentioned virtual places to exchange ideas and information. However, it is evident that social networks also have the potential for an influence beyond control and of which users are unaware. The global environment for the exchange of ideas on social networks is the Internet rapidly evolving following the currents of the digital revolution. From the perspective of typical users, the Internet is the same as the World Wide Web (WWW). WWW is not a synonym for the Internet but is the most recognized part of it. WWW could be identified as a techno-social network for human interaction based on technological networks. The techno-social network is a system that contributes to human cognition, communication, and cooperation. Cognition is imperative for communication and precondition for cooperation. In other words, communication is necessary for interaction, and knowledge is essential for fruitful communication (Fuchs et al., 2010). WWW was evolved technologically since 1980, when Web 1.0 was presented (Getting, 2007; Spivack, 2011), until today, when symbiotic networks Web 4.0 (Aghaei Nematbakhsh & Farsani 2012) are under conceptual consideration.

2. SOCIAL BEHAVIOR AND CYBER SOCIAL BEHAVIOR

In the core of social behavior are attitudes. Regarding Allport, attitude is neutral and mental readiness formed upon experience, which makes directive and dynamic influence on human cognition regarding situations and objects in its correlative interactions (Allport, 1935). Consequently, human action depends on human attitudes. Attitudes cover three factors: cognitive, emotional, and conative. The cognitive factor includes understanding and knowledge of the objects to which the attitude is. That knowledge can be very narrow and organized as a knowledge system. The emotional factor indicates that perspectives always include feelings about the object that we are forming the attitude for, and it can occur as a whole set of emotions. The conative factor considers a tendency to do something - willingly with the object toward which we have an attitude, behavior manifest in a series of actions (Greenwald & Banaji, 1995). Attitudes of one are part of the group's positions, and as that is recognized as public opinion. Public opinion is most easy for reshaping in contrast to all other core components of behavior management (e.g., values and political culture), generating behavior of a person and

group (Mitrović, 2018a). Attitudes contribute to the prediction of behavior, and they're used in the planning of information operations, as variables for preparing reactions of the population (Mitrović, 2018b).

WWW, as a dominant part of daily users' routines of the Internet, has a significant influence on the creation of attitudes and, consequently, one's behavior. The particular aspect is the abuse of content on the WWW, as a form of manipulation of behavior that can lead to security-related consequences. Such abuses are called Impact operations and are used in the context of the recruitment of extremists and future actors in terrorist acts.

In this paper, all three core factors of attitudes are considered in the context of the WWW domains' effectiveness on social behavior in cyberspace. Considering cyberspace has no overall, contemporary research. It works indicated that cyberspace is an environment in which, by intellectual activities through an interface of information and communication systems, create a cognitive world (Vasiljević, Vasiljević & Djurić, 2018). Also, developed technical solutions, which are the base for implementation of channels for communication, make actual societies dependable on information and communication technologies. Moreover, contemporary civilization is linked with digitalized communication, which makes all nationals (state) systems potentially fragile and vulnerable for all sorts of attacks in cyberspace (Mitrovic & Miljkovic, 2018).

Indicated characteristics of cyberspace are core for information operations, which have a goal to influence public audience's attitudes and cognition. Effects are specifically influential on motivation for defense, trust in political and army leadership, but also aspects of mobilization and recruitment. Influence on cyberspace's personality can affect the predictable behavior through personality change attitudes, depending on their essential psychological characteristics. The weight on the anticipated response of the personality is the goal of contemporary psychological operations performed in cyberspace, referred to as "impact operations."

However, do all WWW contents are ascendant, and which have more influence on social behavior in cyberspace?

3. METHOD

One of the advantages of the AHP method used in this paper is to convert intangible factors into numerical values and systematically evaluate the weights of selected elements in pairs through a series of pairwise comparisons (Saaty, 2008). Correlations can be represented by algebraic expression through an estimation matrix or paired comparisons (Lee & Walsh, 2011). To simplify the application of the method, the decision support software Super Decision 2.6.0 - RC1 was applied in the specific example. In our research, the AHP method was applied through five phases:
1) Problem structuring;
2) Understanding the phenomenon of social behavior;
3) Data collection;
4) Assessing relative weights;
5) Determining the solution to the problem.

3.1. Structuring the problem

Problem structuring consists of decomposing a particular complex decision problem into a series of hierarchies (Fallahpour, Olugu, & Musa 2017), where each level represents a smaller number of managed attributes (Nepal, Yadav & Murat 2010). The aim of the multi-criteria analysis of AHP by the method used in this paper is to determine the effectiveness of WWW domains of utmost importance on social behavior in cyberspace.

Effectiveness in the context of the impact of the World Wide Web domains on social behavior in cyberspace in this paper is discussed through four stages:

- The first stage is made by statistical analyzes of traffic and ranking Web domain in cyberspace. The aim of the statistical analysis at this stage is to weigh the "Availability" criteria. Consideration of availability and ranked WWW domain was conducted to identify quantitative properties of the domain in which it is possible to influence social behavior effectively.
- The second phase considers surveys and statistical data processing in the SPSS software. The aim is to identify media that significantly impact the effectiveness of the WWW domains on social behavior in cyberspace.
- In the third phase, we have surveyed with domain experts, and, after data collecting, processes it in the software tool Super Decision 2.6.0 - RC1. This phase aims to benchmark Web domains and to determine the effectiveness of Web domains based on criteria.
- In the fourth phase, we summarized results to determine the importance of Web domains on social behavior in cyberspace.

3.2. Consideration of availability and ranking of WWW domains

Consideration of availability and ranking of Web site domains have been realized by Alexa ranking, which is a subsidiary of company Amazon and specializes in providing commercial Web traffic information. Web domain rankings are calculated by using a combination of average daily unique visitors and average page views over three months. The web domain with the highest number of combinations of the above metrics is ranked as #1. These data are derived from a subset of Internet users who use a browser than 25,000 extensions for Google Chrome, Firefox, Internet Explorer, etc. In addition to what is listed on the Alexa analytics site, it is possible to view country rankings of web domains and specific search categories such as health, science, military, academia, and more (Alexa, 2018).

Table 1: Ranging of WWW domains according to Alexa (05 January 2018)

Ranking	Domain	Daily visit (mm: ss)	Daily page /visitor	% traffic by explorer	Total WWW interconnection
1	Google	7:38	8.69	4.80%	4,114,642
2	Youtube	8:19	4.81	15.90%	3,106,319
3	Facebook	10:17	4.03	8.70%	8,251,598
4	Baidu	7:33	5.92	8.30%	194,758
5	Wikipedia	4:15	3.29	66.80%	2,200,261

Comparison data provided from Alexa with finding from SimilarWeb (2018) and Ranking (2018) indicate identical conclusions, with a variation of order for Youtube and Facebook. The research suggests that the most significant combination of average daily unique visitors and average page views on the site, and in correlation with the declared aim of the analysis of the effectiveness of the WWW domains to social behavior in cyberspace singled Youtube and Facebook. Besides, the most significant bit and observations Wikipedia and Twitter because they represent domains within which social behavior in cyberspace can be influenced. Consequently, WWW domains with the most availability influence are Youtube, Facebook, Wikipedia, and Twitter. They are not listed by grade because they have more sophisticated analyses of unique impact in different areas (attitudes, behavior, cognitive, conative, etc.). They could be used for various purposes depending on the aim of those who send a message of individual interest of message/information consumer.

3.3. Surveys and statistical data processing

Comparative analysis of availability influence also involves an online survey obtained on the 148 persons, to review attitudes towards the similarity of understanding of defined terms. The questionnaire was prepared according to the Likert scale of attitudes (Vasilijevic, 2016). The respondents had the task of expressing the degree of their agreement on a five-point scale, such as "1-disagree", "2-disagree", "3-don't have an opinion"," 4-agree" and "5-completely agree". Statistical processing of collected data was carried out in the SPSS software tool. The survey group's gender structure was the conduct of males (60%) and females (40%). Education level was high school -18.9%, higher education – 10.1%, college/bachelor – 20.4%, master – 40.5% and PhD – 10.1%. Survey include people from six countries Netherlands (10.1%), Croatia (19.6%), North Macedonia (10.1%), Slovenia (19.6%), Serbia (30.4%) and USA (10.1%). Table 2 presents the results of an online survey conducted on the above-described group toward a gradient of influence of social networks in WWW to social behavior in cyberspace.

Table 2: Attitudes toward understanding the importance of WWW domain effectiveness on social behavior in cyberspace.

Parameter	Youtube	Facebook	Wikipedia	Twitter
Valid	148	148	148	148
Missing	0	0	0	0
Mean	4.0000	4.6959	2.9122	3.6892
Std. Error of Mean	0.03713	0.05309	0.05747	0.06421
Median	4.0000	5.0000	3.0000	4.0000
Mode	4.00	5.00	3.00	4.00
Std. Deviation	.45175	.64585	.69916	.78117
Variance	.204	.417	.489	.610
Range	2.00	2.00	2.00	3.00
Minimum	3.00	3.00	2.00	2.00
Maximum	5.00	5.00	4.00	5.00
Sum	592.00	695.00	431.00	546.00

The goal of the multi-criteria analysis AHP method applied in this paper is to determine the efficiency of the WWW domain in cyberspace is of utmost importance for social behavior. The respondents were asked to

express their position according to the following criteria: cost, infrastructure, procedures, availability, knowledge, entertainment, and dialogue. The results of the survey on the significance of the requirements are presented in Table 3.

Table 3: Results of a survey regarding importance.

Parameter		Price	Infrastructure	Procedures	Availability	Knowledge	Entertainment	Dialog
N	Valid	148	148	148	148	148	148	148
	Missing	0	0	0	0	0	0	0
Mean		3.9392	3.8851	4.8851	4.0068	4.8851	1.9932	3.3514
Std. Error of Mean		0.01971	0.02630	0.02630	0.04011	0.02630	0.02795	0.06277
Median		4.0000	4.0000	5.0000	4.0000	5.0000	2.0000	3.0000
Mode		4.00	4.00	5.00	4.00	5.00	2.00	3.00
Std. Deviation		0.23979	0.31994	0.31994	0.48790	0.31994	0.34000	0.76367
Variance		0.058	0.102	0.102	0.238	0.102	0.116	0.583
Range		1.00	1.00	1.00	2.00	1.00	2.00	2.00
Minimum		3.00	3.00	4.00	3.00	4.00	1.00	3.00
Maximum		4.00	4.00	5.00	5.00	5.00	3.00	5.00

3.4. Experts survey

The expertise of the effectiveness of the WWW domains of utmost importance for social behavior in cyberspace was performed by applying the AHP method in the software tool Super Decision 2.6.0 - RC1, by interviewing five domain experts. After implementing the results of a survey on five experts in a particular domain, cumulative results indicate that all of the experts examined to have a non-divided opinion that Facebook is most influenced social networking site to behavior in cyberspace. Aggregate interpretation of expert's survey is in Table 3.

Table 3: Overall conclusion of influence ranking of social networks on WWW

	Ranking of social networks on WWW by experts			
	Facebook	**Twitter**	**Wikipedia**	**Youtube**
Expert 1	1	4	3	2
Expert 2	1	4	3	2
Expert 3	1	4	3	2
Expert 4	1	4	2	3
Expert 5	1	4	2	3

Summarizing interpretation of results of AHP method indicate that expertise of efficiency of the selected social networking site in the sense of influence on social behavior in cyberspace is as follow:
1. Facebook, most influence – consensus 100% experts;
2. Youtube, less influence - 60% experts;
3. Wikipedia, significantly less influence - 60% experts;
4. Twitter, weakest influence - 100% experts.

3.5. Interpretation of results

Evaluating multiple alternatives on a single scale makes it challenging to evaluate alternatives accurately. Therefore, pairwise comparisons were made in the paper. Also, it has been observed that a sufficiently accurate scale is a scale from 1 to 9 (Likert or Saaty scale). In other words, a smaller scale is not sufficient to reflect differences between alternatives, while a more substantial scale makes it difficult to express a difference. Comparison of alternatives in pairs by a defined criterion (in this paper, the following are defined as criteria: cost, infrastructure, procedures, availability, knowledge, and dialogue) is made in the valuation matrices. Since the entertainment criterion has a value of 1.9932, which is significantly less than the value of the other criteria, it will not be included as an analysis criterion.

The estimation matrix is completed by assigning values from 1 to 9 to the "estimator," thus comparing alternatives. A value of 1 represents an equal preference between the compared alternatives, while a value of 9 represents an extreme preference of the alternative (Triantaphyllou, 2000). Graf model of resulting AHP method of research is in Figure 1.

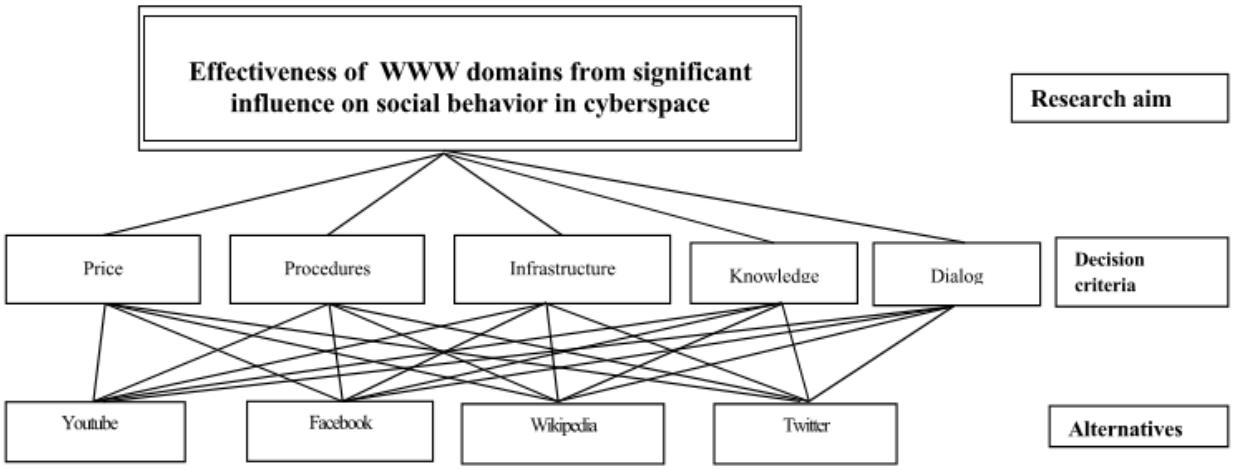

Figure 1: Graph model of AHP results in the conducted research

4. CONCLUSIONS AND FURTHER RESEARCH

Cyberspace is an interactive and dynamic environment of influence. Daily users mainly identify the Internet through functions of the World Wide Web - WWW, and its services, social networks, multimedia, and broadcast platforms. Contemporary society is globalized and connected by WWW services in interactive "global society." Internet, carefully social networking sites that operate on it has the potential to influence attitudes of one and through them, to society in total. We recognized the potential of influence by which it is possible to create destructively and for dangerous society attitudes. Particular dangers are likely to influence the sense of extremisms and terrorism mobilization. That is why it analyzed the availability and influential potential of some social networks and its ranking.

The comparative analysis of the results obtained by AHP method based on the data of experts from the domain field and the results of the respondents conclude that as an alternative for the determining the effectiveness of the WWW domain of the utmost importance to social behavior in cyberspace by the significance ranked as a first Facebook, Youtube in second place, Wikipedia in third place and Twitter in fourth place. The difference was identified in the ranking of alternatives between Youtube and Wikipedia.

According to delivered results, Facebook has the most potential for influence and manipulation on behavior in cyberspace. This potential should be recognized as a research point in analyzes for modeling of impact operations and manipulative seduction of one in mobilization and preparation for society undesired and dangerous acts.

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CORPORATE REPUTATION AND STRATEGIC DIGITAL COMMUNICATIONS IN INVESTOR RELATIONS

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Abstract: *This paper presents the results of research into the role of strategic digital communications in creation and management of quality investor relations who are among key stakeholders of every company. The primary goal of the paper is to define the nature of the relationship between strategic digital communications and investor relations. The secondary goals are directed towards determining the causality of the relationship between strategic communications, investor relations and corporate reputation. The methodology of the research in the paper includes the following: first, the paper focuses on defining relationship with investors and identifying relations between corporate reputation and the relationship with investors; second, it encompasses the analysis of strategic communications and their role in the establishment and management of effective relationship with investors. Finally, it includes the definition and analysis of the importance of strategic communications and on-line media in the process of construction and management of the desired relationship with investors. One of the conclusions of the research is that strategic digital communications are the basis of establishing good investor relations with the goal of building positive reputation and taking the desired position on the global market.*

Keywords: *investor relations, reputation, strategic digital communications, on-line media*

1. INTRODUCTION

Ensuring financial and other means necessary for regular business operations as well as for reaching the desired position on the market is the priority of every company. In regard to this, investors stand among the most important stakeholders of a company and that is why investor relations, as a strategic function, hold special importance for the success of the business. Nel and Brummer (2016) define investor relations as a "connection between a company and financial community where the financial community is given information relevant for the assessment of the company." Laskin (2008) looks at investor relations from the viewpoint of the function of the public relations and defines them as: " a management function which establishes and maintains the mutually beneficial relations between an organisation and the investors on whom its success or failure depends." On the other hand, a significant role in investor relations is played by marketing activities, where a special focus is, according to Kim et al. (2019), on assuring the investors of the good prospects of the company through facilitating communication with them.

The subject of the research of this paper is as follows: investor relations as one of the key groups of stakeholders; corporate reputation and its interrelationship with successful investor relations; strategic communications and their role in establishment and management of the desired investor relations as well as the efficiency of the application of strategic digital communications with the purpose of creating quality investor relations. The methodology used in the paper is based on the secondary qualitative research. The structure of the paper encompasses several parts, each dedicated to a separate topic covered by the research. Following the introduction, the first part of the research deals with the relation between corporate reputation and investor relations, while the second part is dedicated to the role of strategic communications in investor relations. The third part of the paper analyses digital strategic communications and their role in the creation and management of successful investor relations. The last part of the paper presents a discussion and conclusion.

2. CORPORATE REPUTATION AND INVESTOR RELATIONS

Van Riel and Fombrun (2007) view corporate reputation as " the overall assessment of a company by its stakeholders", while Vlastelica et al. (2018) present the following definition: "Corporate reputation is a set of relatively long-term impressions, attitudes and feelings of an individual or a group regarding a company, which

have been formed on the basis of personal experience or indirect information from a trustworthy source, in the context of personal and social expectations, and which influence the intentions and behaviour of an individual or group towards the company. ” Corporate reputation manifests itself as intangible assets and represents a sustainable comparative advantage in the case of companies which possess strong and positive reputation (Deephouse, 1997),which is why numerous companies in the world recognise its value and see it as a strategic policy in business.

Every company can be subjected to assessment by numerous stakeholders who form attitudes towards it based on its overall behaviour on the market, as well as particular segments of its business operations which are not equally relevant for different groups of stakeholders. Having in mind the huge importance of investors, from a company's point of view, it is significant to identify and analyse the causality of the relation between corporate reputation and investors, as well as the consequent behaviour of this category of stakeholders towards the companies with good reputation.

In this respect, quality investor relations have a positive impact on corporate reputation (Inoue & Lee, 2011), where such relations can represent a strategic tool for the creation of long-term competitive advantage (Hoffmann et al., 2011). Owing to the good reputation, companies can create effective relations with stakeholders, especially key stakeholders, as held by Fombrun and Van Riel (2004) who notice that this also leads to better prospects for the increased demand for the company`s shares and therefore easier acquisition of additional capital. The same authors describe the relation between reputation and financial performance as interdependent. On the one hand, good reputation influences the enhancement of business performances of a company and thus increases its profitability which directly impacts the market value of the company. On the other hand, as the authors state, the enhanced financial performances and the increased market value of the company allow bigger investments which influence the reputation.

Hoffmann and Fieseler (2012) view corporate social responsibility and reputation as one of the main categories which financial analysts take into account when making an impression about a company, while Inoue and Lee (2011) claim that positive reputation ensures quality investments into a company and consequently influence its profitability, financial and business operations stability as well as the achievement of its desired position on the market. Investors view the companies with good reputation as an opportunity for good investment, considering that, in this case, the investment risk is low. On the other hand, bad reputation, as emphasised by Fombrun et al. (2000), is reflected in decreased revenue and diminished ability to attract financial capital.

Good reputation has an important role in the creation of investors` loyalty to a company, regarding that, as held by Helm (2007): it can influence their readiness to pay more for its shares, keep the shares longer, buy additional shares of the same company or advise other investors to buy the shares of that particular company. The same author quotes that the basis of the loyalty is the investor`s satisfaction, which stems from the level of the correspondence between the expectations and the experience with a company, which Vlastelica et al. (2018) recognize as important factors of reputation.

Also, it is necessary to consider the fact that the information linked to finances is not the only type of information investors take into account when they decide on investing financial resources. In this process, various aspects of the company`s business are analysed with the goal to gather all the necessary data for the creation of a realistic portrait of a company so that the investment risk can be minimal. In the context of the above mentioned ideas, numerous companies put an emphasis on corporate social responsibility with the aim to create good reputation and consequently reach business and financial goals.

3. THE ROLE OF STRATEGIC COMMUNICATIONS IN INVESTOR RELATIONS

Plowman and Wilson (2018) define strategic communication as “the management of communications between an organization and its stakeholders on the long term basis so that measurable goals can be achieved in a real time frame.” Strategic communications represent a purposeful use of communication by an organisation, which helps achieve its mission (Van Ruler, 2018) and goals (Gulbrandsen, 2019), and thus, uniting communicative aspects of public relations and marketing, these become an important part of the company`s management.

The planned and realized effective investor relations, based on a dialogue, have an important role in the creation and management of corporate reputation, so that communication with investors, who are important stakeholders for the success of the company, is obviously one of the most important segments of strategic communications. Kostic-Stankovic and Nedeljkovic (2012) notice that in the times when capital markets become increasingly international and when companies compete for investments against competition from all around the world, communication with investors gains importance.

The basis of good investor relations lies in their obtaining of information about financial and business results of a company. The information should enable analysts and investors reliable assessment of a company`s value, given that the results should give a proof that the company is able to achieve its goals (Djordjevic et al., 2012), which greatly influences investors' decisions (Xu et al., 2018).

Strategic communications of a company represent one of the key factors in the achievement of the desired investor relations, whereas the communication has to be two-way, proactive, continuous and dialogue-based as contrasted to one-way financial reports. This implies knowing the investor`s characteristics, mainly regarding the way they receive information. As prompt and transparent approach accompanied by appropriate communication with investors and shareholders is necessary, Salvioni et al. (2016) point out that it is necessary to provide relevant information, beginning with the company`s strategy to its periodical reports and results. This is why, according to the authors, companies that care about their reputation, establish departments for investor relations which aim to satisfy their need for gathering information. Recognising the importance of communication with investors, Van Riel and Fombrun (2007) quote the example of *General Electric* which was the first company in the world to establish a specialised department for investor relations in the 1950s, which, according to Doan and McKie (2017) marks the beginning of investor relations.

3.1. Strategic Communications Channels in Investor Relations

Stakeholders, as well as investors, analysts and creditors, are interested in as many financial indicators of a company`s business operations as possible (Djordjevic et al., 2012: 114), which is the reason why voluntary publication of financial reports has a positive influence on a company`s value (Dorfleitner et al., 2018). Henry (2008) quotes that many companies issue public statements after each quarter in order to inform the interested public about the achieved financial results, whereas such practice has a twofold role: first, to inform about the facts relating to the company`s performance and second, to promote it and achieve a positive impact on the readers` attitudes to the performance. Thus, promotional aspects of public statements may influence journalists who specialise in finances so that they write about the company with a positive connotation. Besides, as the author points out, these statements are also sent to investors, who can thus gather the information they need directly from public statements, and not only from the media. Hoffmann et al. (2011) hold that corporate presentations aimed at analysts increase their interest in shares, while Salvioni et al. (2016) emphasise the importance of press conferences and direct meetings of top management with investors. In the context of quality communication with investors, Segars and Kohut (2001) observe that executive directors` letters to shareholders are a strategic instrument, which is even more visible in the era of online media and its use to convey the messages by top management. Also, it is possible to communicate with investors via email, newsletters, video conferences, webcast conference calls, presentations and video recordings on the internet. Dunne et al. (2013) point out the opportunity to publish data on the digital platform XBRL (*eXtensible Business Reporting Language*) enables the interested parties to download the financial data of a company and to enter it directly into a software for data processing.

4. STRATEGIC DIGITAL COMMUNICATIONS IN INVESTOR RELATIONS

Successful investor relations have a potential to create positive experience of these stakeholders with the company, which is especially visible after the development of digital technologies, which is why online media are becoming an important channel of strategic communications with investors. By providing necessary information, as well as by creation of positive experience through direct communication, these media have become an important tool in the strategic activities of reputation creation and management, both regarding investors and general reputation. In this respect, it is especially important that investors trust their information resources i.e., to hold them trustworthy. Thus, a company contributes to the transparency of its business, boosts investors` trust, and finally, enhances the creation of positive corporate reputation. The significance of contemporary media for reputation creation and management is emphasised by Khan and Digout (2018) who quote the notion of *corporate e-reputation* that represents online reputation of companies as a part of overall reputation, which is based on two-way communication via online media.

Communication with financial public via online media has led to a revolution in the way of conveying information, mainly through the following: technical possibilities to create multimedial content, global availability of information, elimination of publishing costs and increased amount of available information compared to traditional media, an opportunity to have a dialogue and interaction, increased transparency of companies` performances which consequently decreases investment risks, availability of other, non-financial, data about relevant companies` business operations, as well as an opportunity for investors to analyse the data in any moment and follow business trends. Moreover, one should not forget the advantages these media provide to small investors, whose only means of gathering and analysis of information is via online media. However, this means of communication with investors has certain disadavantages, mainly regarding the accuracy and reliability of information companies publish on the internet. This can lead to investors` wrong decisions and negatively affect company`s reputation and trustworthiness of its official publications. Besides, complex

financial statements may be incomprehensible for some investors (Xu et al., 2018), while another problem arises concerning the appearance of unprofessional analysts, who face little regulatory supervision, as contrasted to the professional ones (Campbell et al., 2019).

For the purposes of creation of desired investor relations, besides official web pages and social media, due attention should be paid to online media that are not under companies` control. Contents created by clients have a great potential in creation and management of reputation, given that these enable communication strategists to follow clients` comments and react to these. Similarly, using a psychology theory, Nguyen et al. (2020) notice the importance of the reactions of institutional investors to clients` feelings about a brand or company expressed through social media, which make them foresee their future performance and make decisions about investments. Chung et al., (2020) point out the importance of communication between a company and its current or potential customers via social media and its influence on investors` decisions.

4.1. The Role of Web Sites in Digital Communications with Investors

Communication with investors based on web pages has become increasingly important and this has significant positive implications on strong corporate reputation (Temizel et al., 2017). Thus, one of the features of successful companies worldwide is financial reporting through web pages. The size of a company influences the amount of the use of on-line media for publishing financial reports (Hoffmann et al., 2018), suggesting that bigger companies display greater probability of publishing their financial reports on their web pages.

Lybaert (2002) holds that company activities of communication with investors via online media are the most common and the best developed in the USA, which is partially due to the obligation of public corporations to submit their financial reports to EDGAR system (Electronic Data Gathering, Analysis and Retrieval System) since 1996, which makes the data easily available. Bagnoli et al. (2014) quote the results of research conducted on a sample of 300 USA companies in 2008, showing that there is a large percentage of USA companies which provide financial information on their web pages, have a quality archive of the reports, while 70% to 80% of these provide a link for investor relations department or access to webcast. Botti et al. (2014) emphasise that the amount of information distributed via web pages by German companies has significantly increased recently, while in France there is a recommendation that companies provide their financial reports on their web pages. In regard to this, Park and Reber (2008) quote the results of research which analysed the contents of web pages belonging to 100 corporations found on the list of Fortune 500, according to which the great majority provided information relevant for investors, such as profit reports (99 companies), annual report (99), information on investment (96), news and events concerning investors (94).

Bozcuk (2012) notices the fact that since 2005 financial reporting via online media has become obligatory for all companies in Turkey which have a web page and are on the Istanbul stock-exchange. Also, the author quotes that bigger companies use more sophisticated forms of publishing these, such as audio and video files. Djordjevic et al. (2012) quote the results of the research conducted in Serbian companies with managers preferring written and direct contact with investors, although the situation has been changing and companies are increasingly beginning to use online media for this kind of communications.

4.2. The Role of Social Media in Digital Communications with Investors

Social media appear to be the key source of information for investors in the process of making their decision to invest (Chung et al., 2020), which is why companies increasingly use this medium for communication with them. Siikanen et al. (2018) hold that social networks such as Facebook and Twitter provide numerous opportunities to companies to enhance communication with different stakeholders, including investors. Besides the above mentioned, Cade (2018) emphasises the importance of You Tube channel, addining that social media provide an opportunity for companies to give opinions, forecast future events such as the change in share prices and state past or potential decisions, while, on the other hand, investors can easily access this information. As to the forecast of what will happen in the future, Alexander and Gentry (2014) hold that the use of social media for business purposes has been an existing trend for years, so even greater number of companies will communicate with investors via platforms such as Facebook, LinkedIn, StockTwits.com.

Besides social media and general social networks, there are those which are specialised for specific, niche audiences. Piñeiro-Chousa et al. (2017) emphasise the importance of StockTwits.com, a type of social network similar to Twitter, which gives an opportunity to its users to share information about shares, indices and financial markets. In the context of the above mentioned, Cade (2018) quotes a good example of Roberta Shanks, financial director of Ford Motor Company who holds question and answer sessions with the community of investors via StockTwits.com. On the other hand, Zhang et al. (2018) give an example of Xueqiu, a specialised social network intended for Chinese investors which attracted millions of users.

5. DISCUSSION AND CONCLUSION

Investors represent a group of the most important stakeholders of every company as they provide the necessary resources for its survival, growth and development. Considering this fact, it is clear that successful investor relations represent a special challenge for a company which aspires to reach its pre-planned goals, especially the long-term ones, and occupy the desired position on the market.

There is a significant, two-way correlation between effective investor relations and positive corporate reputation which, in the final instance, has relevant implications on company`s market position, its profitability, the attitude of clients towards it, loyalty of key stakeholders, media reporting and the attitude of financial audience towards the company. Therefore, a positive reputation has influence on attracting investors and increasing their readiness to invest as well as on preconditions for the investment. Also, it reduces investment risk while investment itself, besides providing key resources for business, represents a significant constituent of good corporate reputation.

In order to achieve good reputation it is necessary to establish desired investor relations, based on strategic communication and its significant segment, strategic digital communication. The communication should be based on transparency i.e., availability of relevant financial information to investors and other financial audiences relevant for company`s business, notably to financial analysts and media representatives who specialise in the field. Besides information concerning finances, experts for communication with investors should pay due attention to communications connected with other aspects of business which can influence the final decision about investment, as well as communication with other stakeholders, especially via online media, which is all visible to investors as well.

With a view to achieving quality investor relations it is necessary to provide a two-way information flow between companies and investors, whereby it is especially important to choose suitable media which will facilitate the communication. Although financial reports are still presented in the traditional manner, strategic digital communication starts to play an increasingly important role in the process. This type of communication encompasses communication via online media such as e-mail, on-line newsletter, webcast calls and conferences as well as other digital platforms. However, the company website has become increasingly important as a popular means of displaying financial data. This type of communication has numerous advantages such as the following: lower costs compared to traditional printed media, transmission of a greater amount and diversity of information; permanent availability of information to interested audiences; use of multimedia for data presentation, transparency and opportunity to update information. This claim is supported by the data quoted in this paper, which clearly show global increase in financial reporting via web pages. There are estimates that social media will play an even more significant role in strategic digital communication with financial audiences, which will open new opportunities for enhancing these relations. This is why communication via online media has increasingly become a common way of communicating a company`s financial information to investors.

Therefore, strategic digital communications are gaining significance, not only in the process of informing investors, but also in the creation and management of successful investor relations which consequently reflects on its corporate reputation.

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ETHICAL CONSUMPTION: OPPORTUNITIES FOR SUSTAINABLE APPROACH

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Abstract: *The paper aims to analyze a relationship between corporate social responsibility (CSR) and ethical consumption (EC). In addition, the case study of Intermarché is examined and discussed in order to observe how CSR and EC can be connected in real-life context. The results suggest not only a relationship between these two concepts exists, but it applies and extends its benefits to the company's stakeholders. The paper also adresses opportunities for further development of sustainable consumption, in terms of smart technologies that can have an important role in resolving contemporary issues of sustainable future. While the conclusions and observations derived from such research are beneficial for better understanding of CSR and EC practices, more investigation on this topic is encouraged in order to fill in the existing research gap, particulary in the context of smart approach.*

Keywords: *Corporate Social Responsibility, Ethical Consumption, Conscious Consumers, Food Waste, Intermarché*

1. INTRODUCTION

The concept of Corporate Social Responsibility (CSR) has begun to gain relevance during the 1980's and 1990's by scholars both in the United States and Europe (Murphy & Schlegelmilch, 2013). Throughout the past decades, CSR has increasingly drawn the attention of both scholars and professionals, as a discipline of study in fields such as management, marketing, communications, as well as a practice to be adopted and advanced by corporations worldwide. As argued by Harrison and Freeman (1999), the role of businesses in society does not only focus on creating wealth for themselves in terms of profitability, but rather to act responsibly towards stakeholders and distribute such wealth in a way to support a wide range of socio-environmental causes. Such causes may vary from cooperating and assisting local communities to water conservation and promoting ethical labor practices. Interestingly argued by Becker-Olsen et al. (2006), social endeavors must today be consistent with the firm's operating objectives (heart) while also being an expression of their values (soul). As a result, some scholars claimed that investment in CSR should not be regarded as an expense, but instead as an allocation and distribution of resources to reinforce relationships with all parties involved in the well-being and thrive of the company (such as, customers, employees, partners, shareholders and others), and a powerful practice that can be used to gain competitive advantage in the market or industry (Eshra & Beshir, 2017).

Simultaneously, when corporate social responsibility is carried out effectively and, therefore, is acknowledged by the stakeholders, consumers, in turn, respond with a particular type of behavior, named by some scholars as ethical consumption (EC), or conscious consumption (Toti & Moulins, 2016). Crane and Matten (2004) provide a suitable definition for ethical consumption as they describe it as "the conscious and deliberate decision to make certain consumption choices due to personal moral beliefs and values". Others have delved into expressing it as a more comprehensive concept, which entails multiple elements into consideration: "conscientious consumption is one that takes into account health, society, and natural environment based on personal beliefs" (Oh & Yoon, 2014). As scholars suggest, there is a growing relevance of ethics in consumption behavior (Bray et al., 2011; Arnold & Valentin, 2013; Barton et al., 2018), and consumers now tend to support and favor brands pursuing a higher purpose and intention than the one of simply making a profit out of sales. Being aware of such shift in consumption behavior, companies have therefore integrated ethics and responsible practices into their organizational strategies precisely through the notion of corporate social responsibility (CSR), which associates social issues and environmental concerns to the economical goal of companies (Toti & Moulins, 2016). Thus, for the majority of companies, CSR is not optional anymore, it is

rather a strategic business concern that indicates responsiveness towards economic and environmental issues striving for a favorable influence on the development of society (Aguinis & Glavas, 2019).

Based on these premises, this paper aims to explore the concepts of CSR and EC, ultimately advancing the argument that CSR and EC are two interrelated concepts, which, if successfully implemented, may have a series of positive implications and benefits for stakeholders. EC as a concept is related to consumer social responsibility, which Schappert and von Hauff (2020) consider as one of the approaches to sustainable consumption. Although Nižetić et al. (2019) argue that smart technologies can become important and useful in resolving important population issues and provide underpinning for a sustainable future, still some scholars emphasize that is not clear how these technologies affect consumption patterns and reaching sustainable consumption (Schappert & von Hauff, 2020).

The paper begins by inquiring existing literature on CSR, followed by explanation of EC and better understanding the implications of ethical consumerism and socially responsible consumer behavior. Both literature review and case study presented in the paper are supposed to provide a more comprehensive reasoning of the topic.

2. LITERATURE REVIEW

A large body of literature has emerged and developed over decades, attempting to deeper analyze what it truly means for a company to be socially responsible (Mohr et al., 2001; Park et al., 2014; Baden, 2016; Aguinis & Glavas, 2019). Corporate social responsibility is a concept that, besides economic, integrates both environmental and society's interests in corporate activities in order to ensure prosperity over the long-term (Park et al., 2014). As a result, CSR refers to the way in which the company acts for the collective good, taking into account environmental issues, while altogether producing tangible results to society and, more specifically, the its stakeholders (Brown & Dacin, 1997; Sen & Bhattacharya, 2001).

Carroll (1999) analyzes the different types and levels of obligations a company must attend and ensure to citizens in order to improve society's wellbeing and to build and enhance its reputation. Economic responsibilities are at the bottom of the pyramid. This level addresses the pure economic and profitable function of an organization, including satisfying consumers with products of good value, and generate appropriate return for investors (Park et al., 2014). The second level comprises legal responsibilities, which require firms to abide laws related to the business they perform, including taxes and regulations. The third level refers to ethical responsibilities, whose exact significance and interpretation have sparked a variety of explanations by scholars. For instance, some describe ethical obligations as behaviors and ethical norms that each organization is expected to follow (Park et al., 2014). From this standpoint, ethical responsibilities are well understood and closely related more to the second level, that is, legal responsibilities, as the behavior and action of a given business must be in accordance with the law. Others, however, have provided a more comprehensive definition of what ethical responsibilities may entail: "Ensuring that a firm's actions do not harm individuals or the public at large; that it does what is right, just and fair" (Smith & Quelch, 1993). The latter explanation, in fact, addresses more specifically one of the most important stakeholders of a company, its customers. In this sense, being ethical does not solely include the law, or abiding to government's regulations at large, as often times one may think, but implies doing 'ethically' and sustainable actions for the sake of society. Preserving customers' safety and, on a broader level, even attempting to improve *status quo* in society. Lastly, the final level concerns philanthropic responsibilities, a dimension which encompasses financial and non-financial matters, and purely deals with and in the pursuit of "betterment of society" (Park et al., 2014). According to these authors, although philanthropic obligations are voluntary activities, and therefore not mandatory in any way, studies have demonstrated that the general public in many cases expects that companies engage in altruistic acts as a way of giving back to society (Park et al., 2014). Many scholars have agreed that Carroll's pyramid contributed to shed light on the causes that have made CSR crucial and necessary in the first place. Furthermore, some argue that due to increased influence and power of businesses over the use of limited resources, CSR should encourage and enable a socially responsible mindset, vital for the long-term welfare of society (Baden, 2016). This is why education on business ethics and sustainable corporate practices is of fundamental importance in order to teach and train future corporate citizens and business owners on how to generate profit while simultaneously delivering adequate resources for the collective benefit.

Following part of the paper explores the other concept which is under the scope of this research - ethical consumerism. This concept is related to consumer social responsibility, which is one of the approaches to sustainable consumption (Schappert & von Hauff, 2020). According to Mohr et al. (2001), socially responsible consumer (SRC) is "a person who bases his or her acquisition, usage, and disposition of products on a desire to minimize, or eliminate, any harmful effects and maximize the long-run beneficial impact on society". This interpretation of the SRC is very insightful for the purpose of the following research, as it allows to draw useful

implications. Firstly, ethical consumption purposes may vary depending from the consumer and his intended intentions and motivations that drive this particular type of consumption behavior. According to marketing researchers, such motivations may be multiple, and largely dependent on the type of product desired, therefore implying a large range of possible ethical behaviors associated (Toti & Moulins, 2016). De Ferran (2007) claimed that the respect for human rights, traceability as a guarantee of quality, the organic label of the product and pleasure seeking were among the main elements that guide consumers when purchasing a fair-trade coffee. Moreover, the social value related to the item is not enough alone; fair trade products must also be appealing and tasty in addition of reflecting such ethical labels.

Conversely, as advanced by others, ethical consumption does not necessarily have to be driven or motivated by ethical concerns, in fact, it may accurately reveal and display the individual orientation when it comes to purchasing decisions (Spiteri Cornish, 2013). Scholarly literature has indeed analyzed that one's 'desire for health' is by far the most common and primary motivation when buying organic products, such as fruits and vegetables, often labeled as being healthy and nutritionally richer (Spiteri Cornish, 2013). According to this author, the 'fear of illness' is a motivation that drive consumers purchasing decision towards such alternatives as they are perceived to be beneficial for the diet and body, altogether with the 'desire for quality', where subjective perceptions of consumers is the primary driver of purchasing decision, as one's viewpoint may be easily influenced by the effectiveness of the package or logo presented on a fair trade coffee or organic fruit. Only at the end, Spiteri Cornish (2013) notes, there is a true 'desire for virtue' as a motivation, in which ethical attributes of a product determine the purchasing decision-making.

Thus, as the literature demonstrates, the ethical consumption behavior one may display during a process of purchase may vary from product to product, as each item presents different intrinsic characteristics and factors (type of product, packaging, healthy vs. unhealthy, tastiness, perceived quality), which could lead the final consumer to drive his ethical choices accordingly and differently depending on the context and item pursued.

Ethical consumer behavior is not a uniform path one would follow within a marketplace context. Scholars have analyzed three primary types of ethical consumption, which are explained in the research of Delistavrou et al. (2017) and presented below. Firstly, the most important type is Positive Ethical Consumption (PEC). It has been described as "the purchasing of ethical products (e.g. ecological & organic products, fair trade products, local traditional products) and the post-purchasing activities in favor of the environment (e.g. recycling, reuse and repair of used products)". As the name suggests, this particular type of ethical consumption is proactively and intentionally carried out by consumers, who are conscious and aware of the positive outcome they are employing in supporting a cause (environmental, social, local) with the act of purchasing a specific item.

The second type of ethical consumption is Negative Ethical Consumption (NEC), also referred to as boycotting. It has been formally described in literature as "the consumers' engagement in boycotts against 'unethical' products delivered and produced by companies, which have been demonstrably accused of unethical business strategies" (Delistavrou et al., 2017). As opposed to PEC, NEC, in pursuit of boycotting a given brand or product, may involve the deliberate choice on behalf of some consumers of not buying it, or even damage its image and reputation through public protests and grassroots initiatives. American biotechnology company Monsanto faced this in 2015, when tens of thousands of people marched in around 400 cities in more than 40 countries across the world to protest against the company and its genetically modified crops and pesticides, as it is reported by The Guardian (https://www.theguardian.com).

Finally, the third type of ethical consumption, which is also the most modern one, is the Discursive Ethical Consumption (DEC), defined by scholars as "all activities that aim at the formulation of the public opinion through social debate either in favor of ethical or against unethical products/services of firms" (Delistavrou et al., 2017). Such type of ethical consumption is particularly interested to examine for two main reasons. Firstly, because it represents a form of support or dissent, which primarily takes place on media, including of course social media platforms as well, where users have absolute freedom of expression (in most cases) and can interact with one another almost immediately with a hopefully productive exchange of opinions and information. The second reason deals with the communicative power that media itself possess when promoting or discouraging the consumption of a certain brand/product. In fact, through DEC and its effectiveness in spreading information, individuals have a large and prominent influence in possibly persuading a large number of people to buy or not a certain product.

After the explanation of these concepts, it is relevant to analyze their relationship. In fact, one could imagine the socially responsible consumer (SRC) and corporate social responsibility as two sides of a coin. From one side, there are the companies that are intentionally capable of generating awareness within society about certain social causes. On the other side, there are conscious consumers who show their empathy and approval for such companies by even changing their purchasing decisions and habits in order to sustain and promote the intended purpose.

The paper now focuses on examination of a particular case study, French retail chain - Intermarché, and the way in which it successfully promoted ethical consumption through a targeted educational campaign in order to increase awareness and consumer knowledge about the specific goods it sold. As it shall be discussed, the favorable implications of this campaign have extended to benefit Intermarché's stakeholders and have further contributed to strengthen the hypothesis sustaining the relationship between Corporate Social Responsibility and Ethical Consumption.

3. ANALYSIS AND DISCUSSION

Several sources are employed in order to retrieve the information and understanding of the manner in which Intermarché promoted and carried out educational campaign. Social media and e-reports have highly promoted and supported Intermarché's initiative and have therefore provided a great number of articles and posts reporting the case (such as the Advertising Age). Scholars have also dedicated time in order to accurately examine the Intermarché's case in details, as a solid example of promoting sustainable consumption during a historical period in which wastage levels have reached alarming peaks. The British NGO Design and Art Direction (D&AD), published a very interesting case study concerning such issues, which have provided further insight in the careful inquiry of Intermarché's strategic campaign. Furhtermore, scholarly sources were employed in order to better comprehend the manner in which practices such as CSR can positively influence and affect society as a whole, by raising awareness on pending issues such as the ecological one. Similarly, academic papers were also analyzed and included, which provided not only an in-depth understanding of the concept of EC, but also contemporary real-life examples, ranging from grocery goods to even sustainable and recyclable materials used for construction. Lastly, in order to provide contextual relevance to the readers on the topic and issues discussed, data from the entities such as the Food & Agricultural Organization of the United Nations (FOA) and the European Environment Agency (EEA) were retrieved and documented.

The analysis and evaluation of Intermarché revolves around an outstanding sustainability issue affecting today's society - food waste (Coderoni & Perito, 2020). To better understand the case of Intermarché, it is first important to provide some information on the context, food waste statistics. According to data retrieved from the Food and Agricultural Organization of the United Nations (2019), approximately one-third of food produced in the world gets lost or wasted every year, where, in financial terms, food losses and waste amount to roughly $680 billion in industrialized countries and $130 billion in developing countries. It has been debated among some scholars and researchers (Blakeney, 2019) that the global mission of reducing food wastages will promote over the long-term the entire efficiency of the supply chain lowering costs for producers and prices for consumers, while also mitigating environmental effects. Among the various food categories, fruits and vegetables are considered to have the highest wastage rates, and this has mainly to do with the way they look (around 57% are thrown because they do not respect the required aesthetical standards).

As 2014 was declared the EU's Year Against Food Waste, the French supermarket chain Intermarché decided to act upon this crucial theme by attempting to change the consumers' perception in regard to food aesthetics while encouraging a more conscious and effective consumption behavior towards these seemingly less appealing fruits and vegetables. It did so by launching "The inglorious fruits and vegetables" campaign with the ultimate goal of teaching consumers that, although not good looking, these products are as good and tasty as its aesthetically accepted counterparts, if not even more. In terms of a corporate socially responsible company, Intermarché also demonstrated responsible practices. Indeed, it made sure to buy from its local growers the products they typically throw away as a result of such aesthetic measures, and subsequentially resold them in stores just like any other product, but with an applied discount of around 30% to attract customers. The manner in which Intermarché carried out this powerful campaign is very inspiring in regard to the way consumers can be educated and encouraged to take part and contribute in a global issue, such as food waste. This issue is not only badly affecting the planet in terms of wasted resources produced, but also the local farmers and growers who face financial losses to keep up with such irrational beauty standards for food.

Intermarché launched the "Inglorious fruits and vegetables" campaign, that included several channels and tools. The company distributed its own print and film campaign, its own local posters and radio campaign, its own in-store branding, its own aisle in the store, labelling and even its own spots on the sales receipt. On top of that, it provided customers with the chance of trying themselves some products made with the same fruits and vegetables consumers were seeing on the shelves and avoiding due to their looks. Intermarché distributed vegetable soups and inglorious fruit juices in stores to make consumers realize that the only factor inhibiting them to purchase such products was the fruits and vegetables appearance. The aesthetical standards refer to a measurement by which food is typically assessed before its launch in the market, such as shape, color, total weight, and smell. The campaign ended up being very successful; once consumers realized that these fruits

and vegetables retained the same tastiness and quality of the others, they rapidly all sold out achieving 1.2 tons average sales per store during the first two days, according to one of Intermarché advertising representatives.

The “Inglorious Fruits & Vegetables” campaign launched in 2014, through the combined forces of the supermarket Intermarché and Marcel Worldwide, a Paris-based marketing & advertising agency, was an inventive effort of educating the average consumer. As stated by Sylvie Cole, communication manager of Intermarché, following and witnessing the success of Intermarché initial local test, two national operations on 1800 points of sales took place across France. “The Inglorious Fruits & Vegetables” campaign became an industry leader case, whose powerful implications extended beyond the consumer segment, reaching national recognition and significance. According to Global Common Ground, two years after the campaign ended in 2015, France passed a new law forbidding supermarkets from throwing away or discarding unsold food items. From this point onwards, French supermarkets will be obliged to donate them to charities and food banks.

This case is a very interesting example of the manner in which a supermarket chain decides to defy and change the way the system works and operates. Typically, companies avoid implementing such drastic and straightforward maneuvers both because they represent a huge investment in terms of costs and time to develop this type of initiatives, and moreover due to the fact that consumers may not react as wished or intended to. However, Intermarché succeed in promoting ethical consumption and encouraging its everyday customers to support the initiative about the global and crucial issue, such as food waste. It has been in fact argued by scholars that the educated consumer represents a valuable long-term asset for the profitability and establishment of your brand/product over time (Yilmaz & Koçoğlu, 2017).

4. CONCLUSION

The paper explored the concepts of Corporate Social Responsibility and Ethical Consumption. The relationship between effective CSR and EC has been demonstrated with the case study of Intermarché. In the pursuit of being a socially responsible company, Intermarché successfully promoted and raised awareness on a very critical socio-environmental issue by an investment in customer education. The ‘Inglorious fruits & vegetables’ campaign resulted to be successful and rewarding under many aspects. Firstly, from a financial point of view, it provided Intermarché with an additional revenue in selling a high-in-demand merchandise such as fruits and vegetables. In fact, thanks to this campaign, fruits and vegetables increased the overall store traffic by 24%, while increasing fruit and vegetables sales by 10% and succeeded in reaching over 13 million people online (Global Common Ground, 2017). Secondly, it managed to provide a win-win-win situation for all Intermarché’s stakeholders. Indeed, Intermarché was able to sell more goods than before, while, at the same time, eliminating wastes from its local growers. Farmer suppliers of Intermarché were able to sell the fruits and vegetables that would otherwise been thrown away and dismissed, thus, increasing their revenues as well. Finally, consumers were found to be also very satisfied both from the initiative and the products themselves, as most of these ‘inglorious’ fruits and vegetables sold out in few days. Thus, under the socially responsible corporate viewpoint, Intermarché did good in both promoting awareness about a social cause and benefitting all of its stakeholders involved.

The case of Intermarché demonstrated that consumers need to be educated in order to encourage them to shift and rethink their purchasing decisions. This involves investments both in terms of time and money, but the final outcome may be very positive and may lead to higher trust in the company and brand, which over the long-term will definitely constitute a valuable asset. The case demonstrated that consumers, if adequately supported, will promote and sustain campaigns and initiatives a company may decide to pursue, providing revenue and being the real actors of the aspired change.

As it is stated earlier, smart technologies can provide foundations for a sustainable future (Nižetić et al., 2019), but still it is unclear how these technologies affect consumption patterns and sustainable consumption (Schappert & von Hauff, 2020). Thus, the opportunity for further development of sustainable consumption, as well as related concepts EC and CSR, can be found in a smart approach that, according to these authors, can enable a framework for circular economy and other related issues important to world population.

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COMPARATIVE ANALYSIS OF CONSUMER PREFERENCES TOWARDS TRADITIONAL AND DIGITAL CHANNELS OF COMMUNICATION

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Abstract: *As the assumption is that digital media take the role of a leader in everyday communication, the question arises whether traditional media still plays a significant role in everyday advertising and consumer behavior. The aim of the paper was to find out which are the preferences of modern consumers towards digital and traditional advertising channels, which media consider the most efficient means of communication, in which they have the most trust, and which they most often practice when collecting information. To answer these questions the research was conducted on a sample of different demographic characteristics with the help of an online survey. The results obtained confirmed the tendency towards digital media and advertising channels in the daily informing of the modern consumer. The fact is that the current trends in advertising have completely influenced the changes in consumer behavior, their thinking, as well as the criteria that help them in everyday purchasing decisions.*

Keywords*: advertising channel, consumer preferences, digital media, traditional media*

1. INTRODUCTION

The modern consumer has significantly changed his description, characteristics and expectations, and it can be said that the digital revolution, new social trends, and current events have contributed to all this (Ammi, 2007; Coskun, 2013). The information has become easily accessible, meaningful, customized, cheap to handle and easy to share. On the other hand, good information is today a valuable tool that a company can have at its disposal because in recent years marketing strategies have shifted their activities exclusively to the customer needs and expectations. Hence, the importance of choosing the way of communication with different groups of target audiences, selection of relevant information, quality processing and interpretation of the same, and ultimately efficient handling of this information.

There is no doubt that digital marketing has left the channels of traditional marketing advertising in the background, primarily due to lower advertising and communication costs, but also due to the possibility of reaching a wider population with digital media, all thanks to the Internet (Khan, 2006). The internet made information available at anytime and anywhere, and as another significant benefit, the easy measurability of the achieved results should be pointed out. However, the biggest disadvantage of traditional media is their mass, lack of direct interaction with the target group and the inability to connect with users, which digital media have used as one of the key advantages.

The aim of the paper was to find out which are the preferences of modern consumers towards digital and traditional advertising channels. Specifically, the goal was to determine which media consider the most efficient means of communication, which media do users trust the most, and which they most often use for gathering information.

2. MARKETING COMMUNICATION CHANNELS

Marketing communication is a way of placing information about products and services to potential customers or existing users, using the tools of mass and digital media. One of its main purposes is to position brand in the minds of consumers, so it becomes the first association and developed positive attitude of customers that can be crucial in purchasing decisions and habits. Looking at the model of the decision-making process,

which consists of five interrelated steps, namely problem identification, seeking information, evaluating alternatives, purchasing decisions and post-purchase behaviour (Kotler & Armstrong, 2011), one can easily conclude how important the availability of timely information is for end-consumer. The moment he becomes interested in a product or service, the consumer first sets out in search of relevant information. Marketing communications have to be integrated for two reasons, because unintegrated databases cause many complications, as there is no single picture of the customer. Secondly, as communications convert into customer experiences, all communications need to be integrated to deliver a consistent experience (Smith & Zook, 2011).

There are two ways to search for information, one of them is increased attention, that is sensitivity to information about a certain service or product and, on the other hand, active search for information, when certain advertising material is intentionally searched, sales facilities, websites, social media profiles are visited, reviews are searched, friends are consulted, etc. Therefore, the sources of information before the purchase process can be family, friends, sales staff, product packaging, traditional/digital media, user experience, etc. The more information available at the same time means the less time needed to make a purchase decision. Great help in searching for relevant information about products/services of a certain brand is provided by advertising messages that are placed through various media. Nowadays marketers must shift their thinking from mainstream marketing to the masses to a strategy of reaching vast numbers of underserved audiences via the Web (Scott, 2007).

2.1. Traditional marketing communication channels

Traditional marketing has been overshadowed by digital marketing tools for years, but its influence in previous decades must not be neglected, because these very beginnings are considered the foundation and inspiration for further progress in this area. Although the world is currently in the era of digital technology, traditional advertisers are still significantly present in marketing advertising. For years, there has been controversy about which method is better, but the fact is that both types of marketing, traditional and digital, can be useful if their potentials are used in the right way. To begin with, besides understanding the target audience, their habits, thoughts, and way of life, it is important to understand the main advantages and disadvantages of traditional media (Table 1).

Table 1: Advantages and disadvantages of traditional media

Media	Advantages	Disadvantages
TV	• National media for mass communication • Achieving the desired emotion (image + audio) • Great medium for campaign image and brand positioning • Rapid awareness building • Lowest price per contact/reach point	• High costs of video production • Dispersion of viewership on a large number of TV channels • High occupancy ad blocks (clutter)
Radio	• Mass media • Possibility of local targeting • Short and clear messages • A smaller budget is needed for the implementation of the campaign, as well as video production • Good for higher frequency messages, for promotions, sweepstakes	•Audio media, lack of image • Data on final effective projects are missing
Daily newspapers	• Credibility of the newspaper • Character news on a daily basis • They provide a choice of topics within which the brand wants to appear • Good for more detailed information about the brand, action	• Lasts one day, often only key titles are read • Often print quality does not allow for good ad production
Magazines	• Targeting by interest • Good print quality • Possibility to choose where the ad will be found (positioning with relevant content) • Reading lasts, goes from hand to hand • Good for a campaign when the goal is to educate consumers about a new product • Possibility to insert test products	•Poor reach to the target group followed by poor readability of printed materials
Out-of-home Advertising (OOH)	• Intended for the general public or specific regions • Good visibility • Suitable for short and clear messages • To raise awareness • Large range and frequency in a short period • Possibility of positioning near the point of sale • Digital OOH provides more visible and customized creative solutions	• Production costs for some special formats are too high • Inability to convey a more complex message • Lack of research on campaign results

2.2. Digital marketing communication channels

Considering importance of digital marketing for companies today, it is obvious that there is no universal answer that could be applied to all organizations at the market. It will most often depend on the nature of the organization's products and services, as well as the behavior of customers previously identified as the target group (Kostić-Stanković, 2011). By investing in building a website or Internet advertising through paid ads, as well as building a community on official profiles on social networks, the company implements a digital marketing strategy, which not only promotes its own products and services from the range, but also builds a broader picture about the brand, as well as public trust (Kostić-Stanković et al, 2017).

The opportunities provided by quality performance on digital advertising channels today have no limits, while virality has become easily accessible with a little creative thinking outside the standard framework. As the Internet became the main place to inform about products and services before buying and going to the store, Google defined the process as „Zero Moment of Truth" (Lecinski, 2011). Being online today is no longer just a matter of choice, but also a necessity, given the power of influence has on daily purchasing decisions.

According to data from December 2018, based on a survey conducted on a sample of 5,000 people between the ages of 20 and 50, the largest media reach has an ad displayed on the Internet (media analysis software TGi), more precisely this means that 89.8% of the target group will see an ad on digital advertising channels at least once, in second place are outdoor advertising solutions, then TV (media analysis software TGi).

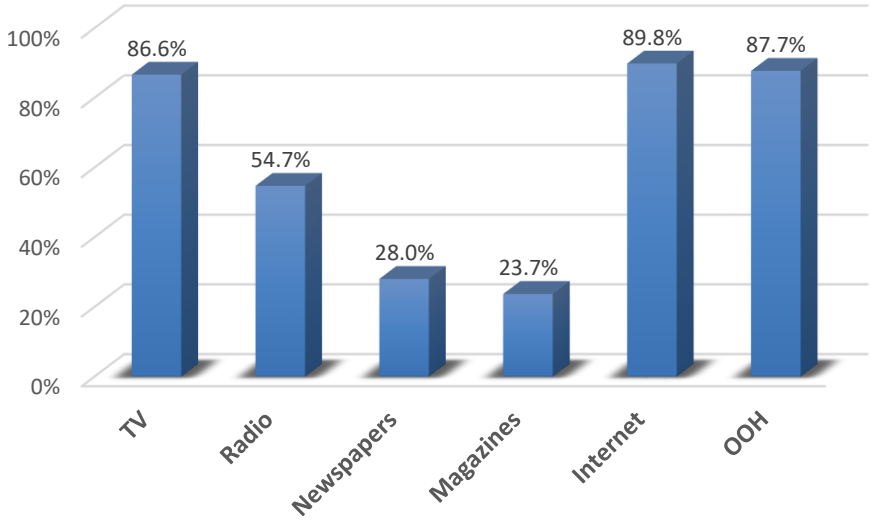

Figure 1: Media Reach 1+ (TGi, December 2018, n=5000)

The advertising campaign on digital channels can be adapted to both local and international audiences, in relation to its demographics, such as gender, place of residence, age, education, monthly income, etc. Content users decide how to access it, some prefer to read texts on the phone, others prefer video content from the YouTube platform watching on their computers, tablets, cell phones, etc. Knowledge is power and the digital technology is shifting the balance of power in favour of the consumer (Ryan & Jones, 2009). Looking from another point of view, traditional marketing does not give its users the opportunity to choose. Most of them are dissatisfied with taking a flyer on the street or from their mailbox, answering phone calls advertising a particular product/service and the like.

Two-way communication with the target audience is an opportunity provided by social media, and above all social networks within them. The main goal is intensive interaction with potential customers, in the desire to take certain actions (Chaffey, 2006). By visiting the company's official website, as well as official accounts on social networks, potential customers are informed about the products and services offered, make purchasing decisions, evaluate their satisfaction with the service and exchange impressions with other users, giving the organization valuable feedback for further business. Instead of causing one-way communication, marketing is more about delivering content at just the precise moment when the audience needs it (Scott, 2007).

In addition to numerous benefits, it is necessary to point out some lacks that may arise from digital marketing, specifically advertising. Although attracting the attention of a large number of people within the target audience are considered an absolute benefit, sometimes this wide reach of the public can be a problem when there are negative reactions to certain brand content, given that online advertising often goes

beyond the control of marketers who think that they can manage it completely. This is primarily because of the speed with which information is spread via the Internet, so timely responses to them are key to success.

While planning the campaign, it's purely up to chance whether it will go viral. The best advice is to create unique and interesting content and put it out there (Eley & Tilley, 2009). Another problem that marketers face is that on digital channels, marketing strategies are sometimes very easy to copy. Given a large number of competitors in individual industries, it is very difficult today to have a unique presence in the market. The company's months-long commitment to launch a new campaign can be very easily and quickly copied by competing organizations, which have thus saved time and money.

Although the use of digital advertising is constantly growing, significant funds are still being invested in advertising through traditional marketing channels. It looks like traditional marketing advertising is trying to maintain its long-standing reputation at a time when the combination of technological and scientific achievements and the Internet has made a real marketing turnaround.

3. RESEARCH

The sample of this study consisted of 114 respondents (75 female and 39 male respondents), who completed a questionnaire. The participation in the survey was voluntarily, anonymous and participants were not remunerated. The instrument for the data collection was a questionnaire, designed for the purpose of this study. It consisted of 19 closed-ended questions with the possibility of choosing one of several offered answers. The data collection was performed during august 2019. The collected data were statistically processed and analyzed using the software program SPSS v20.

4. RESULTS AND DISCUSSION

Of all respondents, 49% most often gather information about products and services through official pages on the Internet (website, social networks profiles), 46%, referred to a combination of in store and the Internet searches, as additional checks, while the rest referred to TV commercials and direct contact with sales staff, while no one referred to printed media.

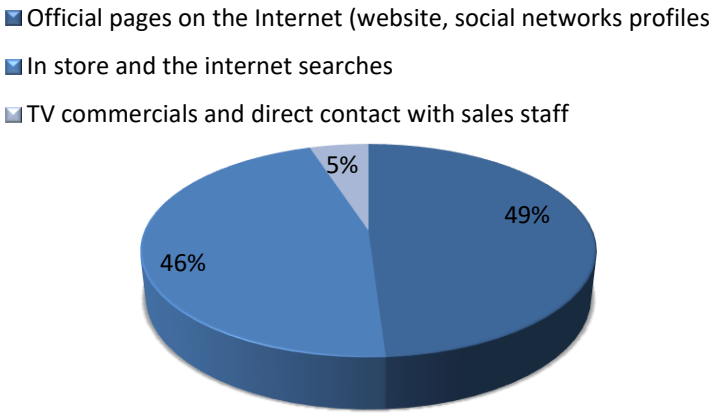

Figure 2: Gathering information on products and services

Exactly half of the respondents stated that a good advertisement for them is one after which they will immediately want to buy a product or service offered by a brand. In addition, it is equally important for them that the advertisement is of an entertaining character, and in addition, the viral character of the advertising message is desirable. In the sea of messages that are broadcast, it is necessary to stand out in relation to the competition and in some way attract attention. A good advertisement is the one that is talked about even after its broadcasting is over.

It is interesting that when asked how they collected information before the Internet expansion, the respondents in the largest percentage (36.8%), answered that they did it directly in the store, in second place are TV commercials (26.3%), then recommendations from friends and family.

As many as 77 out of 114 respondents said that the medium on which they saw the last advertisement they remembered was the Internet, followed by TV, then outdoor advertising on billboards, etc. In not so significant numbers, printed newspapers and radio were mentioned.

Of all respondents, 43% stated that after seeing the advertisement, they must additionally check information

from other sources before making a decision. The fact is that there is a certain amount of public distrust towards advertisements, perhaps as a result of the network being overloaded with numerous advertisers who try in every way to constantly enter the consumer's consciousness and gain his favor by constantly repeating the name of their brand or product. It is not uncommon for this "aggressive" type of marketing to end with an unplanned outcome for the company. This is confirmed by the fact that almost 29% of respondents do not consider advertising a reliable and relevant factor that could influence their purchasing decisions.

Almost 66% of respondents answered that the effectiveness of advertising depends on the target group for which it is intended. In the second place they consider effective advertising on the Internet, and finally, in a small percentage, TV commercials. Although the current trend of digital advertising on the Internet is in the form of banners, search ads, advertisements on social networks and the like, the most acceptable answer to the question of which advertisement is more effective, is related to the target group for which the advertisement is intended. We must not omit the fact that consumers are the end-users of a message, more precisely the product/service it offers. A good idea for advertising is in itself insufficient if it does not reach the target public for which it is intended, and in order to reach it, it is necessary to develop meaningful strategies in accordance with the set goals.

Another fact about the lack of trust in advertising messages launched by brands is the fact that for the majority of respondents (44%), the most credible advertisement is the one they heard in the form of a recommendation from a friend or family. As many as almost 22% of them said that they do not trust advertisements, in third place in terms of credibility are advertisements on the Internet, which according to the obtained results in almost all answers were one step ahead in relation to advertisements on TV.

Respondents almost completely agreed with the statement that digital media have completely replaced traditional ones. Those who were undecided in the decision, previously analyzed, were representatives of Generation X. Therefore, the conclusion is that they are currently in the phase of adapting to the digital media they are surrounded by, the speed with which everything is happening and a large number of innovations that happen every day, make them so for a reason because they are still accustomed to the media in which frequent changes were rare, and in the case when they happen, they were given global significance because they mainly concerned great inventions and scientific achievements. Today's changes are usually small, but quite frequent and effective for the user.

That TV advertising is still somewhere in the viewer's subconscious, and that perhaps its lower ratings in recent years is only the current phase, will confirm the time. What is certain based on the obtained results is the fact that the respondents generally do not agree with the statement that advertising on TV today is a pure "waste" of money for the company. It should be borne in mind that the budgets allocated for TV advertising are many times higher than the budgets intended for commercials on digital channels. More expensive does not necessarily have to be better, but since these are large sums of money, it is necessary to analyze your target group well and draw conclusions about them and their habits, lifestyle and information, in order to avoid unnecessary costs.

Printed newspapers and magazines are far behind the TV, which is confirmed by the obtained data on the frequency of their purchase.69 out of 114 respondents said they do not buy newspapers at all. The largest percentage of respondents were members of generations Y, Z, who did not even have the opportunity to develop the habit of reading printed newspapers, magazines and professional magazines. And those who have the habit usually do it online.

More than half of the respondents fully agree or generally agree with the statement that the Internet is sufficient for them to inform about products/services and make a purchase decision. Interestingly, the largest percentage of responses regarding the question of whether the Internet sufficient for informing were Millennial who said it’s not, although this phenomenon might be more associated with the older generation, yet the younger ones are more inclined to choose between several alternatives, which may be related to distrust which exists according to advertising messages. In addition, 65% of respondents believe that the biggest benefit of digital media is the availability of content at all times, followed by quick and easy content sharing.

Although the Internet is undoubtedly currently used in the largest percentage for searching and informing about products/services, according to the data in the sample, valid for the territory of Serbia, according to the majority of respondents (83%) goods are bought directly in the store, after the information is found on the Internet, of course, if there is a possibility of direct sale. In the world, these figures are a little different, in favor of online shopping, but gradual growth of this trend is expected in the coming period in Serbia.

When asked what is the crucial "trigger" when choosing a product/service, the largest percentage of answers

were related to the recommendations of friends and family, bearing in mind that respondents consider this type of advertising the most credible, this result was expected. For 19% of them, everything is important when choosing the right product or service (from TV commercials, printed materials, recommendations, social media, to Internet advertising). None of the answers referred to the working staff in the store, which should still play a significant role in the sales facility during the purchase.

The question: “Would you choose to purchase products/services that do not have an official website, social media account, or any user experience shared on the Internet?” provoked a lot of different answers from the respondents. However, there is a higher percentage of those who said that they absolutely would not or mostly would not do a purchase for products or services which don't have a web site, which can confirm the importance of online presence for a brand.

5. CONCLUSION

The paper presents a comparative analysis of consumer preferences towards traditional and digital advertising channels. According to the results, it cannot be claimed precisely and with certainty that one of the mentioned ways of advertising is more effective than the others. The question is, what does this mean in practice, and the answer was just received after the research. None of the options was the absolute favorite of the respondents, combinations of different answers were always considered in order to find the best solution. Everyone who is a little more familiar with the importance of marketing and choosing the appropriate marketing mix knows how important a role it plays in the competitive struggle to win the customer. No single media is enough, nor does it have the ability to reach all the targeted members of the public. Accordingly, a mix of different media is a winning combination of almost every successful advertising marketing strategy.

The fact is that digital advertising is the current trend and that with the advent of the Internet, its use has left aside others, until then very effective and used media. However, the current trend does not necessarily have to always be the best solution for everyone. Knowing the target public, which is a narrow definition of the end group of users that a company wants to reach with its advertising, is considered a starting point on the way to creating a media strategy of each organization, so it is necessary to pay attention to those who are offered products/services and intended. In order for the message to reach the end-user, a certain amount of data about him is needed, and one of the traditional, but above all effective ways to do that is research in the form of a survey conducted on a selected sample, based on which conclusions will be made about the general population.

A modern consumer is demanding, picky, lack of available time, tendency to search for additional information, insistence on quality, so it is not surprising that customers are paying more attention to digital communication on the Internet because they consider it relevant, meaningful, accessible, easy to use, and recommended for fast sharing of multimedia and textual content. The initial assumptions that traditional media remained in the shadow of the current digital ones were proved on the basis of the answers obtained from the research results, due to the fact that the respondents showed a slight but significant preference for traditional media, primarily due to the availability of content in each instant, cheap to use and fast content sharing. This may be the initial guideline for planning a media appearance of an organization, but not the only one, because other methods of media advertising, depending on the market situation, have proven to be effective in terms of recorded results and target populations that can be reached through their own channels of advertising.

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APPROACHES TO DEFINING LUXURY

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Abstract: *The concept of luxury is apparent even with the earliest civilisations. However, luxury has become the subject of scientific research only 30 years ago, with major companies going public and the formation of large luxury conglomerates. The aim of this paper is to present different approaches to defining luxury - by consumption motivations, luxury goods characteristics and approaches to building luxury brands. The final segment presents how the luxury industry coped with past crises, and new strategies to overcome contemporary hardships.*

Keywords*: Luxury management, crisis, defining luxury, luxury customer*

1. INTRODUCTION

What is luxury? This seemingly simple question has no unique answer. The concept of luxury depends heavily on the social and economic context and it is clear that what may be luxury for some is not for others. The definition of luxury varied over time - what we mean by luxury today has little similarity with what luxury was just a century ago. Luxury is elusive in nature, hence it might be useless to search for its universal definition. However, it is important to understand why some brands are considered to be luxurious and what justifies the superior position they hold in the market.

The word "luxury" has an etymological origin in Latin:
- Lux, us – excess, intemperance, extravagance;
- Luxuria, ae – rank, splendor;
- Luxus, a, um – dislocation, division;
- Lux, lucis – light, luminosity.

Luxury derives from the word *lux* which means light. This detail explains the properties of luxury goods perfectly. Luxury sparkles, it is golden and every product tends to be a gem in a sea of ordinary stones (Kapferer, Managing luxury brands, 1997). Luxury draws attention to itself, it must be noticed, which is why brands showcase their signature so proudly. The power and reputation of a brand affect how far and how strong it will radiate. Luxury is international and when it shines, it shines from Capetown to Hong Kong. *Luxury is art applied to everyday functional objects.*

2. DEFINING LUXURY

If one was to see the watch from Figure 1, he would know it is a luxury product.

How would one come to this conclusion? Customers assess items as luxurious based on five main elements:
1. *Craft* – 860 hours of work by skilled artisans;
2. *Complexity* – an open-worked case to showcase the complication of the mechanism;
3. *Material* – titanium case accented by a ceramic bezel, crown and pushers;
4. *Price* – 869,000$;
5. *Brand – Audemars Piguet Le Brassus*.

All of the elements are equally important in the creation of a luxury product. Customers are willing to spend their money on a well-known brand with a strong positive reputation whose specialists design and make items from natural and rare raw materials by using their unique skills to portray the complexity of workmanship.

Figure 1: Audemars Piguet Royal Oak Offshore Grande

3. LUXURY DEFINED BY CONSUMPTION MOTIVATIONS

Luxury can also be defined by consumption motivations. Multiple motivations are identified:
1. Functional motivations (such as quality),
2. Experiential motivations (search for pleasure or hedonism),
3. Symbolic interaction motivations (connection to a group or affirmation of a social status) (Vickers & Renand, 2003).

Functional motives relate primarily to quality and functional performance of an item. The recipe for superior quality and design excellence requires ingredients such as skill, precision, special and rare raw materials, uniqueness, outstanding product capabilities, innovation etc.

On the other hand, **emotional and experiential performance** need to be taken into account as well. Luxury brands have an intangible value which draws customers in. When it comes to experiential motivations the focus is not so much on what the product is, but what it represents.

The dual face of performance in luxury, function and emotion are all the more powerful if they are closely connected.

Ladies often choose *Loubotin* high heels because of the widely recognisable red sole, gudied by the proverb "If you wear nice shoes you enter nice places". However subtle and inconspicuous, the *Louis Vuitton* monogram will always be noticed even by those who are not aficionados of high fashion and luxury items. Many *BMW* clients choose their car not only for the great quality the German automaker guarantees, but also to keep the key with the well-known logo on the table during meetings. These are all **symbolic motives** that can often be contradictory. The theory of the Roman god **Janus** further explains this paradoxicality of symbolic motives.

The *Janus theory* says that choices are dependant on two opposing worldviews people have that inform the ways individuals approach their life goals or purpose. There are two main, mutually opposed, worldviews. When applied to the world of luxury, this concept exposes two faces of customers. On one hand, consumers are seeking affiliation and control. They show a strong desire to fit in and an individual's choices are based primarily on the motivation to belong to a desired group. Decisions are being made with the goal to establish the individual within a group. Having that in mind, luxury customers value the product's potential to reflect status and provide acceptance by the group. On the other hand, clients seek freedom and uniqueness. Individual's choices are driven by the motivation to stand out of the crowd. Customers value craftsmanship, uniqueness and the potential an item holds to help them differentiate from the masses (Mostovicz, 2020). A great challenge for brands is to successfully meet these two opposing needs of their customers.

4. LUXURY DEFINED BY ITS CHARACTERISTICS

Luxury is also defined by its characteristics. Anne Michaut, an HEC Paris marketing professor, identifies seven key criteria when it comes to luxury goods (Michaut, Introducing Luxury, 2019).

- *Quality of production that lasts long as well as aesthetic appeal – Hermès* handbags represent a symphony of classic shapes, top notch quality leather and superior craft and as such they never go out of style. With the right upkeep these bags can last for decades.
- *Scarcity* – Cognac *L'or de Jean Martell* is made from 400 extremely rare ingredients, which is why it is sold in limited quantities.
- *Delivering experiential rewards* – For many couples around the world a*Tiffany & Co.* diamond ring plays a key role in an enganement and completes the romantic experience.
- *Signed by brands; symbols of distinction and status – Dior, Chanel* or *Louis Vuitton* bags are considered prestigious for, among other things, the strong brand name they hold which makes them a recognisable status symbol.
- *Sold in controlled channels – Hermès* products can be found exclusively in their brand-owned boutiqes in all major cities in the world.
- *Sold with personalized services* – When buying a *Jo Malone* fragrance, customers receive full attention from the sales personnel who are there to recommend a perfume according to individual taste.
- *Price uncorrelated to functional performance alone; expensiveness* – A rain coat can be easily bought in any of the high street stores for an affordable price, however many customers choose *Burberry* for its contemporary image and classic pieces (Phan, Thomas, & Heine, 2011).

5. LUXURY ACCORDING TO A BRAND BUILDING APPROACH

The only success that counts on the cruel market of today is commercial, the success in sales. However, such success can be achieved in different ways. Newer luxury brands such as *Ralph Lauren, Calvin Klein* or *DKNY* prove that it is possible to achieve success "over night", without the pedigree of old European brands such as *Chanel* or *Givenchy.* These young brands still have to prove their ability to outlive their founders, but their success in sales is in indisputable and confirms how attractive they are to customers globally. Authors point out differences between two business models. The first one is used by brands who have a significant history to their name, whilst the other business model is applied by luxury brands who are relatively new to the industry and use imagination to invent dreamy stories which compensate for the lack of tradition (Kapferer, The New Strategic Brand Management: Creating and Sustaining Brand Equity Long Term, 2008).

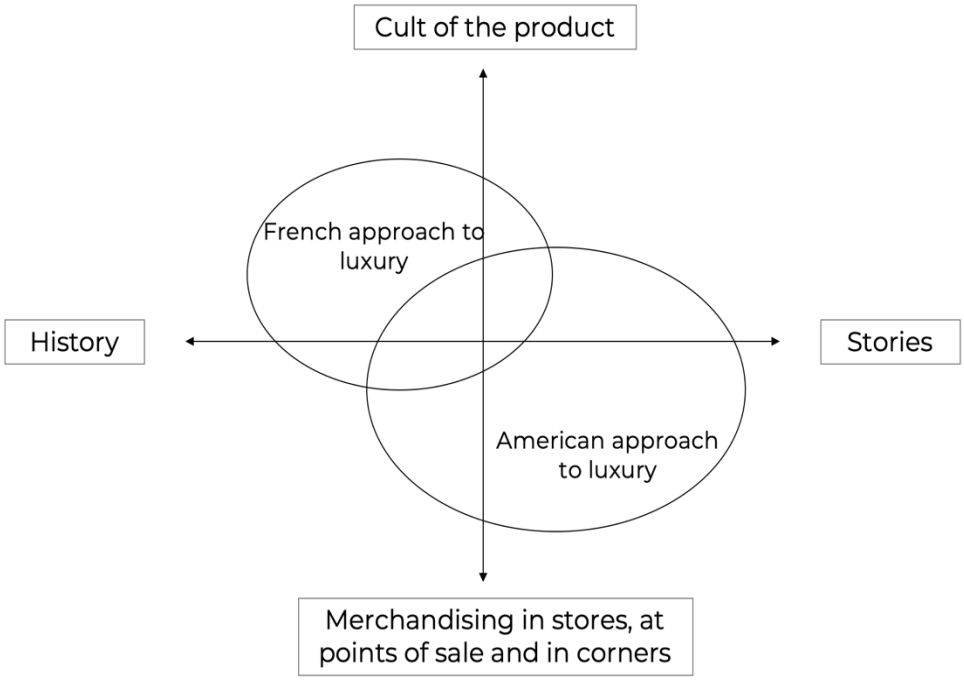

Figure 2: History-based and story-based approaches to luxury (Kapferer, The New Strategic Brand Management: Creating and Sustaining Brand Equity Long Term, 2008)

Companies which practice the second business model are predominantly from the United States of America, which is logical considering that they were founded in a young, modern state. European luxury brands emphasize their tradition, craftsmanship and highlight the product as a key success factor. Brands of American origin focus more on the art of selling and the image they create through brand manifestations. The founder of *Ralph Lauren,* Ralph Lifshitz, built his brand on the ideal of the American aristrocracy symbolised by the high society of Boston. Consequently, all of the brand's manifestations are orchestrated to further support such an illusion. Even though this approach originated in the USA, some European brands such as *Armani* and *Hugo Boss* built their empires using this business model. The ideal and the vision of the brand is in the center of the galaxy, whilst all the brand manifestations are equidistant from the center. All extensions are treated with equal care, because each represents the brand in an equally important way. In the pyramidal structure, which is mostly seen in European luxury brands, everything converges to the top of the brand where lies the creativity and craft of artists and designers. The "galaxy" model, which is characteristic of new American brands, is centrifugal and expands as new "planets", i.e. new brands, appear (Sicard, 2013). The pyramidal structure is exclusive in nature and the options for expansion must be found within the pyramid. The galaxy structure is more inclusive, its contours are blurred and more mobile. The brands which use this model integrate heterogeneous elements into their business more easily, which makes them more flexible and helps them take advantage of opportunities that arise in the market.

Figure 1: The Galaxy model (Sicard, 2013)

The European business model can be illustrated with a pyramid on Figure 3. At the top of the pyramid is the *griffe* - the signature of a designer on a unique piece of work. The following level refers to luxury brands that make small product series in the workshop or manufactory, which is a guarantee of good workmanship. Examples of such brands are *Hermès, Rolls Royse* and *Cartier.* The third level is that of simplified mass production, for example cosmetic lines of well-known brands such as *Dior* or *YSL Beauty.* At this level, brand fame adds value to products which, in reality, resemble many others in the market. This level is often reffered to as massive prestige or, shorter, *masstige.* In this business model, the main goal of luxury management is creating an optimal interaction between these three levels (Kapferer, The New Strategic Brand Management: Creating and Sustaining Brand Equity Long Term, 2008). The first level provides the prestige and dreaminess which is crucial for any luxury brand, while the remaining levels are there to bring profit. The creativity from the top of the pyramid is the essence of this business model and provides attractiveness, which is then distributed to other levels.

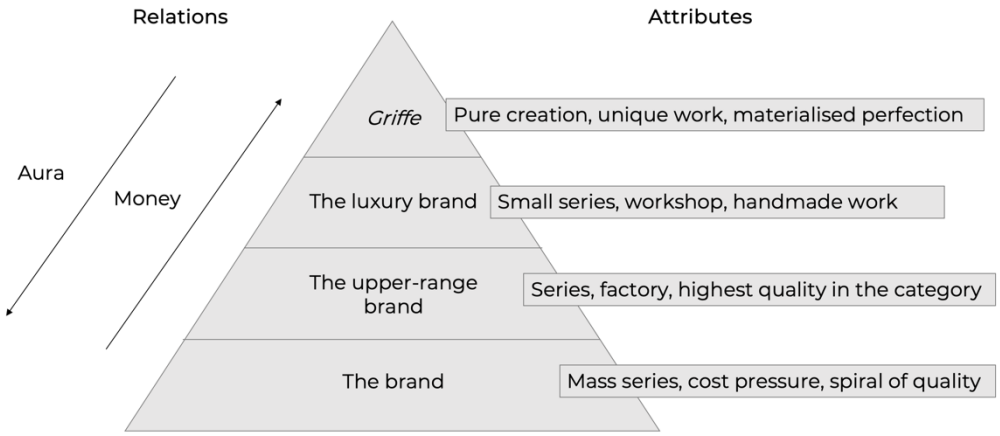

Figure 2: The pyramid brand and business model (Kapferer, The New Strategic Brand Management: Creating and Sustaining Brand Equity Long Term, 2008)

6. LUXURY IN CRISES

On one hand, the luxury industry is said to be recession-proof due to the noncyclical nature of the industry (Som & Blanckaert, 2015). Luxury customers are generally the happy few who are not majorly affected by economic crises and continue spending at the same levels. During the economic breakdown, everyone is trying to save money, except the rich who continue to buy luxury products at higher prices (Perocchi, 2011). However, in the period from 2009 to 2013, the impact of the crisis became evident. The democratization of luxury during which companies created products accessible to a broader target population, and which we observe in the period from 2001 to 2007 in Figure 4, calls into question the noncyclicality of luxury. In the recession that started in 2007, the future did not look bright for the luxury industry. Bain & Company estimated that the sector lost 10% of its revenues in 2009. The European debt crisis caused another drop of 13% in 2011 (Som & Blanckaert, 2015). Despite the global and precisely European economic hardship some global luxury brands have attained strong performance levels, so perhaps it is their globalness that keeps them going. Figure 4 depicts the effects of these two recessions showing that the luxury companies are not immune to the decline in growth and revenue that follow each crisis. However, crises provide an opportunity to modify competitive positioning and luxury brands have come out of each one with a different position and a unique recovery strategy (Chevalier & Mazzalovo, 2012). Some critics suggest that the entire industry may be taking a new course due to noticeable changes in external environment. One factor that has had an influence on the luxury industry is the shift in consumer demand. For instance, consumers in emerging markets are becoming more sophisticated in their tastes (Hassan, Philippe, & Melika, 2015). For example, the Chinese market is accountable for over 50% of the total growth in consumption of luxury goods in the period from 2012 to 2018 (McKinsey & Company, 2019).

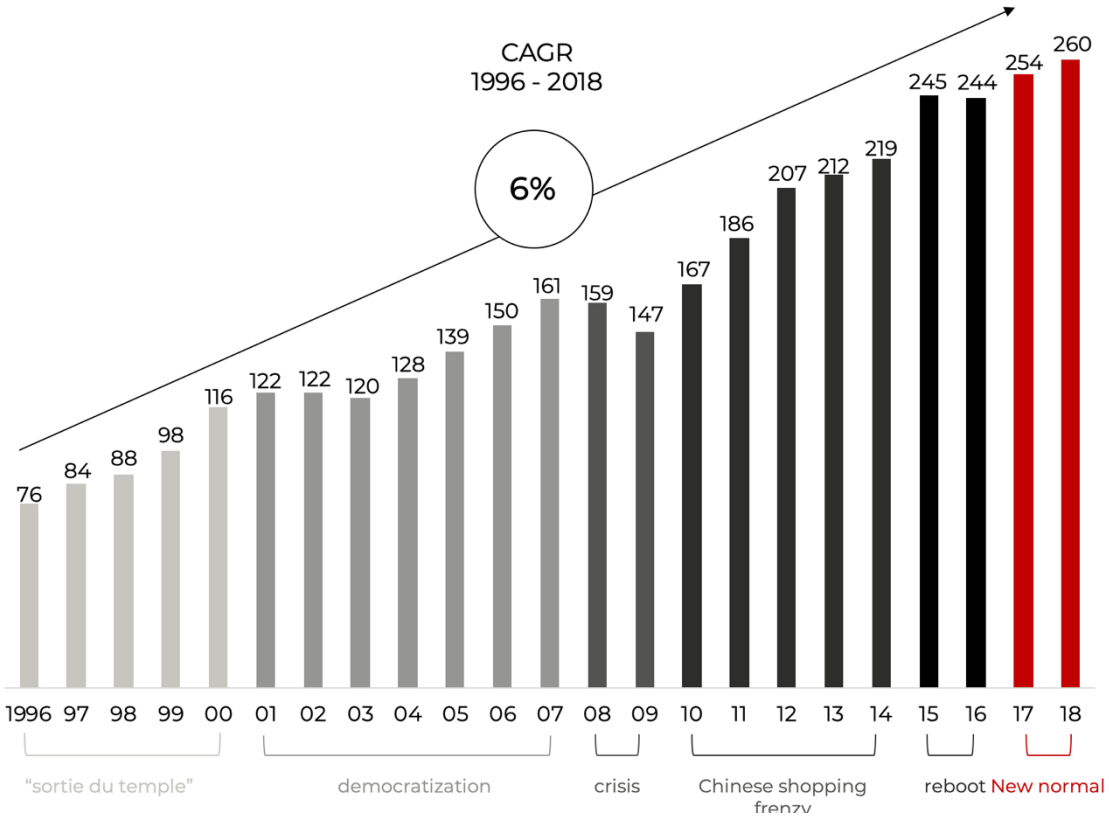

Figure 3: Global personal luxury goods market (€ billion) (Bain & Company, 2018)

"The only question is when the recession will occur and what types of luxury categories will actually be impacted by the next recession and how severe the impact will be," said Bob Shullman, founder and CEO of the Shullman Research Center (Jones, 2019). One of the biggest uncertainties for global markets surrounds the U.S.- China trade war, which continues to escalate. Since the luxury industry relies heavily on the Chinese market, any type of economic downturn in this part of the world poses a great threat to brands. With global travel restrictions being imposed due to COVID19, luxury companies need to appeal to the Asian customer in domestic markets. In 2018 domestic luxury spending in China accounted for only 27%, whereas the rest of shopping was done abroad (Bain & Company, 2019). The lesson to be learned from the 2008 financial crisis was to always be prepared and that every brand should already have locked and loaded strategies that will help them through the next one. How luxury companies will perform through the global pandemic of COVID19 will be a good indicator of who did their homework.

The biggest luxury brands managed to overcome the previous crises. Their power is displayed in the table below.

Table 1: Luxury brands strength 2013 vs 2019 (Interbrand, 2013) (Intebrand, 2019)

Overall rank 2019	Overall rank 2013	Brand name	Brand Vaulue ($M) - 2019
17	17	Lous Vuitton	32,223
22	Out of 100	Chanel	22,134
28	54	Hermes	17,920
33	38	Gucci	15,949
68	60	Cartier	8,192
94	75	Tiffany and Co.	5,335
96	77	Burberry	5,205
100	72	Prada	4,781
Out of 100	88	Ralph Lauren	Out of 100

More than 40 percent of global luxury- goods production happens in Italy— and all the Italian factories, including small, family-based façonniers, have temporarily shut down due to COVID19. Many luxury executives have demonstrated caring leadership during this crisis. They are prioritizing the safety of employees and customers and proactively communicating with all stakeholders about their new health and safety protocols, crisis-response activities, and the steps they're taking to keep operations running (Achille & Zipser, 2020). McKinsey consultants recommend taking strategic action for recovery, such as executing an online and omnichannel strategy, building new partnerships including through M&A deals (which was a common practice during the 2008 crisis) and digitizing the supply chain from end to end.

Here are seven new ways that independent luxury brands think will help them weather the COVID-crisis induced changes and bounce back stronger. These new practices might well help the industry in general.

1. From shirking virtual marketing to using it for emotional bonding - e.g. giving manufacturing updates of a client's masterpiece via live chat with the workshop.
2. From lavish extravaganzas to asking "Is the Return on Investment really worth it?" - questioning the ROI of large trade shows, events, fashion shows.
3. From long-term strategizing to incorporating shorter-term, more pressing concerns too - prioritizing societal impact and agility.
4. From putting the brand center stage to elevating the customer to this role - implementing a customer centric approach.
5. From being at the more irrelevant end of some industries to actively bringing value to the table - brand that have something to say will be more desirable than others.
6. From the growing reliance on Chinese traveling consumers to the re-connection with local consumers - overcoming rigidity and becoming more locally relevant.
7. From mysterious company cultures to transparent good practices - collaborative team dynamics. (Girod JD, 2020)

7. CONCLUSION

From the review of theory, it can be concluded that there is no one exact definition of luxury, but that it is dynamic. What is luxury for some today may not be for others, and in time it may not even be considered luxury at all.

Luxury divides and unites at the same time. It helps individuals differentiate themselves, while promising all social layers an escape from the ordinary to the extraordinary. The luxury market is open to new definitions and new discoveries. Emerging markets are becoming increasingly important and young brands with unique strategies are disrupting the industry. While luxury consumers are more financially insulated than most, they still changed their habits during the last recession What remains important, however, are the extraordinary experiences luxury offers to make us dream.

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PEDAGOGICAL APPLICATION OF NEW MEDIA: ENHANCING HIGHER EDUCATION PRACTICES WITH ICT ADVANCEMENTS

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Abstract: *This paper investigated pedagogical application of new media (social media, augmented and virtual reality and educational games) and the possibilities of their implementation into higher education practices. In order to answer research questions, a qualitative survey design was implemented. Based on examined body of literature, significant findings were revealed. ICT advancements and modern technology concepts (gamification and edutainment) were found to positively influence student motivation, engagement, mutual collaboration and, consequently, learning outcomes. Model for implementation of new media into educational practices was presented.*

Keywords: *new media, pedagogical application, higher education, ICT advancements.*

1. INTRODUCTION

Transition to more engaging and interactive education is present in countries worldwide. Advances of modern technology have altered the way in which the process of acquiring knowledge, studying and teaching is being performed. Literature reports on favorable learning outcomes which are the result of social media integration into systems of formal education (Eid, Al-Jabri, 2016). Research results implicate that multimedia instructional messages result in better understanding and enhanced learning outcomes than information communicated only in words (Gan et al., 2015). Therefore, lecturers significantly implement ICT advancements into their teaching practices in order to ensure better understanding of subject matter and provide students with additional information.

An increasing interest of academics and practitioners on the use of ICT tools for providing better education has resulted with policy makers' incentives for introducing technological innovations into classrooms. Reasons for such incentives are multiple. Innovative technologies have enabled students to exchange study materials, share knowledge and personal insights through online communication channels and thereby develop the sense of critical thinking. Additional benefit lays in the fact that innovative technological solutions have provided the opportunity for students to create, share and gain knowledge beyond the confines of traditional classrooms (Tsai et al., 2013). Therefore, it is argued that seeking and sharing information in any given moment has resulted with the concept of learning on demand (McGloughlin, Lee, 2010), which enables information seekers to solve problems in academic or professional environment in real time.

In recent years, there has been an increasing interest in the employment of these technologies in learning contexts. The application of technology to teaching and learning is known under the term technology-enhanced learning (TEL). Among technologies used for educational purposes, authors recognize Augmented Reality (AR) (Lee, 2012), and digital games which are familiar under the concept of game-based learning (GBL) (Prensky, 2001). Authors have reported on numerous benefits of AR and GBL in enhanced learning. AR tools are proved to be useful in promoting collaborative and autonomous learning in higher education (Martin-Gutierrez et al., 2015). It was reported that GBL offered an engaging and interactive approach in teaching engineering (Callaghan et al., 2013). Moreover, challenging games were proved to be the endorsers of continued learning (Hamari et al., 2016) since they have a positive influence on student motivation and performance outcomes (Woo, 2013). Other authors highlight growing usage of virtual reality (VR) technology

and consequently growing demand for specialist in this field, which calls for its introduction to educational courses (Häfner et al., 2013).

The implementation of social media has revolutionized the way in which knowledge is disseminated and acquired. This makes information and knowledge accessible to a larger number of people through online courses and educative websites (Mao, 2014). It is argued that communication software, such as Google Hangouts and Google Docs, can help students to achieve educational aims through teamwork realized from the comfort of their individual work environments (Wu et al., 2017). Moreover, among several ICT advances, management students perceived collaboration tools as the most useful in achieving educational aims, followed by social media. This can be explained by students' digital sophistication, remarkable self-expressiveness (Bolton et al., 2013) and constant communication with peers via latest technological advances.

The aim of this paper was to explore the following research questions: (1) What are the perspectives of using AR, VR, GBL and social media to facilitate the process of knowledge acquisition? (2) What kind of benefits do AR, VR, GBL and social media result with in the process of studying? (3) What kind of model would be appropriate for introducing AR, VR, GBL and social media to higher education courses? To examine stated issues, this paper is organized as follows: First, authors have provided a literature review of relevant studies on benefits of AR, GB and social media use in studying and teaching practices. Second, a model for introducing AR, VR, GBL and social media in higher education was presented. Benefits of proposed model were discussed. Finally, conclusions were presented and directions for further research were provided.

2. GAMIFICATION, VIRTUAL AND AUGMENTED REALTY IN HIGHER EDUCATION

The need to prepare students for the challenges of working in computer-based environment has resulted with the requirement for introducing technological advances into educational curriculums. Internet technology has influenced students' preferred learning styles, as they wish to study through mutual collaboration and technology supported activities, which qualifies gaming as a suitable teaching method (Bekebrede et al., 2011). It was proved that interactivity significantly enhances learning outcomes, whereas technology provides suitable solutions for captivating students' attention and increasing their motivation for studying (Marquez et al., 2016).

Authors argue on the popularity of games and computer technology among university students, since they had significant impact on today's young adults from their earliest age (Valentine, Powers, 2013). Literature indicates that gamification and GBL have to be distinguished from games created merely for entertainment purposes. Even though educational games also provide enjoyment, their main purpose is to educate users (Koivisto, Hamari, 2014). Therefore, they are believed to be "exceptional, mind-changing and effective" teaching instruments (Tobar-Muñoz et al., 2017). Educational games are proved to be beneficial in fostering student motivation (Von Wangenheim et al., 2012). Another benefit lies in the fact that it makes the process of studying an enjoyable and amusing experience as it includes social interaction and an immersive interface (Morford et al., 2014) (Soflano et al., 2015). Student competences which are believed to be associated with employability, such as communication, adroitness and versatility, could be developed through the use of games in education (Barr, 2017).

Apart from educational games, AR has also provoked significant interest among researchers who consider it to be one of the key emerging technologies for education. AR is defined as a technology which provides combination of camera captured real world elements and multimedia elements such as images, video, animations and 3D models (Martín-Gutiérrez et al., 2015). It was proved that the implementation of AR in formal education practices results with enhanced learning outcomes due to increased motivation (Hung et al., 2017). This might be the result of the real-time component provided by virtual technology, as instant feedback on one's performance can help students to adapt their learning activities to the achieved results in order to realize their educational aims. The latter had favorable impact on student engagement, while some authors highlighted the development of creativity, which was a consequence of autonomous exploration and learning by doing (Rojas-López et al., 2019).

Arguing on the advantages of incorporating emerging technology to university courses, (Häfner et al., 2013) provided an overview of its benefits on learning outcomes and personal skill development. Authors researched benefits of developing VR applications as a part of educational courses. VR is widely spread technology, defined as "immersive, realistic, 3D environments" which include visual feedback from body movement (Aarseth, 2001). Research results indicated that benefits of VR in education were found within both technical and non-technical students. Developing applications in interdisciplinary groups improved students' collaboration skills. By adding a competition component to the process of application development, students were encouraged to search for creative solutions, develop team work competences and presentation skills when explaining their conceptual solution to classmates. Authors (Martín-Gutiérrez et al., 2015) claimed that this kind of studying process results with enhanced learning outcomes due to reduced distractions, as VR and

AR technologies provide immersive experiences, and the possibility to receive instant feedback on their learning performances.

Relevant literature expresses concern for the future of education, especially in the field of science, technology and engineering (STE), proposing that immersive education which combines elements such as e-learning, distance learning, VR and virtual worlds as well as avatars could be a solution to close the gap between traditional education and the requirements which modern technology imposes to educational institutions (Potkonjak et al., 2016). The potential of AR to bridge formal and informal learning was highlighted as well (Wu et al., 2013). It was proved that by connecting virtual and conventional museum visits students' intrinsic motivation for learning science and understanding of specific science concepts could be positively influenced. Moreover, Pascual-Miguel et al. (2016) argue that the implementation of business simulation game tool for digital economy courses in engineering degrees can bridge the gap between engineering curricula and new economy, and prepare students for the requirements of 21st century labor market.

3. INTEGRATION OF SOCIAL MEDIA AND EDUTAINMENT IN HIGHER EDUCATION COURSES

Since higher education institutions have acknowledged the prospects of introducing innovative technology to educational practices for enhancing learning outcomes while current college-aged students are considered to be “most salient social media users” (Bal et al., 2015) several published studies have focused on the implementation of social media for academic purposes in higher education institutions (Sharma, Joshi, & Sharma, 2016; Wu et al., 2017).

Authors argue that the implementation of social media into teaching activities resulted with the "shift from teacher-centered to student-centered" approach. By placing online platform users into the center of attention, (Sobaih et al., 2016) argue that students’ academic performance and meeting desired learning objectives could be enhanced. Social media is defined as a group of virtual platforms which provide users with the opportunity to communicate, collaborate, create and share content and exchange information in real time within interactive and dynamic communities (Freberg, 2016). Interactive component of social media enables students to improve their mutual communication, as well as to establish a connection with higher education institutions through virtual communication channels.

Several studies have examined the opportunities for implementing social media into educational curriculums. Fowler and Thomas (2015) argue on the significance of creating blogs as an integral part of marketing classes, which supports the concept of experiential learning. Authors have found that practical experience in creating communication on social media helps students to employ theoretical knowledge and develop the ability of creative thinking and problem solving. Since interactive technologies, especially the concept of gamification, have been successfully integrated into social media platforms, researchers have hypothesized about the possibilities of employing this concept for the purposes of online learning (Domínguez et al., 2013). The concept which combines gamification with social networking is known as social gamification. It is believed that gamification can increase students' interest in course materials whereas social media can encourage meaningful conversations and collaboration (Garcia-Lopez & Garcia-Cabot, 2016).

Doğan et al. (2018) conducted a research on the use of social media in engineering education for teaching Computer Programming. Research results have indicated that social network Edmodo, which is considered to be the “Facebook of Education”, had a positive influence on students’ academic and laboratory performance when implemented as an assisting tool to traditional educational practice. Gnaur and Clausen (2015) proved that learning environment in engineering education can be enhanced through the implementation of digital audio files, as it was noticed that they facilitate deeper and more integrative learning. Other researchers (Neier, Zayer, 2016) have examined marketing course students’ attitudes towards the employment of social media into educational practices. Students believed that social media can be of importance for expressing ideas and facilitating communication between students and lecturers, as well as among peers, which can be a source of valuable information and knowledge. Moreover, YouTube was perceived as a valuable tool for finding and sharing useful content and is recommended by authors as a mean for starting conversations and opinion exchange on subject matters.

Authors suggest that, from lecturers' point of view, tweeting can help in assessing students' comprehension of subject matter taught in class. On the other hand, students perceived Twitter as more interactive and amusing way of learning than lectures as traditional method of knowledge transfer. (Eid & Al-Jabri, 2016) suggest that activities facilitated by social media platforms such as chatting and discussion are important predictors of knowledge sharing. Research model created by same authors indicated that knowledge sharing is a strong predictor of learning performance which is also positively influenced by enjoyment and entertainment as the outcomes of social media use.

Literature indicates that edutainment, implemented into formal e-learning processes, can be an effective solution for the challenges of 21st century education and result with enhanced learning outcomes (Anikina, Yakimenko, 2015). Edutainment can be defined as the implementation of different forms of entertainment into classes and lessons. This concept can be successfully implemented for learning on social media, as they both rely on multimedia content, interaction and information sharing through amusing activities. Moreover, it is considered that student best learning experiences are the result of combining several sources of information, such as educative websites, podcasts, virtual and augmented reality applications and other multimedia content (Gan et al., 2015).

4. PROPOSED MODEL FOR IMPLEMENTATION OF NEW MEDIA IN HIGHER EDUCATION

As traditional education is thought to be losing its pace to the demands of contemporary job market, gamification and social media are believed to be the answers to this issue. Innovative learning models, which aim is to develop 21st century skills among students, are essential to meet the demands of the world which changes rapidly. It is believed that by placing students as users of social media platforms, into the center of attention, their academic performance and reaching desired learning objectives could be enhanced (Sobaih et al., 2016). The reason can be found in the fact that implementation of social media into teaching activities resulted with the shift from teacher-centered to student-centered approach.

Educational games and social media could successfully complement each other, as social media environment could be employed for playing games and sharing tips and tricks for mastering subject matter material.

The interactive component of social media enables students to improve mutual communication and establish connection with higher education institutions through virtual communication channels. Moreover, literature indicates that social media can upgrade student-teacher communication, ensure prompt feedback and facilitate the process of active learning (Hung & Yuen, 2010). This could be the solution to student decline in interest and engagement in class as well.

By introducing educative games to social media platforms, students could learn in an amusing and familiar environment. Authors highlight the anchoring effect of games (Kim et al., 2017). This means that by completing less demanding tasks and going towards more complicated ones, users believe that the overall mission of the game can be completed. This concept could successfully be employed for educational purposes as lessons could be divided into learning tasks or assignments and presented in a form of game levels.

Empirical researches indicate that student attitudes on benefits of game-based learning are very much in accordance with literature findings. Barr (2018) conducted a series of interviews with students after they completed a task which involved playing video games. Student responses were in favor of author's assumption, claiming that effective communication skills, adaptability and resourcefulness can be developed with the help of video games.

Another important benefit of introducing gamification concept in educational practices is that it can challenge students to reach top score results of peers and therefore upgrade their motivation for studying. By assigning students who performed well in an educational game with points which consequently lead to a higher final grade, an example could be given to the rest of the class.

Moreover, literature reports on the possibilities for streaming educational content to live audience who can get in touch with the streamer during the session (Haaranen, 2017). In essence, streaming educational content is very much alike live-streaming of video games playing, which has a growing number of spectators worldwide. In the educational context, the streamer is the teacher and the spectators are students. Due to the nature of this technology, students can interact with teacher during live stream, while the lesson footage can be made available after the class.

Model of new media implementation in higher education should be designed in order to enhance student motivation for learning through collaboration, stimulate their cognitive skills, increase their creativity and improve their chances for generating new ideas and solutions. The exciting new environment should enhance active and experiential learning, based on challenging, problem-based tasks (Connolly et al., 2012). The model presented in this paper is based on literature findings on the benefits of incorporating new media in higher education.

This model could be interesting for observation and possibly integration into teaching practices, at least some its fragments. Literature speaks in favor of it, as researches show that students approve of the social network use in class (Milošević et al., 2015). Students found course sites to be fun and engaging, and liked to access

them often to find out what colleagues are up to (Hung & Yuen, 2010). This had a positive impact on the quality of their collaboration with peers in both online and offline environment.

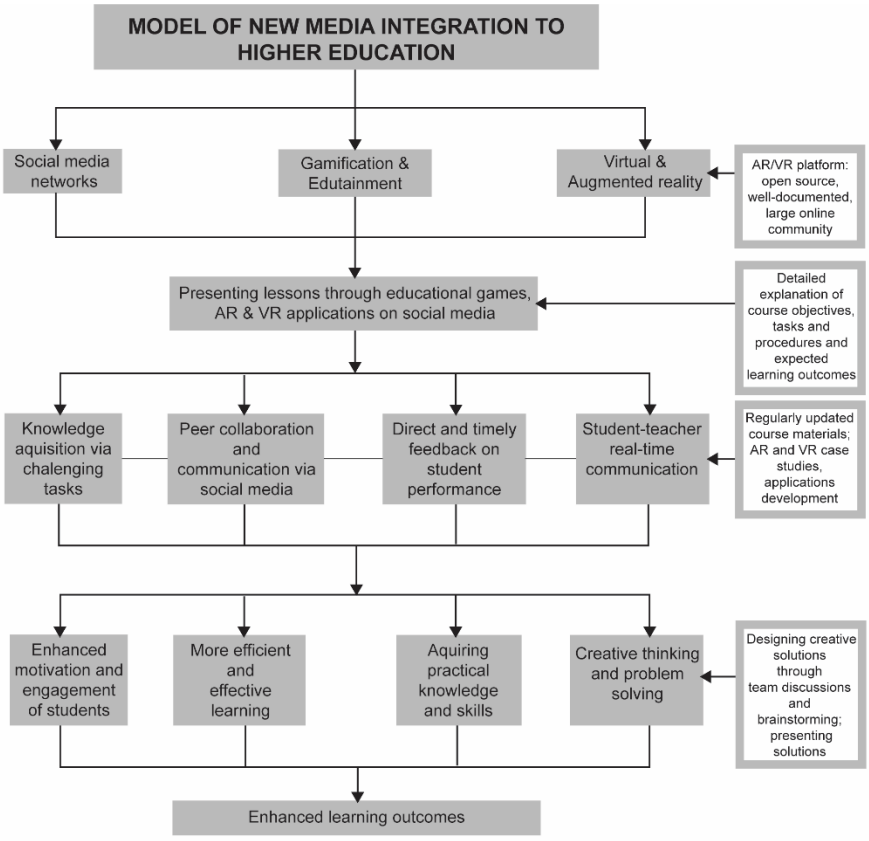

Figure 1: Proposed model of new media integration to education

Authors report that AR could be a solution to overcrowded classrooms and laboratories. Large number of students in courses makes it complicated for lecturers to dedicate themselves to each student individually, which worsens teaching quality (Martín-Gutiérrez et al., 2015). When introducing AR and VR software to teaching practices, software platform should be selected thoughtfully. Choosing an open source platform which is largely documented and has numerous online community can facilitate the process of teaching and learning with AR ad VR (Häfner et al., 2013).

Encouraging students to be active learners is one of the benefits of introducing this model into teaching practices. Virtual technologies facilitate learning by doing through operating within complex concepts. This results with enhanced student engagement, development of creative thinking and problem solving abilities and more efficient and effective learning. During the course, students should be encouraged to design creative solutions through team work. Enhanced learning outcomes are to be expected as a consequence of this approach.

4. CONCLUSION

Todays' students have grown up surrounded with different technological solutions, which predisposes them to a high degree of technology acceptance in different spheres of life. Literature reports that by integrating web based platforms into course curriculums, students can benefit in multiple ways (Gan et al., 2015). Firstly, social media sites are easily accessed through portable devices, which facilitates student interaction with peers and lecturers beyond the confines of a traditional classroom. Secondly, by combining several sources of information, such as social media, educative websites, virtual and augmented reality applications and other multimedia content, students are equipped for best learning experiences. Thirdly, by assigning students to solve real world problems through the implementation of latest software, they can better understand course goals and develop practical skills needed in labor market through the process of active learning. It is believed that more blended learning experience could result with better-trained future professionals, which provides benefits for the individuals and consequently for the job market and entire world of professionals.

Proposed model is based on the integrated use of gamification, social media and VR/AR technologies. As technology continues to develop at a rapid pace so will its scope of application. Therefore, some educational systems might find it challenging to adapt to the needs of future generations who will expect greater representation of technological solutions in education. These information draw attention to the need for investigating prospects and capacities of higher education institutions to implement new media into teaching practices. Moreover, perceptions and roles of lecturers are as important as students' perceptions, which calls for further investigation of this issue as well.

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TRANSFORMATION OF

FINANCIAL SERVICES

CONTENT

CHALLENGES OF FINANCIAL RISK MANAGEMENT: AI APPLICATIONS

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Abstract: *Financial technology has significantly changed the business operation which required transformation of financial industry. The key change has been made in financial risk management that needed restructuring because the methods that have been used in past became low effective. The artificial tools proved their efficiency and contributed to fast, low –cost and improved financial risk management in both, financial institutions and companies. Artificial intelligence (e.g. machine learning techniques) largely improved the market risk and credit risk management through data preparation, modelling risk, stress testing and model validation. In respect of artificial intelligence tools can be useful in data quality assurance, text-mining for data augmentation and fraud detection. The financial technology will continue to affect the financial sector through requiring the adoption and adaption to new environment and new business models. Because of that, it could be expected that artificial intelligence will become the integral part of financial risk management framework. Artificial intelligence tools should provide, not only improved data management and stress testing, but also creation and generation of advanced scenarios and new methodology for complex risk problems solution.*

Keywords*: artificial intelligence, market risk, credit risk, operation risk, machine learning*

1. INTRODUCTION

Today is almost impossible to manage financial risks without some kind of artificial intelligence (AI) tools. There are a number of reasons for this, but undoubtedly one of the most important is the fact that traditional financial risk management approaches, methods and techniques became costly, time-consuming and insufficient. Namely, the traditional financial risk management approaches in practice need to be applied in combination with different AI approaches and tools. This can generate more efficiency, confidence and potential to operate and growing in modern turbulent business environment for every participant regardless the industry.

Over the past ten years the challenges and issues that require to be solved can be summarize as: market risk modelling (Day, 2017), evaluation of so called “market impact” (i.e. Impact of firm’s own trading on market prices), validation of market risk management models (Regan et al., 2017), cost reduction through identification of assets in which would be desirable to take position (Heaton et al., 2017).

Financial technology (Fintech) development in period of the last five years has led to fast development of artificial intelligence tools that improved the way in which financial industry operates. The use of different technologies (blockchain, artificial intelligence and big data analytics) has changed the financial industry and has enabled direct and easier access to financial services. Regardless this, Fintech introduced many risks that may deteriorate participants' protection (e.g. market risk incompliance, credit rating underestimation etc.). This led to disruption of finance, and within this, the need for financial risk management transformation and improvement. Financial risk management will continue to use new technologies so that can provide efficiency and more reliable decision-making. In this regard, the use of AI became inevitable for both, financial institutions and corporations.

The rest of the paper is structured as follows, in the section two the relationship between AI and financial risk management is presented. In the section three, the use of AI in market risk management is presented. Section four considers the possibilities of use AI in credit risk management. The use of AI in operational risk management is presented in section five. Section six is pointed out to challenge of AI in financial risk management. Finally, in section seven are given the concluding remarks and the directions for further research.

2. AI IN FINANCIAL RISK MANAGEMENT

Financial risk management today is transforming because of influence of Fintech that led to financial sector disruption. Financial risk management is a practice of optimizing the way in which financial institutions or corporation can take on financial risk. In broader terms, AI is a part of Fintech and it already changed the manner in which the financial risk is managed. Besides this, AI helped financial risk management by increasing the decision-making efficiency.

As it is already mentioned, AI is a broad field oriented towards the use of different tools or techniques that use higher intelligence than human does. Of course, this does not mean that those tools exclude human intelligence, but instead that the past experience (e.g. different data sets) can be used in a more efficient and intelligent way. Key AI tool is machine learning that enables the data preparation and predictions which can be valuable for decision-making regarding different types of financial risk. Machine learning consists of supervised learning, classification and unsupervised learning. Supervised learning is based on collected data and tries to predict the outcome by using principal component analysis, partial least squares, least absolute shrinkage and selection operator, least angle regression, ridge, artificial neural networks and deep learning techniques (van Liebergen, 2017). Classification used techniques such as support vector machine and decision trees, while unsupervised learning uses input data to learn data structure by applying different clustering methods (e.g. X-means, hierarchical principal component analysis etc.) and deep learning (van Liebergen, 2017).

All the mentioned techniques can be used in financial risk management. Hence, some techniques are used more frequently in credit risk management. For example, principal component analysis is commonly used for credit repayment risk determination, credit assessment along with artificial neural networks (Hamdy and Hussein, 2016) but also as an input for neural networks for asset price and stock indices predictions (Wang & Wang, 2015) and equity portfolio management.

In addition, support vector machine learning has been used for default risk predictions which is important risk to which bondholders are exposed to (Nazemi et al., 2018), credit scoring (Harris, 2015), credit default prediction (Abedin et al., 2018), credit risk evaluation (Lean, 2014), estimation of Value-at-Risk (Radovic & Stankovic, 2015) etc. This technique especially combined with some other machine learning techniques (e.g. neural networks) showed advantages compared to traditional ones.

The unsupervised techniques are used for better classification among the data and to create cluster groups enabling to get signals that might be included in decision-making.

Finally, deep learning and neural networks should be viewed as a part of both, supervised and unsupervised machine learning because they can be applied to outcome prediction (e.g. level of market or credit risk) as well as to learning from data and providing more reliable indicator for financial risk management. Artificial neural networks are widely used for credit risk prediction (Pacelli & Azzollini, 2011), credit risk evaluation, asset price predictions.

Deep learning combines artificial neural networks with techniques that enable automatically discover the representative data for variable detection and/or to make classification from data. This technique represents the new technique which adds so-called hidden layers (variables) to input data and allows modelling the influences among them. By doing this, deep learning creates problem known as a „black box“ because it's hard to detect the manner in which the inputs have been recombined and then used for output prediction. In this regard, deep learning has been and will be used in financial risk management because the „black box“ is something that characterizes the decision-making regarding financial risk. Deep learning can be used for estimation of asset pricing models for individual stock returns through combining different deep learning techniques (Chen et al., 2019). Besides, deep learning can be applied in market risk management, trading book risk management of banks, trading risk prediction etc. (Kim et al., 2019).

3. USE OF AI IN MARKET RISK MANAGEMENT

Market risk refers to changes in financial instruments' or contracts' values due to unpredicted fluctuations in asset prices, i.e. commodity prices, interest rated, foreign exchange rates and other market indices. In other words, market risk is the risk of portfolio's value fluctuations due to changes in price level or market price volatility (Bogojevic Arsic, 2009, p. 333). This suggests that every participant in financial market is exposed to market risk, directly or indirectly. Depending of the financial strength and the position size exposed to this risk, participants need to manage this risk. In this regard, financial institutions strive to manage this risk actively choosing the type of market risk to which they want to be exposed because of their knowledge about market prices’ volatility. In contrast, nonfinancial companies seek for mitigating or, if possible, to remove this risk together with other risk types (to mitigate market risk or to eliminate it along with other risk types). AI

techniques can be helpful and their implementation in market risk management may lead to significant improvements. Machine learning as a core tool of AI can contribute to better market risk management the most.

Financial Stability Board (2017) pointed out that market risk management has benefited from AI use in very stage of this process, i.e. from data preparation, to modelling, stress testing and model validation. The most contribution in data preparation gave machine learning techniques which proved their capability to deal with raw data taken from financial market and institutions or companies.

Machine learning techniques (such decision trees, neural networks and deep leaning) showed that they can be used for cleaning the data, but also that they are able to in some extent overcome the missing or inaccurate data problem which is presented in papers of Garcıa-Laencina et al. (2007), Garcıa-Laencina et al. (2008), Twala (2009), Ding and Simonoff (2010), Ghrobani and Zou (2018) and Wang et al. (2019). Different machine learning techniques are also applied for classification which enabled more accurate data and those data is then used as inputs for model creation. This model includes also risk of using inadequate or incomplete or incorrect or, in some instances, risk of using the model that is no longer valid. In this regard, AI tools (e.g. different machine learning techniques) can be used for market model stress testing in order to determine unintentional risk or to identify risk which influences on trading behaviour and which can provide the benchmark or feedback mechanism for market risk decisions improvement or modification. A number of financial institutions are tried to use machine learning for Value-at-Risk estimation and expected shortfall (Wilkens, 2019), but also to trading book because it has became a significant source of risk during the financial crisis in 2009 (for example PNP Paribas). Depending on model risk source of risk and measurement of risk, the possible implementation of AI differs (Klein et al., 2015).

Abramov et al. (2017) gave an overview how to rum market risk model validation and how machine learning techniques should be used so that the market risk managers could make better decisions regarding market risk reduction and quantification of acceptable market risk level.

In one word, AI applications are inevitable because of their potential to lower the operating costs and provide more reliable data for financial risk management decision-making, which in turn enables financial institutions and companies, not only to survive, but to compete and grow.

4. USE OF AI IN CREDIT RISK MANAGEMENT

Credit risk is the risk of economic loss due to counterparty inability to meet its contractual obligations. Accordingly, credit risk represents a risk of incurring loss because of borrower default or because of his credit quality reduction (Bogojevic Arsic, 2009, p. 439). The credit risk management represents a process of risk factors identification and analysis, measuring the risk level and selecting the appropriate measures to credit activities management in order to lower and/or to eliminate the credit risks. Over the past few decades a range of different statistical techniques had been used in credit risk management. But with emergence of Fintech, those methods became insufficient and frequently not enough efficient in dealing with credit risk. Due to incompleteness of traditional techniques use in credit risk modelling, financial institutions started to use AI techniques for credit risk management enhancement.

AI techniques showed better performance in credit risk modelling compared to traditional statistical techniques, but only their combination can improve accuracy (Altman et al., 1994).

The most complex task is the credit risk assessment with AI techniques (such machine learning). AI can help in credit event determination and cost of default estimation in the credit risk occurs.

Machine learning is used for enhanced lending decisions, both, consumer and small and medium sized enterprises lending. Decision trees and support vector machine application can provide significant cost savings (Khandani et al. 2010) and better credit risk modelling (Yao et al, 2015). Use of multivariate outlier detection machine learning techniques improved credit risk estimation in small and medium-sized enterprises lending (Figini et al. 2017). In addition, machine learning techniques helped lending-based crowdfunding development through improvement of credit scoring and credit rating profiles creation which helped the borrowers (especially, the startups and small companies) to get loans and lendors to have trust in data presented and to be willing to extend the loans (Byanjankar et al. 2015).

Finally, deep learning showed the advantage compared to traditional techniques in credit default prediction and credit risk prediction both, in traditional and alternative lending through lending platforms and credit (Son et al., 2016; Thang et al., 2019; Van-Sang et al., 2019; Hou, 2020).

5. USE OF AI IN OPERATIONAL RISK MANAGEMENT

Operational risk is the risk of incurring the loss due to physical decay, technical incompetence and human error in business operations of enterprises and institutions, including the fraud, unsuccessful management and process errors (Bogojevic Arsic, 2009, p. 530). However, this type of risk for each enterprise or institution has a different meaning because of their specifics (e.g. business portfolio structure, risk preferences etc.) that affect on operating risk exposures. In this regard, AI can help enterprises and institutions in every stage of operational risk process (Sanford & Moosa, 2015). A study, conducted by ORX Association, the largest operational risk association in the financial sector, showed that risk managers concluded that AI should be more included in operational risk management and that investing in AI tools application would've provide running business in a more competitive, predictive, low costing, less risky and efficient way (Carrivick & Westphal, 2019).

AI can be useful in creating adequate strategy of operational risk mitigation as well as to deciding whether to shift or to trade this risk and how to do this.

The application of AI in operational risk management has to start from data preparation and classification and analysis of large data and the performances to prevent external losses).

The AI, and especially the machine learning, can contribute operational risk management through (Carrivick & Westphal, 2019):

- Reduction or elimination of time-consuming and repetitive tasks and process (e.g. some financial institutions managed to reduce the number of process that needed to be reviewed),
- Deeper insight into data in order to get valuable data,
- Easier decision-making process based on providing both, wider and concise information,
- Development of skilled employees and managers that are communicating with regulators and
- Customers, and economy of scale through speed and accuracy within all organization.

The main areas in which machine learning techniques can support operational risk management are: data quality assurance, text-mining for data augmentation and fraud detection (Carrivick & Westphal, 2019).

Machine learning can be helpful in collecting quality data by identifying duplicated data entries and extreme data values more accurately (e.g. to unsystematic or less probable risk identification such). Application of machine learning may be able to analyze the large amounts of data needed for risk management (e.g. internal and external loss data, internal risk indicators, macroeconomic data etc.) and to store and maintain data. In this way, different machine learning techniques can make categorization of individual entries and augment the data. Finally, the most common use of machine learning is to detect the fraud and money laundering. The fraud is not easy to detect and is commonly done by financial transaction classification to suspicious and harmless. Machine learning can help by appropriate classification of these transactions as well as by reduction of false alarms where fraudulent transactions are overlooked. The common machine learning implementation is for preventing credit card fraud detection, but it can be used for securities fraud detection (stock fraud, foreing exchange fraud, commodity pool fraud etc.).

6. CHALLENGE OF AI IN FINANCIAL RISK MANAGEMENT

Evolution of AI in financial risk management is multidimensional and depends on many variables (nature of business, specific business lines, organizational structure, geography, regulations etc.). In some areas of financial risk management (e.g. model validation and behaviour-based modelling), the underlying complexity, multivariable and non-linear character of risk management. Chartis research (2019, p.45) indicated that AI tools have been mostly applied in retail banking, commercial banking and capital market financial risk management. In retail banking AI has used for modelling improvements and stress testing through supervised machine learning techniques and classification methods (such as support vector machine and decision trees). The further development regarding AI implementation will be toward behavioural models, scenario generation and behavioural and segmentation integration in asset pricing and portfolio optimization. Commercial banks represent the great challenge to AI application because they have relatively poor data management with big and complex documentation, not well structured data of benchmarks and credit curves. Some activities such as passive strategies need to be automated in some extent to ensure profitable operating. Besides this, AI applications could be expected in scenario creation and testing, credit risk analytics and credit portfolio management. Lastly, in capital markets AI (i.e. different machine learning techniques) has been applied for database creation, yield curve and volatility surface anomaly detection and portfolio construction. In the near future it could be expected the more sophisticated and advanced AI applications in scenario creation, model validation, portfolio optimization and credit and equity risk modelling.

7. CONCLUSION

The further development of Fintech will continue to influence significantly the financial risk management. This influence will require the continuing the financial risk management transformation and change. In this regard, it could be expected that AI will become the integral part of financial risk management framework of financial institutions and other participants in financial market. This means that AI would provide automation and simplification in data management and improved stress testing and scenario generation and create new methodology for dealing with complex, multivariable problems and non-linear optimization (Chartis research, 2019, p.48). In addition, greater application could be expected in equity-based and lending-based crowdfundig through facilitation and acceleration of raising capital by equity issuance or loan approval to potential borrowers. Besides this, AI could contribute to improved credit scoring of potential borrowers and creation of their credit rating which is essential for platforms' functioning as intermediary in crowdfunding process.

Based on the above, it follows that there is no barriers to AI tools application in financial risk management which will deliver accurate real time information on financial risk types to which institutions and companies are exposed and which need to be managed in an advanced manner that will combine traditional statistical techniques with AI tools, such as deep learning techniques, artificial neural networks and advanced classification methods.

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SYNERGETIC EFFECTS OF INTEGRATED COLLABORATION BETWEEN HUMANS AND SMART SYSTEMS IN BANKING: AN OVERVIEW

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Abstract: *This paper aims to shed light on the role of artificial intelligence in banking, the phenomenon which will continue to reshape business models at an accelerated pace, implying the development of new landscape, founded on synergetic effects of integrated collaboration between humans and smart systems. These synergetic effects bring many opportunities and challenges at the same time. To create sustainable value for an organization from a harmonized collaboration between humans and smart machines, changes are expected in both, hard and soft components of any organization, with the primary focus on AI strategies development, organizational culture, "fusion skills" and knowledge economy. Future management practice relies heavily on the adoption of new managerial and leadership knowledge and skills, implying empowerment of human-centric approach, emotional intelligence, creativity, and flourishing paradigm "leading by heart".*

Keywords*: Artificial intelligence, integrated collaboration between humans and smart systems, human-centricity, AI strategy, knowledge economy, fusion skills.*

1. INTRODUCTION

The business ecosystem that consists of various, dynamic networks and components that interact with each other at an accelerated pace represents environment characterized by many challenges and opportunities for organizations in the banking sector. Digitization determines the rules of competition. Organizations that are founded on traditional business models are at risk of being left behind (Lauterbach & Bonim, 2016). Overall trends in the business ecosystem will create a difference between competing banks in the future and significantly reshape the business landscape. In addition, the fast-changing marketplace and "COVID-19 era" put sustainability in the narrow focus of executives, implying continuous reconsideration of strategic direction and development of competitive strategies (Gartner, 2017; Tornjanski et al., 2017).

Innovations are widely recognized as a key value driver for economic growth, sustainability, and development of organizations and core of competitive advantage in banking (Porter & Ketels, 2003; Tornjanski et al., 2015). Moreover, some authors argue that organizations may achieve improvements in business performance with clear and unambiguous innovation and open innovation strategies (Löfsten, 2014; Tornjanski et al., 2015a; Tornjanski, 2016). Aslam et al. (2020) have proposed the "Absolute Innovation Management (hereafter: AIM)" framework that synergizes innovation ecosystem, design thinking, and corporate strategy with twofold objectives, to make innovation concept more practical, and to prepare organizations for forthcoming IoT and Industry 5.0 revolution.

1.1. Shifting from Industry 4.0 to Industry 5.0

The birth of Industry 4.0 relies heavily on disruptive technologies: Internet of Things (Hereafter: IoT), Cyber-Physical System (Hereafter: CPS), Information and communications technology (Hereafter: ICT), Enterprise Architecture (Hereafter: EA), and Enterprise Integration (Hereafter: EI) (Lu, 2017). Industry 4.0 was introduced in 2011 by the German Government, when new information technologies penetration secured "the world to stand on the threshold of the 4th industrial revolution" (Skobelev & Borovik, 2017, p. 307). Industry 4.0 is based on four key principles: interoperability, decentralization, technical assistance, and

information transparency, representing flywheel for business transformation (Paschek et al., 2019). Almada-Labo (2017) depicted the key benefits of Industry 4.0 changes in manufacturing companies that encompass: efficiency, agility, innovation, customer experience, costs, and revenues (Paschek et al., 2019). With reference to Industry 4.0 and the continuous adoption of new digital practice, traditional business models are increasingly faced with high pressure to respond to all internal and external challenges. Tornjanski et al. (2015b) have synergized various aspects of the digital disruption in the banking sector, pointing out the suitable framework for banks to effectively deal with the 4th industrial revolution (Sundaram et al., 2020) that signifies digitalization - a phenomenon that drives all societies and businesses worldwide (Paschek et al., 2019). Fitzgerald et al. (2014) have recognized:

- Streamlining of operations,
- Better customer experience and
- Integration of innovation into the existing business model

as key benefits organizations may achieve by adopting digital transformation. However, despite all recognized opportunities, organizations still struggling to achieve expected benefits from all these opportunities. Key recognized constraints lie in managerial behavior in terms of the sense of urgency, leadership quality, organizational culture, IT systems, unclear roles, and lack of vision (Sundaram et al., 2020). Although Industry 4.0 takes a significant part in our daily lives (Ozkeser, 2018), Skobelev and Borovik (2017) are with the opinion that Industry 4.0 is at the initial stage of the development, expecting real business achievements in years to come.

On the other side, Industry 5.0, named: "Society 5.0" flourishes. Industry 5.0 represents a core concept and growth strategy for Japan, adopted by the Japanese Cabinet in 2016. "Society 5.0" is a strongly promoted concept outside the country's boundaries as a response to global challenges (Fukuyama, 2018). Faruqi (2019) explained Industry 5.0 as an idea that reshapes people's lives with the extended development of Industry 4.0, by integrating both, technology and humanities aspects. Similarly, Ozkeser (2018) has shown the main difference between Industry 4.0 and Industry 5.0. Industry 5.0 concept shifts focus to increased human-smart machine interaction while empowering people towards personalization (Aslam et al., 2020).

According to Fukuyama (2018), the world is faced with increased uncertainty and complexity, caused by numerous challenges of global scale such as COVID-19, global warming, exploitation of natural resources, growing economic disparity, and terrorism. When Japan is in question, Fukuyama (2018) has recognized specific challenges that encompass: declining birth rate, increased social security costs, and shrinking labor force. Moreover, Fukuyama (2018) noted that these challenges of Japan's society may be threats for many other countries in the future, too. Accordingly, Society 5.0 is developed as a response to all global challenges that require the adoption of open innovation concept in the social ecosystem, by the active participation of multiple stakeholders at the global scale, in which government, academy, and industry play a leading role. More specifically, Industry 5.0 aims at maximizing leverage ICT to acquire new knowledge and to create sustainable value by integrating "people and things" and "real and cyber" worlds to efficiently and effectively ensure better quality of life, sustainable and healthy economic growth. In other words, the purpose of Industry 5.0 development is to shift focus to human-centricity by synergizing effects of integrated collaboration between humans and smart systems (Fukuyama, 2018).

2. OVERVIEW OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence (hereafter: AI) is viewed as a big game-changer in the global marketplace (Rao & Verweij, 2017). AI dates back for more than 60 years (Duan et al., 2019, Sharma et al., 2020) and represents a phenomenon that has been subjected to public discourses for a decade (Dwivedi et al., 2019). Over time, AI has arrived in the present as an emerging strategic topic, attracting numerous and different views from leading experts (Duan et al., 2019). Despite all controversial opinion regarding AI, PwC research results predict an increase in GDP up to 14% higher in 2030 at the global scale, as a result of AI. The results of the analysis are viewed as a significant commercial potential for the world, which can be achieved on the basis of AI (Rao & Verweij, 2017). Moreover, the report shows that the greatest benefits from AI are likely to be in China, by boosting up to 26% GDP and North America, by boosting up to 14% GDP in 2030. From the sectors' perspective, the highest values are expected to be in retail, financial services, and healthcare (Rao & Verweij, 2017).

2.1. Defining AI

There is no unique definition of AI. According to Duan et al. (2019), AI refers to a machine's ability to learn from experience, adapt to new inquires, and simulate human cognitive tasks. Similarly, Russell & Norving (2016) view AI as "systems that mimic cognitive functions generally associated with human attributes such as learning, speech and problem solving" (Duan et al., 2019, p. 2). A broader definition is given by Rao &

Verweij (2017), who understand AI as a term for computer systems with a sense for the environment, machines that think, learn, and take actions at the same time. Dwivedi et al. (2019) have synthesized all definitions of AI and concluded that all concepts rely on non-human intelligence systems that are programmed to carry out specific tasks. In other words, AI represents the increasing capability of machines to provide particular roles and cognitive assignments, currently performed by humans in overall society.

Lauterbach & Bonim (2016) define AI as one component of computer science that deals with machine learning and enables software to carry out problem-solving akin to the cognitive intelligence of humans. Authors have analyzed AI from two key perspectives:

- Narrow AI: AI that is incorporated into the system to perform specific tasks, and
- Deep AI or AGI: AI that is conceptualized to "think in general", designed after the neural networks of the human brain (Lauterbach & Bonim, 2016).

Narrow AI includes speech and text recognition, expert systems, heuristic classification systems, knowledge engineering, gaming technologies, advances in algorithms of data mining. Examples of narrow AI are given in text hereafter: Google, Uber, Amazon Alexa, Connected Home, Drones, Kespry, Drive ai. Connected Car, Building Robots, Robots, Neurensic Financial (Lauterbach & Bonim, 2016).

On the other hand, Deep AI or AGI represents an emerging area with a primary objective to build thinking machines with intelligence that can be compared to human cognitive intelligence. Examples of deep AI are as follows: Vicarious, Curious AI Co., Deep Mind, Watson, GoodAI, Fanuc, Numenta (Lauterbach & Bonim, 2016).

2.2. AI values, opportunities, and challenges

Dwivedi et al. (2019) have recognized AI technology is no longer an area of futurologists, but an integral element of a business model and key strategic priority in plans for many organizations in various sectors, worldwide. AI as the key source of a new wave of disruption, transformation and competitive advantage (Rao & Verweij, 2017) brings simultaneously value to the business, opportunities, and challenges that should be holistically perceived and properly addressed to all stakeholders including government, academia, and industries. The existing theoretical fund records factors that contributed to the AI development, i.e.: the growth of data, cloud technology, better algorithms, gaps in smart networks, cyber insecurity, and development (coding) mistakes (Lauterbach & Bonim, 2016). Duan et al. (2019) have developed research propositions with reference to opportunities and challenges from different perspectives when the application of AI for decision making is in question. Duan et al. (2019) have concluded that Big Data, improved computing storage, and power, advanced algorithms represent key driving forces of AI popularity nowadays.

The existing literature suggests that AI is likely to have huge opportunities in various sectors and domains. For example, Sharma et al. (2020) have carried out an analysis of existing literature with reference to AI in the government sector. According to the research results, it may be concluded that potential in investments and adoption of AI lies in (Sharma et al., 2020):

- Education,
- Healthcare,
- Physical infrastructure,
- Transportation,
- Data security and management,
- Telecommunication,
- Research and development,
- Finance,
- Legal and justice system,
- Policymaking,
- Public safety,
- Defense,
- Predictive maintenance and many others.

The purpose of AI application in the government sector is twofold:

- Efficiency improvement for the government and
- Better quality of life for citizens (Marda, 2018; Sharma et al., 2020).

On the other hand, research results depicted in the PwC report indicate sectors' and products' impact of AI, aiming at enabling businesses to recognize opportunities and threats as well as the capacity for greatest return of investment. The general AI application area according to Rao & Verweij (2017) is shown in Table 1.

Table 1: PwC AI index evaluation according to the sector

Number	Sector	Consumption impact*
1	Healthcare	3.7
2	Automotive	3.7
3	Financial services	3.3
4	Transportation and logistics	3.2
5	Technology, Communication, and Entertainment	3.1
6	Retail	3.0
7	Energy	2.2
8	Manufacturing	2.2

**Consumption impact represents PwC AI index evaluation, where 1 indicates the lowest potential impact, while 5 signifies the highest potential impact.*
Source: PwC Publication (Rao & Verweij, 2017).

Moreover, Rao & Verweij (2017) are with the opinion that robotic doctors may be one of the revolutionary changes. However, when the application of deep learning (AGI) is in question, Sharma et al. (2020) argue that there are still open questions needed to be further researched in the context of better understanding the range and effects of AI-based implementation, including a holistic view of all related challenges this area implies. Duan et al. (2019) have analyzed key opportunities and challenges of AI from different perspectives. Results have shown that both, opportunities and challenges lie in the same area, i.e. theoretical development, technology-humans interactions, and AI implementation.

Wilson & Daugherty (2018) understand the value for an organization is joining forces of collaboration between humans and AI. The collaborative value that is based on humans and AI interaction primarily lie in:

- Flexibility,
- Speed,
- Scale,
- Decision making and
- Personalization.

According to the presented results in the report, these five elements may be beneficial for all organizations in all industries (Wilson & Daugherty, 2018).

However, there are still lots of challenges that the AI revolution brings, which should not be neglected, but rather should be taken into account for further analysis and beneficial solutions development. For example, Dwivedi et al. (2019) in their recently published paper have analyzed AI-based challenges from a multidimensional perspective. Recognized challenges are retrieved from existing literature and are grouped into seven aspects, shown in Table 2.

Table 2: AI challenges retrieved from the literature

AI challenge aspects	AI challenge details
Political, legal and policy dimension	• National security threats • Privacy and safety • Copyright issues • Responsibility and accountability • Lack of clear rules • Autonomous intelligent system governance • Lack of officially industry standards and performance evaluation • Competent human resources that are legally required to deal with the AI-based decisions
Economic dimension	• Costly patients • Computational expenses transparency • High costs and reduced profits for hospitals
Social dimension	• Insufficient knowledge of values and advantages of AI • Cultural limitations • Human rights • Unrealistic expectations from AI • Patient / Clinician education • Country specific medical practices • Country specific disease profiles •

Organizational and managerial dimensions	• Organizational resistance to data sharing • Lack of AI strategy development • Lack of in-house AI talents • Lack of interdisciplinary talents • The threat of humans replacement • Realism of AI
Technology-related dimension	• Lack of interoperability and transparency • AI safety • Specialization and expertise • Architecture issues and complexities in interpreting unstructured data • Big data
Ethical dimension	• Lack of trust regarding AI-based decision making • Unethical utilization of shared data • Responsibility and explanation of the decision made using AI • Moral dilemmas and AI discrimination • Processes concerning AI and human behavior • Compatibility between human assessments and judgment in comparison with machines
Data dimension	• Lack of data to certify benefits from AI • Quality and quantity to input data • Reproducibility • Transparency • Available data pool size • Data collection standards • Lack of data integration and continuity • Format and quality • Dimensionality constraints

Source: Dwivedi et al. (2019)

Based on the holistic overview of artificial intelligence, its values, opportunities, and challenges, the next chapter aims to narrow focus on the future perspective of integrated collaboration between humans and smart systems in the banking industry, and further development of synergetic effects by incorporating joined forces of both toward sustainability.

3. SYNERGETIC EFFECTS OF INTEGRATED COLLABORATION BETWEEN HUMANS AND SMART SYSTEMS IN BANKING

3.1. Overview of banking landscape

Continuous development of the banking sector represents a vital component in an overall country's financial sector stability and growth. The significance of the banking sector lies in its role incorporated in shaping the industrial structure and the country's economic growth through extending and deepening financial markets (Ye et al., 2019). On the other side, recent decades for the banking sector are characterized by numerous challenges as a result of various external forces that foster various types, sizes, and shapes of changes to both, market and organizations at high speed (Čudanov et al., 2019). To sustain competitively, banks have undertaken various strategic actions to simultaneously:

- Fit effectively to ever-present external changes and
- To ensure internal growth.

These strategic perspectives opted on key components that strengthen organizational performances and growth on the long run (Fasnacht, 2009; Tornjanski et al., 2014; Tornjanski et al., 2015; Tornjanski et al., 2017):

- Ambidextrous development of an organization,
- Tailoring of appropriate strategies towards long-term vision achievement and
- Creation of a strong operating model to foster time to market and ensure smooth short-term implementation capabilities.

Continuous banks' adaptation to the 4th Industrial revolution creates benefits, opportunities, costs, and risks at the same time, implying strong strategic alignment to all internal and external components in the business ecosystem, aiming at achieving sustainable competitiveness based on smart investments and shift in generating and managing intellectual property. More specifically, this shift is founded on principles of the

holistic innovation management approach, primarily focused on generating value for the business through (Chesbrough, 2006; West & Gallagher, 2006; Vargo et al., 2008; Tornjanski et al., 2014; Tornjanski et al., 2015; Tornjanski et al., 2015a):

- Open business models,
- Open innovation management and
- Value co-creation process.

From an innovation perspective, artificial intelligence is one of the emerging subjects that should be further better understood in the context of achieving overall performances and sustainable growth in the banking industry. To this end, Rao & Verweij (2017) have clustered the biggest AI potential from the perspective of time as follows:

- Early adoption
- Potential for the medium-term period
- Potential for the long-term period

3.2. AI in banking: Early adoption

Artificial intelligence in the banking industry has found its place in terms of the initial phase of implementation and further opportunities for adoption in various domains of a banking business. According to the report published by PwC, key areas of the biggest AI potential include (Rao & Verweij, 2017):

- Personalized financial planning,
- Anti-money laundering,
- Fraud detection and
- Process automation

Robo-advisers, insurance underwriting, and robotic process automation in various areas of banking operations are recognized domains that fit into early "AI birds" perspective when the time horizon is in question (Rao & Verweij, 2017). Many banks across the globe integrate FinTech into services to effectively respond to customers' high demands. FinTech understood as a specialized banking branch for intelligence machines, enables more flexibility, alternatives, and control over banks' products and services (Lui & Lamb, 2018).

Early adoption of AI in the banking industry was introduced in the UK and refers to banking applications that are based on voice recognition. Other banks, such as Bank of America, Swedbank, Societe Generale, and Capital One have introduced chatbots with the purpose to virtually assist and interact with customers in the financial advising area using online web chat or textual messages. According to the experimental results related to virtual assistants, key benefits that are recognized by customers lie in strong confidence, trust, accurateness, efficient services, and 24/7 availability. Moreover, wealth management is viewed as one of the beneficial areas when the utilization of virtual assistants is in question (Lui & Lamb, 2018).

The mortgage application area is recognized as one of the AI potentials that might be achieved in the short-term period. To reduce the time-consuming and bureaucratic process, two approaches were introduced in banking. One approach enables Robo-advisers in synergy with the online broker community to interact with customers. Another approach is based on creating synergy between "digital mortgage advisors" and human advisers (Lui & Lamb, 2018). Nevertheless, virtual assistants have limitations that should be taken into account. At initial implementation phase of chatbot queries, which are simple and repetitive in its basis, there are no doubts that humans will continue to assist and interact with customers for more complex subjects in the financial advising area, regardless of customers' demands that might be in correlation with products, services and/or discussion on a specific topic initiated by customers (Lui & Lamb, 2018). The future perspective of AI adoption for the financial advising area lies in providing all complex and non-repetitive answers to customers, which signifies a lot of challenges that should be further taken into account before going forward. The key challenge is recognized in providing inaccurate answers by virtual assistants, which could disturb the trust and confidence of customers (Lui & Lamb, 2018). As such, future perspective in financial advising may create various risks that should be carefully evaluated and customized to fit strategic objectives and organizational capabilities.

Leonov et al. (2020) have recognized a need to develop an analytical model that is based on artificial intelligence technology for ATM service. The purpose of the model is to optimize cash collection, i.e. to (Leonov et al., 2020):

- Reduce the number of cash collection and
- Secure a sufficient number of banknotes to satisfy customers' demand, timely.

The AI-based analytical model is designed to open a new perspective to the banks by providing efficient cash flow management in ATM networks and effective cash management to reduce overall costs related to financial monitoring (Leonov et al., 2020).

Examples of early AI adoption potential in banking have multidimensional values. The synergy that is created between AI and humans in the financial advising area satisfies customers' needs in one hand and increases the quality of work to humans on the other, making services more personalized, efficient, and effective at the same time. In other words, joint forces of AI and humans show that benefits may be achieved in cost management, increased quality in service delivery, better customer experience, employees' and customers' satisfaction by boosting a human-centric and customer-centric approach.

On the other side, the AI potential in the medium-time period encompasses consumer sentiments and preferences with the purpose to optimize product design in banking (Rao & Verweij, 2017). According to Lui & Lamb (2018), the AI area is both, wide and deep, which opens a lot of space for further research to better understand all hidden benefits and challenges in the long run that should be taken into account when developing AI strategies.

3.3. Future perspective of integrated collaboration between humans and smart systems in banking: towards sustainability - Society 5.0

Sustainability has been analyzed from numerous perspectives in theory over decades. Various definitions of the concept strengthen views on the phenomenon, which indicate its multi-dimensional and complex nature. Accordingly, sustainable development should be taken into account as an integrated system of economic, social, ecological, and institutional aspects to shed light on its real value in the ecosystem (Ciegis et al., 2009; Tornjanski et al., 2017). Society 5.0 represents a vision of sustainability, which is grounded in the 4th Industrial revolution and primarily focused on the human-centric approach development in the fifth phase (Fukuyama, 2018; Fukuda, 2020). Society 5.0 aims at designing a cyber-physical society to enhance the quality of life of people. The vision relies significantly on the close collaboration between humans and artificial intelligent systems (Gladden, 2019).

Translating Society 5.0 vision at the level of the banking sector, human-centricity has attracted attention due to three underlying and correlated elements that directly and/or indirectly contribute to the overall organizational performances and long-term sustainability (Tornjanski & Milosavljević, 2016; Tornjanski et al., 2017):

- Significance of employees' work-life balance
- Efficient and effective service to customers
- Quality (in terms of services and work)

To achieve sustainability, Society 5.0 focuses on the deep integration of rapidly evolving technologies into daily operations, while Industry 4.0 focuses on production utilization within business segments. Industry 4.0 paradigm is understood to create a "smart factory", yet, Industry 5.0 is conceptualized to design "super smart society" for the world, making a key difference in relation to Industry 4.0 (Gladden, 2019).

In other words, Society 5.0 vision seeks to harmonize emerging technologies with humans to create sustainable development in the long run (Gladden, 2019). According to Gladden (2019), emerging technologies include:

- Embodied AI,
- Social robotics,
- IoT,
- Ambient intelligence,
- Advanced human-computer interfaces and
- Augmented and virtual reality.

Wilson & Daugherty (2018) have recognized that collaborative intelligence founded on joined forces of humans and AI, transforms business with a significant paradigm shift to effectively incorporate smart machines in daily operations with human intelligence to sustain in the long run. Similarly, Bryndin (2018) noted that Society 5.0 is designed to create equal opportunities for everyone in the ecosystem, by maximizing each individual's value. The primary objective of emerging technologies in Industry 5.0 is to eliminate administration, physical, and social boundaries while allowing people to deal with more quality of work (Bryndin, 2018; Gladden, 2019).

Synergetic effects from an integrated collaboration between humans and smart systems in banking may be analyzed from different perspectives. Wilson & Daugherty (2018) are with the opinion that organizations can benefit from integrated collaboration between the two, based on the following principles:

- Business process rewriting,
- Experimentation/employee involvement,
- Active design of AI strategies,
- Responsible data collection,
- Work redesign and
- Employees' skills development.

Lui & Lamb (2018) argue that the synergetic effects of integrated collaboration between humans and smart systems lie in segregates roles. When humans are in question, the future perspective creates new opportunities that lie in inputting, training, and assisting machines to learn. Moreover, Lui & Lamb (2018) are with the opinion that augmented collaboration is necessary to allow regulators and industry players to carry out supportive regulation and financial stability, implying that the future of AI regulation is in the interdisciplinary character.

Taking into account that Industry 5.0 may be revolutionary for the banking industry, implying the transformation of banks, changes can be expected in both, hard and soft elements of any organization. Taking into account that Society 5.0 vision is oriented to human-centricity, future management practices rely on the adoption of new managerial and leadership knowledge and skills, with a narrow focus on empowerment of people, emotional intelligence development, boosting creativity in day-to-day business and development of paradigm "leading by heart". Moreover, "fusion skills" and knowledge economy come to the fore.

On the other side, besides technical knowledge to implement all potential that Society 5.0 concept may bring, organizational culture barriers play a significant role in a newly designed model of any organization, as well as management and unclear AI strategies. Finally, the organizational maturity level is also one of the challenges that should be taken into account before going forward.

Working in harmony with cognitive computing brings a lot of opportunities, but also challenges that should be transformed into opportunities at both levels: government and regulations in one hand, and those that related to the organization itself.

4. CONCLUSION

Innovations are widely recognized as a key value driver for economic growth, sustainability, and development of organizations and core of competitive advantage in banking (Porter & Ketels, 2003; Tornjanski et al., 2015). In the 4th industrial revolution, digitization defines the rules of competition, implying the risk of being left behind to all organizations that run operations on traditional business models (Lauterbach & Bonim, 2016). Besides, the fast-changing marketplace and "COVID-19 era" put sustainability in the narrow focus of executives, implying continuous reconsideration of strategic direction and development of competitive strategies (Gartner, 2017; Tornjanski et al., 2017).

Artificial Intelligence is viewed as a big game-changer in a global marketplace (Rao & Verweij, 2017). Dwivedi et al. (2019) have recognized AI technology as an integral component of the business model and key strategic priority in plans for organizations. However, AI brings simultaneously value to the business, opportunities, and challenges that should be holistically viewed and properly addressed to all stakeholders including government, academia, and industries.

Wilson & Daugherty (2018) have recognized that collaborative intelligence founded on joined forces of humans and AI, transforms business with a significant paradigm shift to effectively incorporate smart machines in daily operations with human intelligence to sustain in the long run. Future perspective of integrated collaboration between humans and smart systems relies significantly on the Society 5.0 vision, bringing a vast variety of opportunities and challenges for the banking industry. Future management practices rely on the adoption of new managerial and leadership knowledge and skills, with a narrow focus on human-centricity, implying empowerment of people and development of emotional intelligence, creativity, and "leading by heart" paradigm. Moreover, "fusion skills" and knowledge economy come to the fore.

On the other side, technical knowledge to successfully implement Society 5.0 concept, organizational culture, management, and unclear AI strategies may be key challenges to fully benefits from harmonized work between humans and smart machines in Society 5.0. In addition, the organizational maturity level is also one of the challenges that should be taken into account before going forward. A synergetic effect of

integrated collaboration between humans and smart systems brings a lot of opportunities but also challenges that should be considered, to achieve effectiveness in sustainability in the long run.

This paper is conceptualized on the basis of secondary data collection. Future perspective should incorporate empirical research to extend and deepen existing theoretical fund and all recognized opportunities and challenges when integrated collaboration between humans and smart systems are in question. However, the paper may contribute to strategic managers in the banking industry, IT sector, FinTech companies, government, and academics who are interested in the implementation of the Society 5.0 concept.

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THE STATE AND SHORTCOMINGS OF E-BANKING IN SERBIA

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Abstract: *Though electronic banking in Serbia is still in its infancy, when one considers the number of mobile phone users and users of banking services, it has great potential. For the purposes of this paper, a research of the electronic banking market in Serbia was performed. It was concluded that there is a connection between the demographic structure and the use of electronic banking systems. The profiled groups are the ones that still need to be introduced to using e-banking services, especially through user education programs.*

Keywords: *e-banking, m-banking, survey, decision tree*

1. INTRODUCTION

In this paper, a research of the electronic business market in Serbia was performed using an anonymous survey. The results indicate that certain demographic characteristics affect the utilization of this system. One of the possible ways to solve this problem is to educate potential users. This would solve the problems of users' aversion or uncertainty towards novelty due to the lack of knowledge. In order to assess the impact of educating the population on electronic banking, the decision tree method was used. The aim was to estimate the number of new beneficiaries resulting from the educational program.

Electronic banking is defined as a set of various ways of performing financial transactions, using computer networks and telecommunications media (Kovačević & Đurović, 2014). Electronic payment systems are currently expanding and are being used by a growing number of modern organizations to speed up payment processes while reducing costs (Savić et al., 2017). Global trends are turning to a cashless society in which online payments are becoming one of the most popular and prevalent forms of payment. However, despite all the advantages that such a system offers, the resources have not been fully utilized (Todić & Dajić, 2016). The importance of this type of payment and way of doing business was made clear during the pandemic of the COVID-19 virus. The authorities in European countries are encouraging citizens to make payments electronically as a safer way to maintain the necessary social distancing. In Italy, e-commerce has increased by 81% since the end of February, according to estimates by consulting firm McKinsey & Co (2020). The opportunities that e-commerce and cashless transactions provide in terms of convenience, efficiency and affordability will help them become even more popular in the coming years.

2. WORLD ELECTRONIC BANKING MARKET

Mobile banking is the latest trend in the development of electronic banking that allows payment via mobile phone, tablet and other devices. Increased use of smartphones with internet access, creates conditions for the use of electronic banking services to a greater extent (Bjelić, 2002; Birovljev, 2016). Smartphones appeared on the market in the late 90s. Their popularity came to the fore with the introduction of Apple and iPhone mobile phones in 2007 (O'Dea, 2020a). The smartphone industry has been constantly evolving ever since. Figure 1 shows the number of smartphone users from 2016 to 2020 in the world (O'Dea, 2020b).

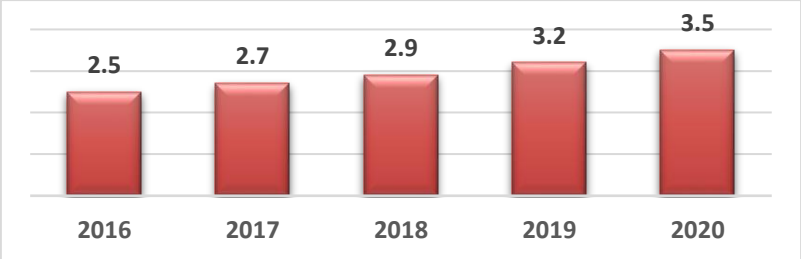

Figure 1: Smartphone users in billions (O'Dea, 2020b)

The number of mobile phones sold to end users worldwide from 2007 to 2020 is presented in Figure 2. From this it can be concluded that with the increase in the number of smartphone users comes a greater potential for using electronic, and especially mobile banking (O'Dea, 2020c).

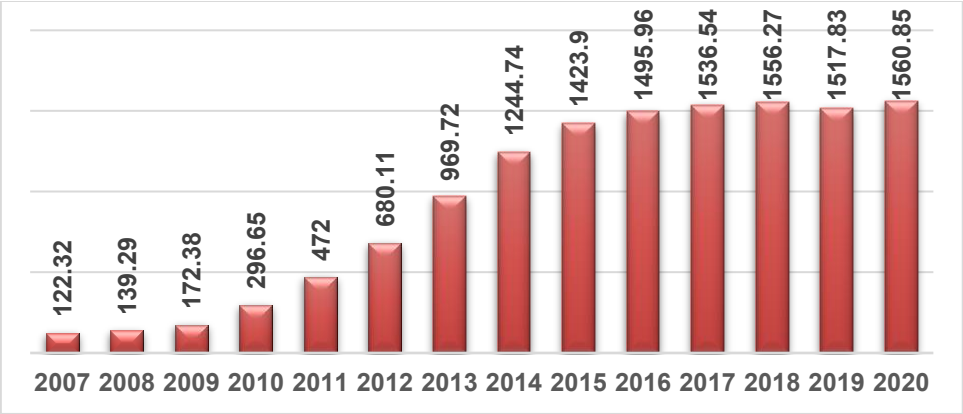

Figure 2: Sales in million units (O'Dea, 2020c)

According to Allied Market Research, global mobile transactions will be worth more than £ 3,5 trillion by 2023, an increase of 33,8% CAGR (Compound annual growth rate) between 2017-2023 (Vapulus, 2019). The value of mobile POS (Point of sale) transactions in the period from 2017 to 2023 is expected to have an annual growth rate of 28.1% which will result in a total of 2,137,510 million US $. Also, the number of users is expected to reach 1,657,2 million by 2023 (Statista, 2020).

2.1. Electronic banking market in the Republic of Serbia

Many authors have analyzed state of electronic banking in Republic of Serbia (Hadžić & Mladenović, 2014; Vuksanović & Tomić, 2014; Simović, 2015). The electronic banking market in Serbia has been developing since 2003, but has progressed slowly compared to the countries of the region. Today, the situation is different than 5-6 years ago. It is noticeable that e-banking is becoming more prevalent, ATMs have become a common occurrence, although people are still skeptical and view novelties with a dose of scepticism. This type of banking is most often used to "withdraw" money from accounts and make payments (Todić & Dajić, 2017). Electronic banking in our country is growing year on year. According to the analysis at the internal level, which includes a review of the state of domestic electronic banking for 2019, the number of payment service users who have opened a checking account for the fourth quarter is 8,696,114. Internet payment was used by 2,748,395 users in the fourth quarter, while 1,702,767 users used mobile payment services in the same quarter (National Bank of Serbia, 2019).

3. METHODOLOGY

The research of the electronic banking market in Serbia was conducted through an anonymous survey which contained a series of open and closed-ended questions. The survey included 420 respondents who gave answers to 21 questions, which are structured in three parts. The first part referred to the demographic structure of the respondents, the second to internet payments and the third to electroni

c banking. The percentage of respondents who are from the territory of Vojvodina is 95% and the remaining 5% are from other areas of the Republic of Serbia. Respondents answers were processed in MS Excel by developing a nxn matrix (where n is the number of responses in the survey). The matrix is shown in Figure 3. The answers to the questions were treated as characteristics of the respondents. The elements on the diagonal of the matrix represent the total number of answers to the nth question. The elements to the left and right of the element on the diagonal represent the number of answers that is directly related to the nth answer of the respondents. In this way, the causality of all characteristics of the respondents was determined. Additionally, for each answer (characteristic) in the columns, aside from the value on the diagonal, the highest number of occurences can be determined as well as the connection with the characteristic that generates it.

Answers, which could not be numbered, are not considered in this table. The methods used in the research are method of description and method of classification. The paper identifies problems and opportunities for further development of the electronic banking market, as well as the importance of educating the population for faster and easier realization of business activities. In addition to the above methods, a decision tree was used as a tool for decision analysis and decision support, which showed the possible outcomes of the user education plan.

		M	Ž	A	B	C	D	E	F	DA	NE	A	B	C	D	E	F	G	H	A	B	C	D	E	DA	NE	DA	NE	A	B	C	D
M		199	0	65	43	47	26	11	7	146	52	17	19	21	15	7	35		48	91	26	67	11	4	196	3	148	51	41	35	71	48
Ž		0	221	60	56	33	31	22	18	132	88	36	17	14	8	12	27		72	114	38	45	19	4	207	13	151	70	40	41	57	81
A		65	60	125	0	0	0	0	0	46	79	10	7	4	7	3	12		76	73	16	35	0	0	123	2	98	27	47	23	21	33
B		43	56	0	99	0	0	0	0	84	15	15	8	16	8	3	12		13	33	18	30	18	0	94	5	85	15	16	29	41	14
C		47	33	0	0	80	0	0	0	76	4	13	10	10	5	5	22		6	30	14	21	11	4	77	3	56	24	11	9	35	23
D		26	31	0	0	0	57	0	0	52	5	8	8	4	2	5	9		4	29	9	18	1	0	57	0	37	20	2	11	20	24
E		11	22	0	0	0	0	33	0	18	14	5	3	1	0	3	6		11	23	2	6	0	2	33	0	16	17	2	4	10	17
F		7	18	0	0	0	0	0	25	2	23	2	0	0	1	0	1		10	17	5	2	0	2	19	6	7	18	3	0	1	18
DA		146	132	46	84	76	52	18	2	278	0	51	34	35	21	18	57		4	109	42	90	28	8	270	8	212	67	43	58	111	64
NE		52	88	79	15	4	5	14	23	0	140	2	2	0	2	1	4		116	96	22	21	2	0	132	8	86	54	38	18	16	65
A		17	36	10	15	13	8	5	2	51	2	53	0	0	0	0	0		2	12	9	17	8	7	53	0	45	9	6	10	29	9
B		19	17	7	8	10	8	3	0	34	2	0	36	0	0	0	0		2	10	8	15	3	0	34	2	24	12	7	7	11	11
C		21	14	4	16	10	4	1	0	35	0	0	0	35	0	0	0		0	12	8	13	1	1	31	4	24	11	6	8	13	8
D		15	8	7	8	5	2	0	1	21	2	0	0	0	23	0	0		1	2	0	14	6	0	23	0	20	3	6	4	12	1
E		7	12	3	3	5	5	3	0	18	1	0	0	0	0	19	0		1	13	2	4	0	0	18	1	13	6	3	2	6	8
F		35	27	12	12	22	9	6	1	57	4	0	0	0	0	0	62		3	36	8	13	5	0	62	0	43	19	14	14	19	16
G																																
H		48	72	76	13	6	4	11	10	4	116	2	2	0	1	1	3		120	82	17	20	1	0	117	3	74	46	34	17	12	57
A		91	114	73	33	30	29	23	17	109	96	12	10	12	2	13	36		82	205	1	0	0	0	190	15	127	78	48	36	31	84
B		26	38	16	18	14	9	2	5	42	22	9	8	8	0	2	8		17	1	64	0	0	0	63	1	43	21	10	14	19	21
C		67	45	35	30	21	18	6	2	90	21	17	15	13	14	4	13		20	0	0	112	0	0	112	0	93	20	18	19	55	21
D		11	19	0	18	11	1	0	0	28	2	8	3	1	6	0	5		1	0	0	0	30	0	30	0	28	2	3	7	17	3
E		4	4	0	0	4	0	2	2	8	0	7	0	1	0	0	0		0	0	0	0	0	8	8	0	7	1	1	0	6	1
DA		196	207	123	94	77	57	33	19	270	132	53	34	31	23	18	62		117	190	63	112	30	8	403	0	295	109	78	76	128	121
NE		3	13	2	5	3	0	0	6	8	8	0	2	4	0	1	0		3	15	1	0	0	0	0	16	4	12	3	0	0	8
DA		148	151	98	85	56	37	16	7	212	86	45	24	24	20	13	43		74	127	43	93	28	7	295	4	299	1	75	73	119	30
NE		51	70	27	15	24	20	17	18	67	54	9	12	11	3	6	19		46	78	21	20	2	1	109	12	1	121	7	3	9	100

Figure 3: Survey response matrix

This achieves clarity of potential results of possible outcomes, where the best outcome is the one that enables the inclusion of the largest number of users, and the worst is the one that leads to failure i.e. stopping the education program.

4. RESULTS

In a sample of 420 respondents, 221 females (53%) and 199 (47%) males were recorded. Most of the respondents were 25 years old or younger (30%), between 25-35 (24%), between 35-45 (19%), between 45-55 (14%), between 55-65 (8%) and 65 and older (6%). Professional qualifications level of the respondents is presented in Figure 4, and the job sector of the employed respondents in Figure 5. It can be seen that the largest number of respondents have a high level of education (49%). A large number of the unemployed within the surveyed sample (35%) is also obvious.

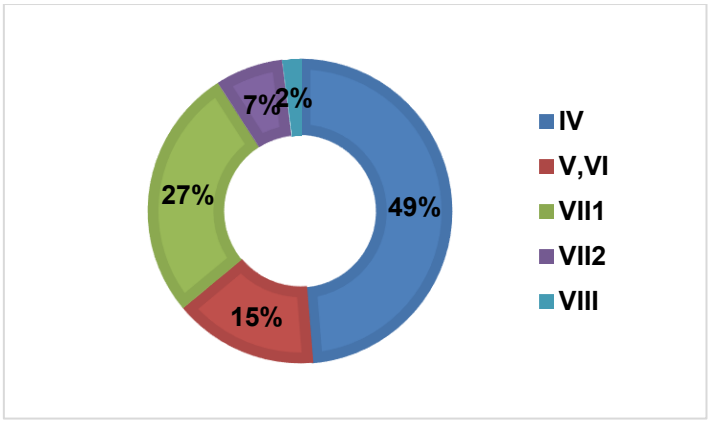

Figure 4: Professional qualifications level

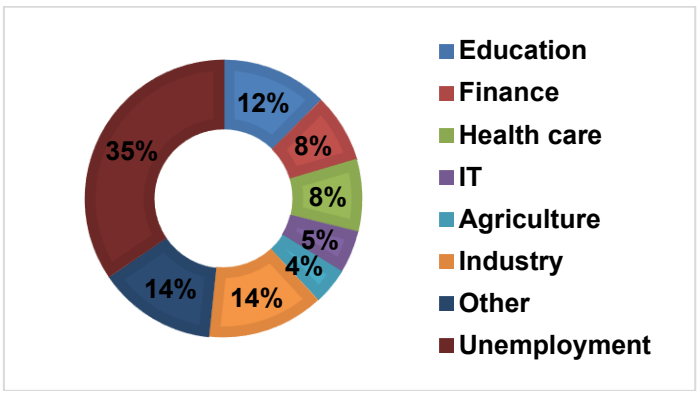

Figure 5: Job sectors of the respondents

4.1. The causality of unfavourable responses and demographic structure

Through the analysis of the entire survey the questions of interest were identified, the answers to which were used to define the problem of underrepresented electronic banking. The questions of interest are:

- Have respondents heard about online payments?
- Do they think that paying online is better than paying over the counter?
- Are respondents sufficiently informed about payment by credit cards?
- What did they point out as the main disadvantage of electronic banking?
- Which problems have they experienced when using electronic banking services?

For this segment of the analysis, only unfavorable answers of the respondents within these selected questions were used. Adverse responses were analyzed from the aspect of demographic structure, in order to determine the cause-and-effect relationships in the responses.

- **When asked if respondents had heard of online payments:** 96% said yes and 4% said no. Among the respondents who have not heard of online payments, there is a higher number of women. The negative answer is most common in the population older than 65, while the majority of respondents have a secondary education.
- **When asked if they think that paying online is better than paying over the counter:** the negative answer was given by 121 respondents. A large number of respondents who responded this way are female. Groups up to the age of 25 and between 35-45 responded identically. Mostly unemployed respondents responded negatively, and most of the respondents have secondary education.
- **When asked whether they were sufficiently informed about online payments:** The answer that they were insufficiently informed was mostly given by men, followed by groups of respondents up to 25 years, 25 to 35 and 35 to 45 years. The respondents who gave this answer are mostly employed and have a high school diploma.
- The answer that they were not informed about this type of payment at all, both men and women gave in approximately the same percentage. This answer is most common in the population younger than 25 and in those older than 65.
- **The answers to the question 'What are the main shortcomings of electronic banking?'** are given in Figure 6. It can be concluded that users mostly avoid this type of banking due to possible abuse, which was the most common answer among the respondents.
- **The answers to the question of which problems users had when using electronic banking** are given in Table 1. The answers to this question were open-ended. Unique answers are shown and highlighted in Table 1.

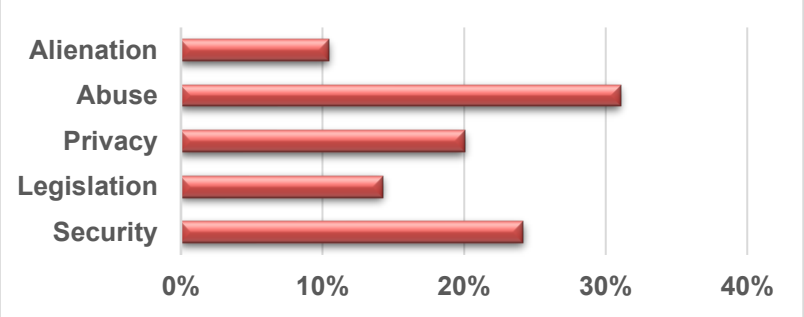

Figure 6: Shortcomings of electronic banking

Out of these shortcomings of electronic banking, the most obvious is abuse, followed by a lack of security. These are the segments that most often cause users to avoid this type of payment. Paying attention to the overcoming of the shortcomings identified by respondents in this study is recommended.

Electronic banking benefits everyone (Cardno Emerging Markets USA, 2018). However, there are challenges that need to be overcome that have been identified by the analysis. By solving them, it is possible to include a larger number of users in electronic banking systems. The causal method concluded that the level of education, as well as the age of the respondents, influence respondents' willingness to use these systems. In this way, groups that should be motivated to be included in these systems were profiled. This can be achieved through education in the form of various training programs, technical support and tempting offers for new users, all within existing banking systems. As an increase in the number of users who accept new ways of paying for goods and services is recorded, it becomes profitable to adapt to new technologies.

Table 1: Problems users had when using electronic banking

Problems users have when using electronic banking
1. Double bank transfer
2. Unresponsive system
3. Forgotten password
4. The seller's company continues to deduct payments because the user did not notice that this option was activated
5. Delayed execution of the order
6. Software issues on smartphones, being totally dependent on having a smartphone and it working correctly
7. Site not working on occasion
8. Checking account balance
9. Failed transfers from domestic to foreign currency account

In addition to the problems and shortcomings mentioned by the users in the survey, they also commented on the advantages they see in electronic banking systems. These advantages are presented in Figure 7. From the graph it can be concluded that the main advantages are time saving and independence from the place where the work can be done in this way.

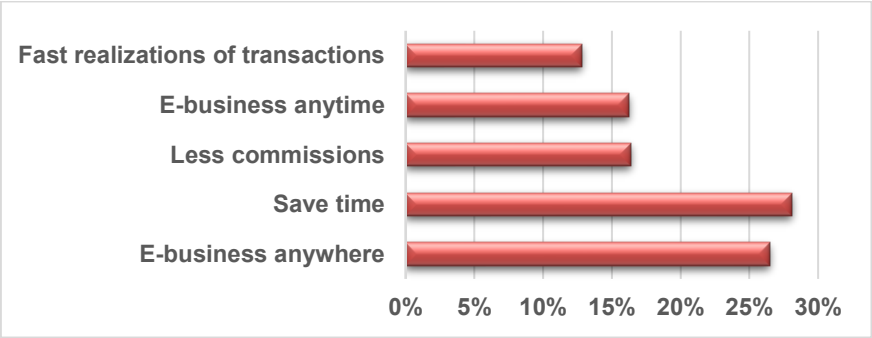

Figure 7: Advantages of electronic banking

Also, another way to attract users to e-banking, in addition to education, technical support and others, are the experiences and personal recommendations of people who already use these services and who emphasize the many advantages. In this way, future users gain more confidence in the reliability and security of a system with which they do not have enough, or have no experience at all.

5. ESTIMATION OF THE NUMBER OF USERS OF THE ELECTRONIC BANKING SYSTEM USING DECISION TREE

Based on the previously adopted conclusions concerning education, in order to increase the number of users of electronic banking, decision tree method was used. The tree was developed from left to right (Figure 8). From the left-most point, which represents the node of the decision, there are two branches concerning education and the absence of education.

Depending on the probability, branches are described as having a high, medium or low outcome. Table 2 presents the expected values with the corresponding probability level, but also the possible outcomes - the number of new users who have joined the electronic banking systems due to training programs. The probabilities in each of the nodes were assigned empirically. The average number of new users in a year was estimated based on data from the National Bank of Serbia (National Bank of Serbia, 2019).

Table 2: Outcome estimation with corresponding probability values

Expected utility	Probability	Number of new customers
High	0,2	400,000 per year
Middle	0,5	350,000 per year
Low	0,3	200,000 per year

If no education is provided, it is estimated that the number of new users will be significantly lower (7000). Education can be successful (probability 0,7) and unsuccessful (0,3). If failure occurs, there are two options: to suspend the training program temporarily or permanently, or to redirect planned resources to another project. If successful, the education project can be very, moderately and less successful. A very successful project with a probability of 0,2 has an estimated number of new users of 400,000, moderately successful project a probability of 0,5 and 350,000 new users and the least successful one a probability of 0,3 and 200,000 new users.

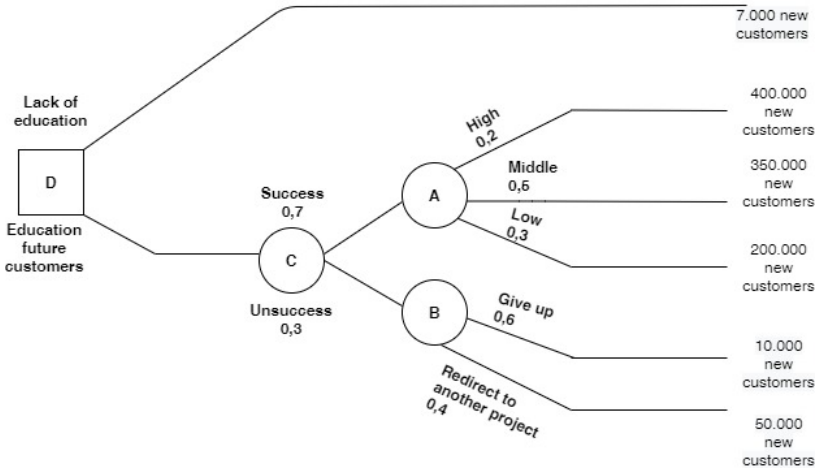

Figure 8: Decision tree

After defining the outcome points and the probability of each individual success on the decision tree, the expected value in each of the nodes (A, B, C) was calculated.

Expected value in node A: E(A) = (0,2*400,000)+(0,5*350,000)+(0,3*200,000)=315,000 new users (1)

Expected value in node B: E(B) = (0,6*10,000)+(0,4*50,000)=26,000 new users (2)

Expected value in node C: E(C) =(0,7*315,000)+(0,3*26,000)=228,300 new users (3)

Based on the obtained results, it can be concluded that the probability of success in node A is the highest, ie. that in that node the number of newly incorporated users is the most noticeable.

The decision tree is easy to understand and interpret. When defining a specific situation (informing/educating users), alternatives, probabilities and preferences of outcomes are defined. For a more detailed analysis, nodes - decision points, as well as the outcomes arising from them can be added.

6. CONCLUSION

In the analysis of the electronic banking market in Serbia, incentives for the inclusion of a larger number of new users have been identified. The causal method concluded that there is a connection between the demographic structure of the respondents and the utilization of resources. By analyzing the advantages and disadvantages of electronic banking, one can get a better understanding of the popularity of this type of payment with certain groups of respondents. These results help to see the real picture and take corrective action to improve the situation in this segment. In developed countries, this type of payment is seen as a way of including the poorest in banking systems. To change the current situation, the identified shortcomings should be eliminated in order to ensure the trust of users in the functioning of electronic business. This aspect is especially pronounced during a state of emergency when users have limited movement and there is no possibility to pay for products and services in cash. The decision tree shows the importance of educating users through the outcomes expressed through the potential number of new users. Future research should focus on a more detailed analysis of cause-and-effect relationships between attributes and the causal method in general.

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THE ROLE OF ERP IN DIGITAL TRANSFORMATION: A USER PERSPECTIVE

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Abstract: *Enterprise Resource Planning (ERP) systems have attracted an immense attention of both scholars and practitioners worldwide. A number of studies have examined the phenomenon of ERP acceptance by adapting the technology acceptance models. This study attempts to add to the current body of knowledge by examining the adoption of ERP among Serbian financial professionals. For this purpose, primary data were collected using a questionnaire as a research tool. In total 82 financial professionals were examined on the acceptance factors for a specific financial module of an ERP system. As the results of research indicate perceived usefulness and perceived ease of use are significant predictors of users' intention to use ERP software while enjoyment has no statistically important contribution to this decision.*
Keywords*: digital transformation, ERP, cloud computing, technology acceptance*

1. INTRODUCTION

Digital transformation (DT) is a multifaceted phenomenon which comes in many different forms. According to Horlacher et al. (2016), DT represents the use of new digital technologies, such as social media, mobile, analytics or embedded devices, in order to enable major business improvements like enhancing customer experience, streamlining operations or creating new business models. DT is the extended use of advanced IT, such as analytics, mobile computing, social media or smart embedded devices, and the improved use of traditional technologies, such as enterprise resource planning (ERP), to enable major business improvements (Chanias, 2017).

ERP systems have attracted an immense attention of both scholars and practitioners worldwide. For some scholars ERP systems are even "the core of every firm" (Costa et al., 2016). Most of the concurrent studies have been focused on the functionality, cost efficiency (Chang & Hsu, 2019) and outcomes (i.e. Weli, 2014; Zerbino et al., 2017) of the ERP usage. Modus operandi has been within the range of scholarly research radars, but the "human" side has been a heavily neglected topic. Only a handful of studies examined the acceptance of a specific ERP system (see Widjaja et al., 2018; Claybaugh et al., 2019; Handoko & Prianto, 2020). As for the geographical context of the study, only a paucity of research related to fintech adoption has ever been conducted in Serbia (i.e. Milosavljevic, Joksimovic & Milanovic, 2019).

This study seeks to add to the current body of knowledge in ERP adoption. The aim of the study is to examine behavioral intention of financial experts (mainly accountants) to use a specific ERP module for financial controlling. By way of utilizing a Technology Acceptance Model, initially developed by Vankatesh et al. (2003), the specific goals of the study are to examine how perceived usefulness, ease of use and enjoyment affect behavioral intention to use a specific ERP module.

The remainder of this paper is organized as follows. Section 2 explains the functionality of ERPs and draws on the main reasons for the implementation of ERPs. Section 3 explains the methodology used in the study. Section 4 depicts the main results and tests the hypotheses. The final section of the paper is reserved for discussion and conclusions.

2. RELATED WORKS ON ENTERPRISE RESOURCE PLANNING

As the company develops, the existing information and accounting systems start to expose their limitations. A simple software, that has been sufficient to handle business operations so far is now not able to process, store and provide accurate data since business relations between the company and its stakeholders have been multiplied. In addition, business analytics become more complex and requires more detailed sets of data. The possible solution may be to upgrade the existing accounting software or to integrate it with

available online systems. However, most likely this will not provide the stable and sustainable information system in the long run.

Business development and market forces are pushing companies into internal IT transformation. This means that the accounting system must evolve into a comprehensive business solution that is able to manage financials, automate and secure supply chains and production, improve the customer service, enable project management and payroll. The advanced information system must provide all necessary data in order to streamline the company's daily activities.

Enterprise resource and planning is "a software package composed of several modules that uniquely provide cross-functional integration through embedded business processes and customizable options for answering specific needs of each organization" (Menon, 2019). Grabski, Leech & Schmidt (2011) state that "ERP systems are typically the largest, most complex, and most demanding information systems implemented by firms, representing a major departure from the individual and departmental information systems prevalent in the past."

According to Hossain (2001), ERP evolution can be described through multiple stages. At early stage of development, during the 1960s, companies focused on inventory management. During the 1970s, new computing modules were developed with the aim to increase efficiency of internal planning. At this point of time, inventory management needed to be aligned with the master production plan. During the next decade, the production process was additionally improved and, finally, in the 1990s, the ERP system was developed as the integration of many business processes throughout the organization. Extended ERP is developed at the beginning of the 20th century. Vendors designed many features and addons that deal with specific business segments like customer relationship management (CRM) or supplier relationship management (SRM) systems.

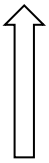

Table 1: ERP evolution

2000s	Extended ERP
1990s	ERP
1980s	Manufacturing resource planning (MRP phase II)
1970s	Manufacturing resource planning (MRP phase I)
1960s	Inventory control packages

Source: Hossain, L. (Ed.). (2001). *Enterprise Resource Planning: Global Opportunities and Challenges: Global Opportunities and Challenges*. Igi Global, p. 18

There is no ERP solution that fits for all companies. The choice of a certain ERP solution depends on a company size, complexity of business operations and the quality of expected data. Panorama consulting (2020) categorizes ERP systems, available on the market, into 4 groups:

Table 2: ERP categorization

TIER I	ERP Systems suitable for companies with above $750 million in annual revenues. Those companies have very complex business operations and versatile product or service mix. Tier I ERP solutions must be able to address multiple industries and very complex organizations.	SAP S/4 HANA, Oracle Cloud Apps, Infor M3, Infor LN
UPPER TIER II	ERP Systems suitable for companies with $250 million to $750 million in annual revenue. Similar to previous group, those companies are very complex and they are involved into multiple business lines. Still, the level of business complexity is below previous group.	Microsoft dynamics 365 for Finance and Operations, IFS, Sage, Enterprise Management
LOWER TIER II	ERP systems suitable for companies with $10 million to $250 million in annual revenue. Those companies may be involved into single business line and may not belong to the group of related parties. Consequently, there may not be any need for business or financial consolidation.	Microsoft Dynamics 365 Business Central. SYSPRO, Acumatica, Net Suite, Plex, IQMS
TIER III	ERP systems suitable for small companies. Those solutions may be used as the only information system in the company or to supplement some of previously mentioned ERP systems.	Sage ERP 100, Sage ERP 300, Aptean, ECI, ASC.

Source: Panorama consulting group. (2020). The 2020 ERP Report.

2.1. Cloud enterprise resource planning

Cloud enterprise resource planning (CERP) has become very popular in recent years. Vendors are substantially investing in the development of new cloud solutions. For instance, Microsoft ERP solutions are

re-designed to be run in the cloud (Azure) technology. The other vendors are offering similar solutions (SAP, Oracle, SAGE etc.). The possible benefits of cloud computing are (Abd Elmonem, Nasr & Geith, 2016; Gupta et al., 2019):

1. *Cost effectiveness:* The company may create significant savings on investments in IT infrastructure since the whole necessary infrastructure is owned, managed, maintained and upgraded by cloud provider.
2. *Infrastructure optimization:* On premise software solutions may require costly hardware whose potential and working capacity may not be fully utilized by the company.
3. *Flexibility:* There is no need for immediate investments into functionalities and resources that are not needed at the moment. The company has flexibility to pay for additional features only when they are needed. If certain feature is no longer needed, the company may simply stop using. This has a positive impact on company business profitability.
4. *Better system speed and performances:* With stable internet connection, it is expected that response time of CERP should be much better compared to 'on premise' ERP. Also, system performances will not be deteriorated by the increasing amount stored and processed by the system (Peng et al. 2014).

Depending on the current stage in the life cycle, existing assets and data security preferences, the company may choose between (Ruivo, Rodrigues & Oliveira, 2015; Gupta & Misra, 2016):

1. Cloud only solution where ERP is run exclusively in the cloud without any connection with existing on premise systems or other physical resources owned or rented by the company. The main advantage of this solution is that the company does not have to own or maintain IT infrastructure that is needed for normal ERP workflow. Cloud only solutions may be suitable for start-ups and companies that are at early stage of their development since priority for them is to invest into business lines, product development and market research instead of investing into expensive hardware and software. In addition, the capacity of hardware cannot be reliably estimated as its necessary capacity will depend on business development.
2. Hybrid on premise and cloud model that allows the company to share resources between on premise and cloud. In this case, cloud solutions may offer functionalities that are not provided by existing, on premise infrastructure. Furthermore, the companies are usually willing to keep some confidential data on premise instead to store them in cloud.

CERP is generally cost-beneficial for organizations looking to reduce implementation costs and this may be one of the reasons that more than half of organizations (62,7%) are using CERP instead of traditional, on – premise, option (Panorama Consulting Group, 2020). Except cost saving, Gupta et al. (2018) found that cloud based EPR has positive impact on big data predictive analysis, operational and market performances of the company meaning that CERP may create competitive advantage among competitors.

2.2. ERP and digital transformation

According to Digital transformation framework (Matt et al. 2015), four dimensions of digital transformation strategies are:

1. Use of technologies. This dimension refers to the company's willingness and ability to exploit benefits of new technologies.
2. Changes in value creation. The traditional value chain should be changed under the influence of new technologies. This means that digitalization of products and services allows the company to penetrate new markets and target new customer groups.
3. Structural changes. Introduced digital activities must be adequately managed within the organization. Depending on the complexity and impact of digital transformation activities, it may be suitable to incorporate them into existing organization or to establish a completely new organizational unit. Except for variations in the organizational setup, three additional structural requirements are identified by Murawski et al. (2019): culture of change, agility of organizational structure and integration of cloud computing and platforms.
4. Financial aspect. Digital transformation requires investments into tangible and intangible assets including human resources. The company must be able to finance digital transformation.

The digital transformation strategy that is clearly defined creates solid ground for digital transformation. During the process of the strategy implementation, all participants should be provided with clear and timely information in order to run the whole process more easily.

2.3. Hypothesized model

ERP implementation is not a simple task. There are many obstacles that should be overcome to achieve a successful ERP implementation. Critical success factors of ERP implementation have been investigated by numerous authors (Amini et al. 2013, Kiran et al. 2019, Sternad et al. 2010, Mahraz et al. 2020). One of the

important factor for successful ERP implementation is users' acceptance of new software and consequently their intention to willingly use it.

Intention to user ERP may be defined as "behavioral intention of the end users of an organization to use the ERP system within and organizational setting and subsequently refers to the actual use of that ERP system" (Soliman et al, 2019). Depending on end users' perception of ERP functionalities, their behavioral intention to use it may differ and may create a high barrier for ERP implementation and digital transformation of the company.

In this paper, we are following the approach used by Van der Heijden (2004), which is, in a grand scheme of things, inspired by motivational theory (Deci, 1975). According to this approach, three important determinants of end users' intention to use the system are perceived usefulness, perceived ease of use and enjoyment.

Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). The perceived ease of use refers to main functionalities of the ERP system and how easily it can be used on recurring basis by end users. Enjoyment may be described as the extent of fun that may be associate with ERP usage. Based on those three dimensions and their expected role during ERP implementation and company digital transformation, research hypothesis is defined as:

Hypothesis 1: Perceived ERP usefulness, perceived ease of use and enjoyment are statistically important determinants of users' behavioral intention to willingly use ERP.

3. METHODOLOGY

3.1. Research instrument, variables and measures

The study was based on a primary data using questionnaire as a research instrument. The questionnaire was based on a validated technology acceptance model inspired by Vankatesh et al. (2003) and validated by other authors (Van der Heijden, 2004; Shih & Huang, 2009; Milosavljevic, Joksimovic & Milanovic, 2018). The questionnaire was structured into five parts. After the demographic part aimed at collecting data on examinees and organizations they have been working for, the next four parts were aimed at collecting data on four variables (one independent, two dependent-independent and one independent). All the variables were multidimensional and measured on a one to five Likert-type scale.

The independent variable was Perceived Ease of Use. The construct was 5-itemed and developed based on Shih & Huang (2009) [individual inquiries were: a) Learning the ERP module is easy for me, b) ERP module does exactly what I want,cb) The ERP function is clear and understandable, d) ERP module is flexible to interact with, e) It is easy to become skillful at using ERP module]. The first dependent-independent variables was Perceived Usefulness. The construct was adapted based on Shih & Huang (2009) and had four inquires measured [<ERP> module would: a) enable me to accomplish tasks, b) improve my job performance and increase my productivity and effectiveness, c) make it easier to do my job, and d) is useful in my job]. The second dependent-independent variable was Perceived Enjoyment was rewarded from Milosavljevic, Zarkic Joksimovic & Milanovic (2018). The independent variable was Behavioral Intention to use ERP financial controlling module inspired by Van der Heijden, 2004 (with two items – intention to use and intention to purchase ERP module). The complete questionnaire is available upon request from authors.

3.2. Sampling procedure, data collection and data processing

The examinees were professional attending seminars on financial controlling. The attendees of the seminars were business professionals who work in financial controlling or similar organizational units in Serbian companies. Data was collected in the second half of 2019.

Data was entered into IBM's Statistical Package for Social Science and analyzed accordingly. For the descriptive statistics, the study used means and standard deviations. For the reliability of constructs (variables) the study used Cronbach's Alpha. The testing of interdependence was based on a Pearson moment two-tailed correlation analysis. Finally, hypotheses testing was run using the regression analysis.

4. RESULTS

4.1. Sample features

The total number of examinees was 82. Most of them work in private sector (> 80%) and above 76% of them have working experience more than 15 years. The sample description according to the ownership of

organization where examinees work and their working experience is presented on pictures 1 and 2, respectively.

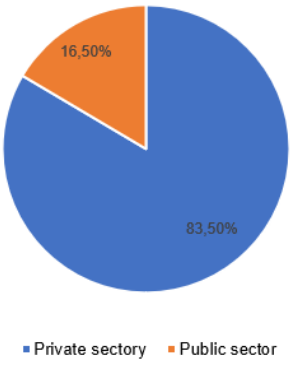

Figure 1 Employer ownership structure

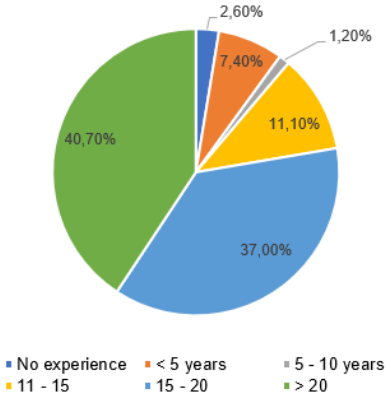

Figure 2 Working experience

4.2. Pre-analysis

Prior to testing the hypotheses of this study, pre-analysis was conducted. For this purpose, reliability, means and standard deviations were tested. Afterwards, a correlation analysis was conducted in order to statistically test the interdependence of variables. The results are shown in the following table.

Table 3: Sample correlation analysis

Variable	Mean	STD	CA	1	2	3	4
Perceived Usefulness	3.40	.98	.78	1	.151	.015	.523**
Perceived Ese of Use	3.00	.94	.71		1	.395**	.432**
Enjoyment	3.45	.83	.84			1	.278**
Behavioral Intention	3.42	1.12	.54				1

*Correlation is significant at the 0,05 level (2 tailed test)
**Correlation is significant at the 0,01 level (2 tailed test)

According to value of Cronbach's alpha (CA), internal consistency of questionnaire is satisfactory (values above 0,70) except for questions regarding examinees intention to use the ERP (Taber, 2017). The reason for this is that questioner related to behavioral intention has only two items and CA almost always underestimates true reliability, sometimes rather substantially (Eisinga et al., 2012).

4.3. Hypotheses testing

The hypothesis testing is based on multiple regression model that may be presented with following equation:

$$BI = B_0 + B_1 * PU + B_2 * PEU + B_3 * E + \varepsilon$$

Where:

- BI – Behavioral intention (dependent variable),
- PU – Perceived Usefulness (independent variable),
- PEU – Perceived ease of use (independent variable),
- E – Enjoyment (independent variable),
- B_0 – Constant term,
- B_1, B_2 and B_3 – regression coefficients, and
- ε – error term.

Based on the above equation, our model has one dependent variable and three explanatory variables. The analysis has been done using SPSS statistical software. The summary of the model is shown below.

Table 4: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,635[a]	,403	,376	,88818	1,939

Based on R square value, the regression model explains 40% of the variance in dependent variable (Table 3). The significance of regression model explanatory power is confirmed by results of ANOVA analysis (Table 4). According to ANOVA analysis, the overall regression model is significant, F(3,67) = 15,0600, for significance level P < 0,001.

Table 5: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35,640	3	11,880	15,060	,000[b]
	Residual	52,853	67	,789		
	Total	88,493	70			

While previous analysis confirmed the overall explanatory power of regression model considering the whole set of three independent variables, the analysis of the multiple regression model i.e. statistical test of regression coefficients explains the explanatory power of each independent variable on standalone basis. The results of the statistical test are presented in Table 6.

Table 6: Multiple regression results

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-,185	,584		-,317	,752
	Perceived Usefulness	,542	,113	,457	4,799	,000
	Perceived Ease of Use	,358	,123	,303	2,906	,005
	Enjoyment	,198	,133	,154	1,492	,140

The p value for each of the tests is present in the last column in Table 6 (Sig. column). Analyzed at significance level of 0,05 it can be concluded that perceived usefulness and perceived ease of use are significant predictors of users' intention to use ERP software while enjoyment has no statistically important contribution to this decision.

5. DISCUSSION AND CONCLUSION

5.1. Key findings, contributions, and implications

The aim of this study was to determine the most influential factors affecting behavioral intention to use financial modules of an ERP. For this purpose, we examined 82 financial professionals in Serbia. The most important determinant for end users' behavioral intention to use ERP is perceived usefulness and perceived ease of use. This finding is in line with previous studies from other geographical regions (see: Amoako-Gyampah & Salam, 2004; Bhattacharya, Wamba, & Kamdjoug, 2019). Enjoyment has no statistically significant influence on end user's decision. This means that, when deciding between various ERP solutions, the company prioritizes usefulness.

This result is grounded in common sense since one of the goals of ERP implementation should be improvement of employees' performances. This will contribute to improvement of employees' productivity allowing them to complete everyday working tasks with minimal effort. A number of studies have hitherto confirmed positive impact of ERP on work performance (Gupta et al., 2019) and generally work environment (Pham, Misra & Ahuja, 2019).

In addition, ease of use is another important factor due to the fact that end users are favoring simple and user-friendly solutions. This has already been confirmed in previous scholarly studies (Hwang & Grant, 2011). The possible explanation may be that ease of use reduces possibility of mistake and provides ease extraction and control of data stored in ERP.

5.2. Limitations and further recommendations

Being quantitative by nature, this study has numerous flaws. First. The study is based on a small sample which might affect the generalizability of the findings. An avenue for further research is the replication of the study outside the realm of financial professionals and examination of other ERP modules and their acceptance. Second, the set of independent and dependent variables has been selected on the basis of previously confirmed models. Future studies should be focused on incorporation of additional variables which

can affect the behavioral intention of users to procure and use financial modules of various ERPs. Third, this study is based on perceptions, rather than objective data related to the factors affecting willingness to use financial modules of ERPs. Finally, this study is cross-sectional by nature. The phenomena examined in the study – financial technology acceptance – is rather dynamic. Thus, a new stream of research could be based on time-series and accordingly capture evolutionary characteristics of ERP acceptance.

5.3. Concluding remarks

Accountants and financial professionals have had several technology-based (r)evolutions in recent decades. For the professions with a centuries-long tradition, recent years have made massive changes in the professional realm. A number of studies have tackled the issue of technology acceptance among accounting and finance professional. This study adds to the concurrent body of knowledge by indicating that perceived usefulness of ERP solutions may play pivotal role for ERP acceptance by its prospective users. Having in mind numerous barriers for successful ERP implementation, the results of this research may be used to design an ERP implementation process that will have more chances for success. If end users believe that ERP brings them benefits in terms of enhanced job performances, they will not be reluctant to software change. It means that all ERP functionalities and their purpose have to be clearly presented to future users in order to facilitate ERP acceptance at early stage of implementation process.

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ACCOUNTING IN DIGITAL ENVIRONMENT

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Abstract: *Information technologies and their improvements have a great impact on accounting. From information producers such as accountants and auditors, information technologies are moving them towards consumers of information: creditors, investors, customers, suppliers and other users of information. Modern information technologies provide timely, reliable and relevant information to all current and potential users. Digital accounting and artificial intelligence in the contemporary conditions have a great effect on everyday business.*

Keywords*: accounting, financial reporting, digital accounting, e-accounting, XBRL*

1. INTRODUCTION

Globalization brings with it various challenges for strategy and economic policy makers, as well as for the accounting profession, among other things. Globalization has conditioned the development of new information technologies that provide faster and higher quality level information in the function of business decision-making. At the beginning of the twentieth century, the industrial economy was transformed into a network economy based on human knowledge, information technology and faster connectivity. The company's operations are significantly affected by a constant reduction of operating costs, greater efficiency, significant increase in productivity, implementation of new information technologies, new organizational models of the company and its constituent segments, as well as new effects of interest to both domestic and foreign markets. It is important to mention that, in addition to the already known classical factors of production, information also appears as a new, very important factor in the production cycle.

That is why accounting in such an environment is transforming by changing its role and significance. With the support of modern information technologies, the collection, creation, analysis and presentation of information has been facilitated and accelerated. There is more and more discussion about the accounting of the future about the so-called e-accounting, because it becomes the pillar of the economy and the language of business. This changed role of accounting requires from the accountant a lot of sophisticated skills, such as: the ability of managers, the ability of financial analysts, the distinction between financial and non-financial data, which are increasingly expressed, to have a penchant for entrepreneurship, to have a penchant for running a business, propensity for strategic planning, to have a propensity for financial modeling, etc.

The rapid growth of information technologies is evident, both in the world globally and in almost all countries. According to its traditional system, the accounting profession was established at the end of the Middle Ages, but it improved and followed the trends of the world order. Computerization has brought the most visible shift in the system of data entry and processing, so that from the process of data entry based on documentation, to the creation of final products, a much shorter time distance is absorbed. Computerization in this discipline also unequivocally guarantees speed. In any case, increasing the speed does not mean reducing the quality, on the contrary. As Polić (2011) states - information technologies increase power from producers, which is the role of accountants, to consumers of accounting information or final products in the form of financial reports, which include investors, creditors and other members of the business community.

When it comes to the accounting profession, there is a permanent demand for relevant, reliable and timely information, and the quality of these can be affected by the system of electronic business in this area, and the quality of modern information technologies. The development of information technologies has influenced the simplification of the accounting records process, and thus financial reporting. The transition from the traditional to the digital economy has conditioned the improvement of monitoring and implementation of business.

New ways of doing business in accounting, in addition to general improvement, opened the possibility of new ways of fraudulent actions, so it is clear that the order of innovations always brings with it good and bad

elements, with always a positive outcome if the benefit outweighs the negative elements. When it comes to the accounting profession, fraudulent activities are always interesting, which have been in the significant focus of research for the last two decades.

In any case, the electronic system conditioned the change of the system and the way of recording and reporting, and also conditioned the change of legal regulations, so that all new affirmative solutions would be legally enthroned. Those are Sarbanes Oxley Act in USA, SAS 99 (Statement on Auditing Standards No. 99: Consideration of Fraud in Financial Statement; XBRL (eXtensible Business Reporting Language); there are also modern solutions and tools ERP (Enterprise Resource Planning) in the form of information systems and CAATT (Computed Assisted Audit Tools and Techniques) audit tools.

Digitization represents the improvement of the functioning of the system, the reduction of paperwork to a minimum in phases, and the goal is to bring the functioning without paper / documents. This all implies that the entire documentation becomes digital. All these changes are supported by the new Law on Accounting of the Republic of Serbia, which was adopted at the end of 2019, and entered into force at the beginning of 2020. It is necessary to note that not all articles of the mentioned law have entered into force, but that their application will be successively revived.

The paper will present a retrospective of the development of information systems in accounting, accounting software and its reliability, XBRL standards and financial reporting, ERP information system, and future accounting and information risk.

2. RETROSPECTIVE OF DEVELOPMENT OF INFORMATION SYSTEMS IN ACCOUNTING

Market conditions in modern conditions pose challenges to managers to create a digital economy in which all business activities will undergo significant changes compared to the traditional economy. It is noticeable that the new electronic-digital business is constantly on the rise. (Polić, S. Krsmanović, B., 2008, p. 349). The beginning of the twenty-first century and the third millennium indicates that more and more people are entering IT businesses, and the changes also apply to accounting.

The company and its constituent segments, as well as managers, usually include an information system. An information system was created to meet specific information needs. The development of the information system went through several phases, namely: electronic data processing, management information systems, decision support systems, expert systems.

Electronic data processing (EDP) is in fact the automation of routine processing and transactions, i.e. events that have an impact on the company itself. Transactions were the first procedures to undergo automation in the company. This means that it is the automated collection, storage and processing of transactions that are often repeated. This way, the accuracy of the data in the company is ensured, as well as a high degree of timeliness is achieved. For the sake of illustration, for example, calculation of salaries, calculation of taxes, etc.

Management Information System (MIS) enables the preparation of regular, standardized reports with a longer-term purpose. Providing information for middle and senior management decision-making.The strong competition, significantly increased risk in business and decision-making are essential characteristics of modern market conditions in relation to information systems, they place more and more complex requirements. As a result of the mentioned MIS, the evolution of information systems took place, and the efficiency and quality of business increased with each new class of systems.

Decison Support System (DSS). These systems significantly facilitate decision-making, both semi-structured and unstructured through a single system. A combination of data, user-friendly software, is performed through complex analytical models. In addition to internal information and information processing systems, DSS also relies on external information in its analysis. DSS has a greater ability to analyze different alternatives. This is because the user can include various subroutines where there is a connection between different components.

The expert system (ES) is used in all areas. Its goal is to solve problems that require reasoning, recognition, comparison, new knowledge, i.e. to answer complex questions.

In the modern conditions of business globalization, accounting is extremely important. It presents information for recording transactions, for valuing resources, for efficient management, for business decision making and financial reporting. Accounting is a fundamental basis for effective business management.

Modern conditions require efficient data processing from accounting, online way of working, modern databases. It should provide information of appropriate quality and quantity to a multitude of different users. Financial reports have been displayed online already a certain period. This information is used in business negotiations with business partners to make business decisions.

The modern way of processing transactions is complex database processing. The process should incorporate elements of the business environment, then financial data, marketing data, and production and employee data. The data is then generated and created in the form of custom reports. Modern electronic data processing enables up-to-dateness, comparability, and objectivity of information.

3. ACCOUNTING SOFTWARE AND ITS RELIABILITY

In modern conditions, data processing on a computer largely depends on the accounting software used in the company. Accounting software in order to be maintained within and outside the national framework is necessary to meet the minimum standard requirements for data processing and preparation of financial statements. Standard JRS 33 - accounting software is defined as “software product used for keeping business books, for compiling, presenting, submitting financial statements, as well as for internal and external audit. This standard was adopted in 1993 by the Association of Accountants and Auditors of Yugoslavia. It was first revised in 1998, and has undergone a large number of revisions so far (http://www.srrs.rs/savez/RSS%2033.pdf).

This standard is established by a professional organization of accountants in the country or adopted by a specific professional body appointed by the state. This standard records accounting software with its advantages, i.e. qualities: functionality, efficiency and productivity, security, protection of hardware and software, as well as qualifications and competence. *Functionality* implies the ability of accounting software to ensure the operation of its functions (data entry, updating data in files and databases, printing financial reports, etc.). Based on the accuracy, convenience and connectivity, the evaluation and functionality of the accounting software is performed. The relationship between software performance and the amount of resources used to measure an accountant's workload over time required to provide a variety of records, reviews, and financial reporting indicates greater or lesser *efficiency* and *productivity*.

Software *security* involves procedures built into protection. In other words, for the sake of illustration, it means preventing accidental or intentional destruction of data, hardware failure, preventing the entry of incorrect, illogical or incorrect data, etc. Security is closely related to the reliability of accounting software. The task of the user is related to the protection of *hardware* and *software*. It refers to adequate management of information protection in the company, physical protection, formation of backup copies.

The competence of staff and qualifications implies that only professionals who know enough about accounting software use the same, because only in this way can an accountant adequately plan, review and perform control.

In 2002, the International Federation of Accountants (IFAC) issued a study requiring management and accounting professionals to continuously monitor information technology innovations. (https://www.ifac.org/system/files/meetings/files/2820.pdf)

4. XBRL STANDARD AND FINANCIAL REPORTING

The main preoccupation of standard creators has become financial reporting via the Internet. The software tool for business reporting, the so-called XBRL, was introduced at the end of the twentieth century. This standard is considered much more efficient and reliable compared to the previous period. It is a unified extended language for business reporting and is essential for electronic distribution and comparison of business reports. It is actually a specially implemented advanced language for business reporting. The XBRL standard in modern conditions is considered an international standard. In other words, the international standard XBRL is created with the application of the information standard XML (eXtensible Mark-up Language) with a built-in specific range of rules and taxonomies intended exclusively, ie. specifically for financial reporting. It automatically adds each piece of computerized business information with tags, ie. with identification code. Information no matter how it is rearranged by the reader, or by the application of software, or how the information is formatted, tags remain with the information. (Bovee et all, 2005.)

The XBRL standard is used all over the world and it actually changes the business communication of companies no matter where they are located. For the sake of illustration, the first publicly named company, ie. in 2001, a news agency called Reuters publicly announced its complete annual results, i.e. reports online using XBRL standards. APRA (Australian Prudential Regulatory Agency) uses the XBRL standard to monitor finances. Also one of the world's largest banks, i.e. the American bank uses the XBRL standard in order to

collect financial reports from their national user base, etc. In essence, the XBRL standard allows users of financial statements to gather the highest quality information. The great benefit of XBRL standards is reflected in the process of preparing financial information, the use of financial information for the country as a whole, having in the preparation and distribution of reports and greater efficiency of vendors and software vendors, as various reporting services for all types of users.

The advantages of XBRL reporting in relation to classic reporting are reflected in the fact that the preparation time is shortened, and thus reduces the preparation costs. Access to information is simpler, and the conditions for making investment decisions are better. Both cost and time, XBRL provides significantly more efficient data retrieval between customers and banks and between all companies. XBRL is primarily focused on business reporting information, and not on capturing data at the transaction level (Polić, Krsmanović, 2008, p. 424).

XBRL can be used for (Pasmooi, 2010):

- Accounting transactions (individual transactions are indicated under the XBRL general ledger);
- Internal reporting (reports to management); and
- External reporting (annual financial reports, reports for statistical purposes, etc.)

Despite the fact that the XBRL standard has become a global standard for the exchange of business information in financial reporting, a survey conducted by the CFA Institute was published, which indicated that 55% of respondents did not know what XBRL was. The survey was conducted worldwide, so that 16% of respondents are from Asia, 24% of respondents from Europe and Africa, and the largest percentage of 60% from North and South America. The survey base was consisted of 25,000 respondents who belong to the category of experts in areas related to the XBRL standard. When looking at the specific occupations of the respondents, analysts in investment banking were rated as the weakest experts in XBRL standards, while research analysts proved to be the best. Respondents' awareness did not increase significantly from 2007 to 2016, which is a worrying fact. (https://www.cfainstitute.org/Survey/survey_extensible_business_reporting_language_xbrl.pdf)

5. ENTERPRISE RESOURCE PLANNINGS (ERP) INFORMATION SYSTEMS

Automation of all necessary and decomposed business processes that are interconnected into a single connection is actually a system of work in an electronic environment. ERP information system is a set of tools for forecasting, planning and allocation of resources at the company level, which connects customers and suppliers in one supply chain (Polić & Krsmanović, 2008, p. 349).

ERP technology is structured in such a way as to automate a complete and complex business, by approaching organized business problem solving using various diagrams, reports - listing with precise determination of business steps with documentation. Its use increases speed, productivity and performance, as it integrates business processes, helps develop communications and distribute information.

The basic goal of the ERP system is to integrate information from all processes and perform their consolidation, so that they can be easily accessed. To illustrate, this integration in the field of finance is realized through the reconciliation of liabilities to suppliers, receivables, general ledger, payments, cash management. Through the ERP information system, best practices are implemented, and in making business decisions, coordination of logistics, operations, procurement, sales, marketing, product development, finance, and human resource management is performed. As observed ERP encompasses the complete business process.

Table 1: Typical modules in ERP and extended ERP system (Petrović, 2009, p. 17)

Typical modules in an ERP system	**Typical modules in an extended ERP system**
Marketing and business planning	Financial management
Procurement and storage	Supply chains
Sales and distribution	Customer relationship management
Production management	E-business
Accounting and finance	Production management
Human Resources	Service management
	Distribution
	Sale
	Marketing

Common steps in the development cycle of the ERP system are shown in the following figure.

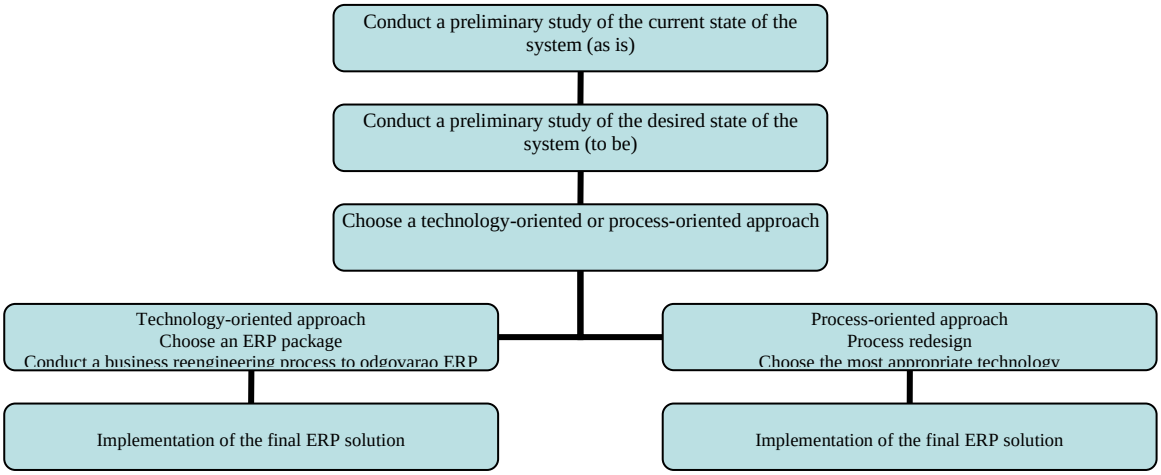

Figure 1: Standard steps in the development cycle of the ERP system: (Panayiotou & Gayialis, 2015, p.632).

SAP is intended for the basic requirements of business software for large and medium enterprises. He is the leader, that is. the most successful module on the ERP solution market. Business information system SAP R/3 base segments consist of: sales and distribution, inventory management, production planning, quality management, operational maintenance, human resources, financial accounting, controlling, fixed asset management, project system, process flows and solution for application in industry (http://www.sap.com).

In the earlier period before the introduction of the ERP system, each segment (department, unit) of the company had a separate i.e., isolated software where much was lost on productivity and efficiency, as synchronization between departments was disabled. The consequences of the above were, among other things, the wrong decisions made at the wrong time.

Due to the mentioned weakness of the ERP system implementation, it is reflected in a significant increase in performance in terms of faster improvement, because there is synchronization of information exchange between each narrower organizational part in the company, increasing both productivity and efficiency, ie. each segment is optimized. For modern e-business, ERP solutions have become a way to achieve a new paradigm. By investing effort and its synergistic connection with the set goals within the ERP solution and leading new information technologies, all of the above is possible. (Polić & Krsmanović, 2008, p. 372).

6. FUTURE ACCOUNTING AND INFORMATION RISK

The end of the twentieth century depicts the development of information technology, and the previous period was replaced by the period of global systems and information. That is why information technologies have become the basis of financial reporting. For many companies, information technology services have become an important segment of the financial reporting process. Numerous services and applications are a great support for creating, processing, storing and reporting financial transactions. To ensure data integrity as well as the security of operations for the global financial reporting process, general computer controls have been incorporated. In larger companies, there is a department of information technology that consists of design controls, all complete supporting documentation. Practical application, testing, monitoring and maintenance of internal controls within information technologies in them.

Information technology risk management is a process that requires an understanding of the factors that lead to failure in the availability, confidentiality and integrity of information systems. Global risk is considered first from the departmental point of view of information services, and then from the point of view of the company. All possible omissions are maintained through poor security and insufficient control in the company regarding the information system.

Analyzes by experts assessing global risk show that inadequate methods of controlling changes in the company “can cause a loss of information integrity in financial applications and data systems. Potential risk includes inaccurate reporting or incomplete reporting.” (Polić & Krsmanović, 2009, p. 13).

The public reform of a company accounting and the investor protection act was the Sarbanes-Oxley Act passed in 2002 in the USA. On the part of the US Government, it is a direct response to the outbreak of corporate scandals and many bankruptcies. The scandals have been uncovered starting with ENRON, Arthur Andresson, Worlcom and many other companies.

Future accounting is based on modern information technology. The condition for the survival of accounting in the future is the reduction of information risks and information security. In order to achieve information security and organizational knowledge, the ISO 27001 standard was adopted, which specifies the requirements that companies must comply with in order to achieve an information protection system. The development of accounting has been greatly influenced by the development of information technology, so modern accounting in the segment of bookkeeping control has a set of control tools that prevent the following undesirable consequences: inability to enter illogical data, inability to delete without prior confirmation, inability to access and change data without password, entering on the wrong side of the account. Quality financial reporting produced by accounting with a single business language has a basic role in the functioning of financial markets and increasing social wealth. It is unthinkable for a company to operate without accounting as a source of a lot of information.

As financial statements became the basic means of communication in the global financial market in the twenty-first century, they are required to be reliable. The application of International IAS/IFRS in their compilation enables their greater reliability. The International Accounting Standards Board of the IASB, as the issuer of the standard, also points out the ethical behavior of all participants in financial reporting.

In modern business conditions, the most widely applied codes of ethics are the Code of Ethics adopted by the professional organization American Institute of Certified Public Accountants (AICIPA) and the International Federation of Accountants (IFAC). Companies must apply professional, legal and internal regulations when preparing financial statements. Pursuant to the professional regulations, companies should establish accounting policies in their general act that will enable the financial statements to contain reliable and relevant information for the purposes of adequate business decision-making. Modern businesses are looking for a way to create added value through identifying, implementing, and using knowledge in a unique way. In addition to modern information technologies, the basic role in achieving the comparative advantage of every company is played by information, and it is common to say that there is nothing more valuable than timely and accurate information that modern accounting should produce.

The ability of a company to learn and change, to learn faster than others, and to quickly transform what has been learned into action, is the greatest advantage it can have. The twenty-first century as a century of knowledge imposes a complex competitive environment in which the survival and success of the company depends solely on its ability to quickly adapt to the new situation.

7. CONCLUSION

In order to respect the new system in the field of accounting, it is necessary to acquire new knowledge, adopt new rules and methods of work, in order to respond to the existing challenges posed by the world order. The profession must follow the tendency of global movements, in order for the system to function in harmony, with the goal of overall improvement.

The age of computerization, and the period of mass computerization, can certainly be called the period of transition, where all business processes experience a degree of informatization. Each new order leads to improvement, but it also brings with it new risks. Since the pioneering ventures of informatization, data security has been woven into the system, but decades have shown that vulnerabilities also occur, which is characteristic of any system.

According to Dmitrović, Benković and Spasenić (2019) “The accelerating growth and development of information and communication technologies has led to the emergence of electronic business that has been reflected in financial reporting since a traditional model of exchanging business information created before the creation of the web and new ones technology, its adaptation is necessary, i.e. transformation into a more efficient model.”

The point is certainly in finding the most efficient and accurate model for accounting records, and improved production of financial statements, and specially tailored reports for business decision making. Of course, it always implies respect for ethical standards, but it is also necessary to make an effort during programming to devise a model that will reduce, or ideally, disable the occurrence of fraudulent actions.

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INTANGIBLE ASSETS PERFORMANCE – THE USE OF 'ROIA' AS THE HYBRID INDICATOR

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Abstract: *In the XXI century, modern businesses rely on intangible assets and its utilization, which affects not only the financial performance, but the value of the company as well. Many authors have shown the positive impact of intangible assets on financial performance and how the impact is being made. Even though there the certain methods which could lead to the potential value of the intangible assets exist, the officially accepted valuation methods are still not confirmed. According to the IFRS and GAAP, only some elements of the intangible assets could be reviewed in a balance sheet. Nonetheless, combining positions from the balance sheet and income statement in order to provide a unique ratio which might be used to analyze the whole structure of intangible assets remains an open puzzle. Therefore, the authors have built and suggested using ROIA (Return on Intangible Assets) as one of the hybrid metrics for tracking the profitability of intangible assets, including not just the purchased, but the internally generated intangible assets as well. This ratio could be used in tracking the level of utilizing the intangible assets. However, its use could be found in the valuation of the intangible and total assets, showing also the potential for measuring the company value as a whole. By presenting the new metric, the authors are giving a contribution to the academia and the researchers who are willing to further expand the know-how in this field, but to the practitioners as well. Nonetheless, the authors also point out the potential weaknesses of this metric, which are related to the intangible assets' specifics, such as the uncertainty of the future economic benefit from using it.*

Keywords*: return on intangible assets, ROIA, intangible assets, valuation models, key performance indicators*

1. THE ASPECTS OF INTANGIBLE RESOURCES

During the last two decades, intangible assets have shown a tremendous impact on the businesses worldwide, providing a great potential for the for their growth and scalability, but also for their profitability in general. According to Kaplan and Norton (2004), intangible resources have been holding in average over 75% of the total assets, which shows the first aspect of its importance. Over the years, this percentage have been growing, especially in the IT industry, where the share of the intangible over the total assets reaches over 90% (Visual Capitalist, 2020). Intangible resources have also taken advantage over the tangible assets in the beginning of XXI century, according to the value added and share of GDP (Haskel & Westlake, 2018).

The importance of intangible assets is not just seen in its growth over the years, but also on its impact on key performance indicators. Many afuthors have researched this area, by showing a positive correlation between investment in intangible assets and the return of the investment through various performance indicators (Andreeva & Garanina, 2017; Chen, Zhu, & Yuan Xie, 2004; Ferraro & Veltri, 2011; Gallego & Rodríguez, 2005; Henri, Paavo, Mika, & Aino, 2014; Mondal & Ghosh, 2012; Sardo & Serrasqueiro, 2017; Steenkamp & Kashyap, 2010). However, in order to understand the effects of intangible assets, the first step is to understand its structure and how it creates an impact on the overall business success of the companies. One of the first authors to analyze the structure of intangible assets was Sveiby (1998), by making a segmentation of internal, external and organizational capital. Ever since, human capital was seen as one of the most important segments. Wang and Chang (2005) have shown a bit different structure, by separating the intangible assets to human capital, relational, structural and innovation capital. In the same study, Wang and Change have analyzed the relationship between the intangible assets and presented three major models of relationships and how intangible assets affect financial performance all together. One of the most important aspects of intangible assets is synergy. No element or segment of intangible assets can affect the business performance isolated.

Having that said, the relationships between intangible assets and its segments and financial performance should be analyzed holistically (Haskel & Westlake, 2018).

All models which were proposed in a study by Wang and Chen took the synergy as one of the key aspects of intangible assets. The first model presented the direct effects of all segments on the financial performance. Unlike the first model, the second model confirms the relationships between the segments of intangible assets. Human capital was one of the first forms which was treated as the intangible part of capital (Hermanson, 1964). This model perceives human capital as the creator of the other segments, where the only relationship among the segments is between the human capital and the rest of the intangible capital. The third and the most complexed model, presents human capital as the generator of innovation and structural capital, where the innovation capital also might affect setting processes and procedures within structural capital (Wang & Chang, 2005). None of them has the direct influence on the financial performance, but through the relational capital which is being influenced by innovation and structural capital. All of these models could be seen in Figure 1.

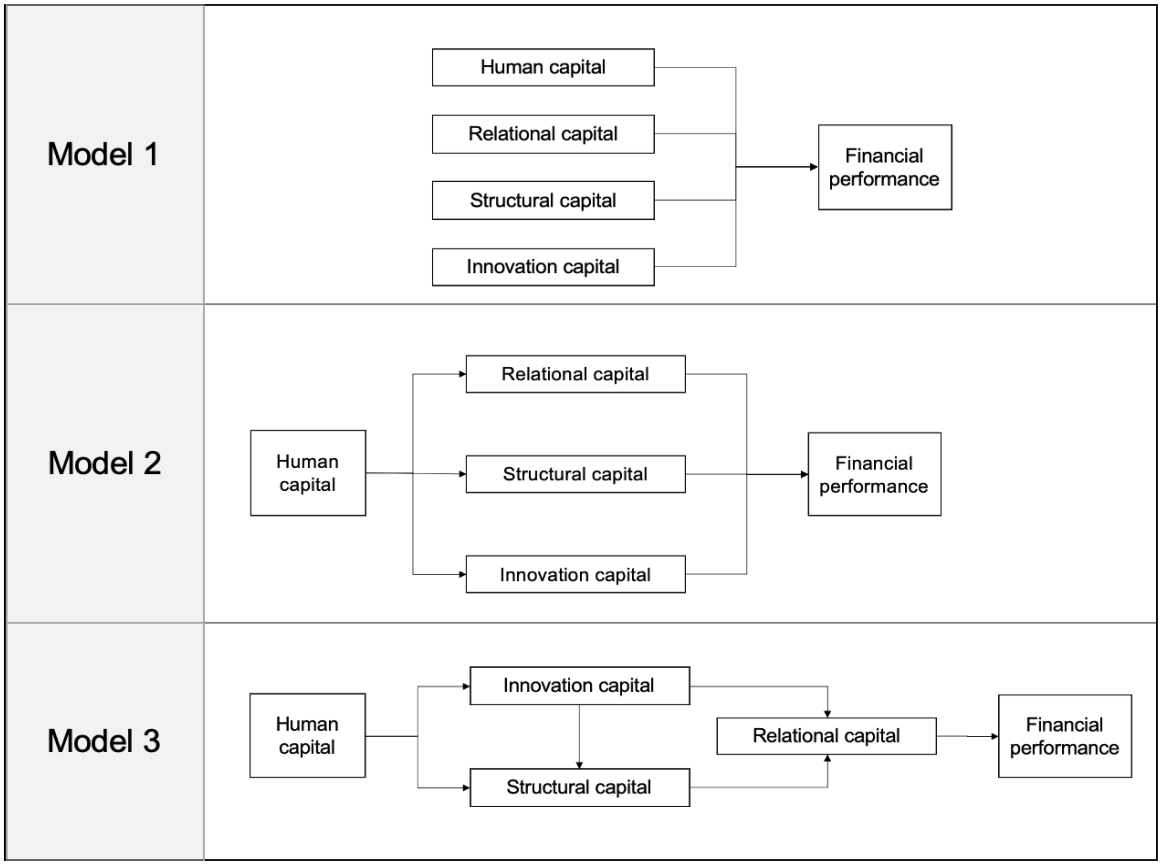

Figure 1: The relationship between intangible assets segments and financial performance
Source: Wang and Chang (2005)

By analyzing the nature of intangible assets and their specifics, Haskel and Westlake (2018) used the model of four S's, including *scalability*, *sunkness*, *spillovers* and *synergy*. Intangible assets are much easier multiplied than tangible assets, which gives them the opportunity for a higher level of *scalability*. On the other hand, *sunkness* might be perceived as a negative aspect of the intangible assets, which could be defined as the difficulty to recover in case of failure. Therefore, companies with failures in managing and utilizing intangible resources tend to be valued less than its real value, while businesses with the greater level of utilizing the intangible assets, might be worth much more than the book value. When discussing the *spillovers*, the authors highlighted the opportunity for other companies to benefit from an open-source know-how (one of the greatest examples of intangible assets spillovers is the development of the open source platform for managing websites – *WordPress*). The last "s" referred to *synergy* which have already been mentioned as the interaction between intangible assets segments in affecting the business performance.

All of the mentioned specifics make it harder for the analysts to assign the value to every element and segment intangible assets consists of. Therefore, in remaining part of the paper, the authors have explained the accounting aspects of intangible assets considering IFRS and GAAP, but the possible metrics which might be analyzed as key performance indicators for managing intangible resources.

2. IFRS AND GAAP STANDARDS FOR RECOGNIZING INTANGIBLE ASSETS

As discussed, the difficulty for valuing the intangible assets is the inability to be fully presented in the financial statements. Balance sheet might include software, patents and other investment in non-tangible assets, but also goodwill in case of M&A. However, the inability to analyze other aspects and segments of intangible assets, requires the use of other data not visible in balance sheet. In the study by Penman (2009) it was discussed about the possibilities of using income statement in order to measure and present the success rate of using the intangible assets.

Non-financial indicators have been providing crucial aspects of businesses worldwide and could be aligned with the business performance. Unlike tangible assets, the investment into intangible assets have shown a positive correlation with the business performance. One of the models which shows the value of the intangible assets is *Tobin's Q coefficient* which perceives the value of replacing the intangible assets (Singhal, Parkash, & Fu, 2016). Similar to Tobin's Q coefficient, VAIC is one of the mostly used methods for valuing the intangible assets which developed by professor Ante Pulić in the 90's. It measures the efficiency of using the intangible capital based on the accounting data (Pulić, 1998). Another model which defines the value of the certain intangible resources is the *Skandia Navigator* which have a bit different approach, integrating five dimensions – finance, customer, process, development and of course human aspect as the generator of value creation (Edvinsson, 1997). However, none of these methods is fully applicable according to the accounting standards.

Both, IFRS (IFRS 38) and GAAP (ASC 805) agree on defining the intangible assets, presenting it as 'nonmonetary assets without physical substance'. Furthermore, in order to accept the recognition of intangible assets, there should be an expected future economic benefit from using it, which is measurable. Considering the capitalization, both accounting models agree on not capitalizing certain expanses. When it comes to amortization of intangible assets, both standards, IFRS and GAAP treat intangible assets as the category which value is being decreased over the time of its use. However, there might be certain difficulties to set the amortization for the costs which are not capitalized, such as training & development, software license fees and others (IFRS Foundation, 2020). Goodwill is analyzed separately and is not amortized. Under the U.S. GAAP, Goodwill is treated under ASC 350 – Intangibles, Goodwill and Others (Ernst & Young, 2019).

Going forward, another similarity for both standards is the recognition of the internally generated intangible assets. Under the IFRS, all costs related to generating intangible assets should be capitalized if they are in a development phase. For example - training and development cannot be capitalized as the intangible assets, which in theory should be treated as the increase of the human capital. From the perspective of GAAP, there is also a certain criterion for capitalizing intangible assets. The costs of generating intangible assets might be related to purchasing patents, trademarks, copyrights as the legal fees. On the contrary, building software and other business solutions should be treated as the intangible assets after they are recognized as ready for sale or internal use. Most of the development costs are treated as the expanse, except in the acquisitions. Besides the similarities, IFRS and GAAP disagree on several topics which are reviewed in Table 1:

Table 1: Differences between IFRS and GAAP in recognizing intangible assets

Type of difference	IFRS	U.S. GAAP
Development costs	As part of the R&D costs, research costs could not be capitalized, while development costs could be capitalized only if the technical and economic feasibility criteria is fulfilled, including the stage of being ready to sell or internally utilize. Internally generated goodwill could not be capitalized and is not treated as intangible assets.	The development costs of building a computer software are capitalized if they are expensed as incurred and if they meet the criteria in ASC 985-20. In case of building a software for the internal use, only the costs made during the application development stage could be capitalized (see ASC 350-40).
Advertising	Advertising and other promotional costs could be expensed only as incurred. Prepayments could be treated as assets after the payment has been done.	Advertising and other promotional costs are expensed as incurred or on the other hand when they take place for the first time.
Revaluation	Revaluation to the fair value of intangible assets is permitted (except Goodwill), for a specific intangible asset. However, due to the lack of data regarding certain intangible assets position on the market, this is not a common practice.	No revaluation is possible and permitted.

Source: Ernst & Young (2019)

The main issue when calculating the value of the intangible assets based on the accounting standards is the distinction between the R&D costs which are presented as capitalized and the ones which are expensed, due to the different value, considering the uncertainty of future benefits of the researches. The accounting standards are crucial in understanding the logic behind the metrics which will be further discussed in this paper.

3. KEY METRICS FOR MEASURING THE SUCCESS RATE OF UTILIZING INTANGIBLE ASSETS - ROIA

One of the key issues with managing the intangible assets is its nonphysical presence, the complexity of intangible assets structure and the inability to value each aspect of intangible assets. There is also a universal quote, stated by many individuals, pointing out that if there is an inability to measure, there is an inability to manage the asset. Therefore, there are many authors which have proposed the metrics which might measure the intangible assets utilization. Liebowitz and Suen (2000) have collected the different approaches from established experts in the field of managing intangible assets. Some of these indicators are financial performance indicators, such as revenue per employee, revenue per customer, advertising costs, R&D costs and others, but most of them are non-financial, such as the number of unique customers, number of employees, NPS satisfaction score, employee turnover, market share, number of patents and others. Skandia Navigator model offers more than 160 key metrics (Edvinsson, 1997). Skandia was the first model to produce the intangible assets report, focusing on the non-financial metrics and to analyze the full complexity of intangible assets structure. However, non-linear behavior and complexity of intangible assets still remains unclear for the accounting standards in order to present the whole structure of it in the financial statements (Bratianu, 2018). Bratianu as one of the ex-Directors in Skandia Navigator, also mentions the inability of the financial statements to fully show the value of the intangible assets, presenting the seven myths of intangible assets.

The inability to capitalize some of the costs, such as advertising or R&D costs, supports the statements for many authors, showing the inability to present the full value of the intangible assets in the balance sheet. On the other hand, the registered form and the development phase of the company, might give different insights into the intangible assets value. For the IPO companies, which are valued on a stock market, it might be easier to track the intangible assets, where it could be calculated using the following equation:

$$\text{IA (IPO company)} = \text{Market value - Capital – Goodwill} \quad (1)$$

Intangible assets are usually generated as the company is able to sell the products or services at a premium price and vice-versa. The customers who see an additional value in the product (brand, quality or other aspects) might be willing the overpay (Showvonick & Muhtasim Fuad, 2016). In total, it might reflect the income statement instead of the balance sheet. However, these two statements shouldn't be analyzed separately, since they are complement (Penman, 2009).

When it comes to the level of utilizing the assets and measuring the return on investing in assets, ROA indicator is one of the best practices. However, when it comes to analyzing the intangible assets utilization, there is a lack of metrics which are taking into consideration the whole structure of intangible assets. Therefore, the aim of this paper is to provide a unique indicator which might consider the full complexity of the intangible assets.

If taking into consideration only balance sheet, if the intangible assets is excluded or not fully shown, then ROA value might be overrated. By taking into account the costs of internally developed intangible assets, such as software, patent or other product, this might not be visible in the balance sheet in full. Moreover, some of the costs which might be assigned to the creation of intangible assets are visible only in the income statement. Some of the costs which might be related to the creation of the intangible assets could be seen in Table 2.

When it comes to the human capital, income statement could recognize the total costs of salaries (including taxes), training and development costs, but other professional fees (such as hiring an external contractor). Human Capital Value Added (HCVA) is one of the indicators which is specialized in analyzing the efficiency of using the human capital (Yudawisastra, Manurung, & Husnatarina, 2018). The equation below shows the effect of the workforce on the revenue and costs, except the total salary costs.

$$\text{HCVA} = \frac{\text{Revenue} - (\text{Total costs} - \text{Total salary costs})}{\text{FTE}} \quad (2)$$

Structural capital on the other hand might take into account training and development as well, total salary costs, license fees (for using some process related software), entertainment costs (related to building company

culture), as well as amortization and other professional fees (external contractors). Building processes and procedures as well as management methodology might include all of the above mentioned.

Advertising costs are specific for building the relational capital, with the focus on customers. 'Return on Advertising Spent' or ROAS is one of the metrics for tracking the efficiency of the funds invested into advertising, especially popular in digital marketing. Furthermore, generating the relational capital might require other professional fees, such as building an affiliate system or hiring an external contractor, which also might be treated as the investment into marketing.

The last segment of intangible assets refers to building the innovation capital. R&D costs are highly related to internal generation of intangible assets, with the focus on intangible assets (software, patents, rights, etc.). Other than R&D costs, total salary costs might be involved into the process of capitalizing the final product, as well as the other professional fees. Amortization of the existing intangible assets which is visible in the balance sheet mostly refers either to innovation or structural capital.

Table 2: Income statement positions related to the creation or maintenance of intangible assets

Segment of intangible assets	Source of information
Human Capital	• Total salary costs (HVAC indicator); • Training and development costs; • Other professional fees (external constructors);
Structural Capital	• Training and development; • Total salary costs; • License fees; • Other professional fees (external constructors); • Entertainment costs; • Amortization;
Relational Capital	• Advertising costs (cost of acquisition); • Other professional fees (affiliate program/external constructors);
Innovation Capital	• R&D costs; • Total salary costs (for the specific project); • Other professional fees (external contractors); • Amortization;

By analyzing the costs from the income statements, companies could approach holistically the concept of internally built intangible assets. From the perspective of the company which doesn't have the estimated market value or is not an IPO company, the process of valuing the intangible assets and tracking the profitability of investing in intangible assets might require data intersection, through balance sheet and income statement, combined. Therefore, the authors propose using a unique indicator, called 'Return on Intangible Assets' (ROIA). Only a few of the papers have proposed calculating this indicator (Arrow, 2002; Ivanov & Mayorova, 2015; Tkachenko, Rogova, Kokh, & Bodrunov, 2018). However, none of the papers have presented a methodology for calculating this ratio, as well as taking into consideration both – purchased and internally developed intangible assets. Hence, the equation for ROAI as the level of utilizing the intangible assets could be presented as:

$$\mathrm{ROAI} = \frac{\mathrm{NI}}{\alpha^1+\alpha^2_{x1,\dots xn}+\alpha^3+\alpha^4+\alpha^5+\beta+\beta*\mathrm{Am}'}, \quad (3)$$

Where:

α^1 – Total salaries cost
α^2 – R&D costs
α^3 – Advertising and promotion costs
α^4 – Training and development costs
α^5 – Other professional fees
Am – Amortization rate
β – Net intangible assets (Purchased software, patent, licenses)
NI – Net income
$x_1,\dots,x_n$ – specific project to which the costs can be assigned to

ROAI doesn't include acquired or internally generated goodwill, even though it should be included when calculating the value of the total assets or the company value. On the other hand, internally generated intangible assets could be valued only after they are ready to be sold or internally use.

The ROAI indicator is usually higher than ROA, considering that ROA is calculated based on the total assets. In the example of GoDaddy – the world's biggest domain register and web hosting company, due to the high developed intangible assets, the intangible assets (including Goodwill) take the big portion of the total assets.

Table 3: Intangible Assets & Goodwill - GoDaddy Inc.

Description	FY '17	FY '18	FY '19
Total Assets	5,738.3	6,083.4	6,301.2
Goodwill	2,859.9	2,948.0	2,976.5
Intangible assets, net	1,326.0	1,211.5	1,097.7
% Intangible assets & Goodwill	**72.95%**	**68.37%**	**64.66%**

Source: GoDaddy Inc, (2020)

Considering that GoDaddy is an IPO company, intangible assets could be calculated as per equation (1), as the difference between market value, goodwill and book value. Furthermore, the ROIA indicator should be higher than ROA. In 2017, GoDaddy started with the implementation of the M&A strategy worldwide, which resulted in aan increased intangible assets in comparison to the previous years, where the intangible assets was valued 749.7, 735.3 and 716.5 million dollars in 2014, 2015 and 2016 retrospectively. From 2017, the goodwill continued with a growth over the years, while the intangible assets was amortized and reduce by 8.3% since 2017.

Therefore, the ROIA indicator might also expect an increase over the years. The simple calculation of ROIA might be different than the one in equation (3), by dividing net result with the net intangible assets (without goodwill). By analyzing GoDaddy, the ROIA is simple to calculate, considering the IPO valuation on a daily basis.

Table 4: ROA & ROIA calculation of GoDaddy Inc.

Description	FY '17	FY '18	FY '19
Net income (loss)	139.8	82.0	138.4
ROA	2.44%	1.35%	2.20%
ROA excluding intangible assets & goodwill	9.01%	4.26%	6.21%
ROAI	**10.54%**	**6.77%**	**12.61%**

As seen, ROIA has been the highest in 2019th, considering the slight drop in the value of intangible assets due to amortization. However, if the equation (3) was used to calculate the ROIA and in the circumstances where the market value is not confirmed by the market, the costs of amortization should also be included, considering that the intangible assets could deliver the economic benefit far in the future. Having that said, the ROIA should be calculated for a longer period of time as the geometric average. By analyzing the period 2017-2019, the $ROIA_g$ shows the return on intangible assets of 9.65% which is comparing to GoDaddy total intangible assets quite high.

In the case of unknown intangible assets, by using the equation (3), the ROIA would be 12.74%, 6.34% and 9.82% in 2017, 2018 and 2019 retrospectively with the geometric average of $ROIA_g$ = 9.26% which is quite close to the ROIA directly calculated as the ratio between net income and the total net intangible assets provided in the official financial statements.

4. CONCLUSION

Intangible assets have made a remarkable impact on the businesses through raising and sustaining their competitive advantage. The complexity of intangible assets, besides its other specifics (non-physical presence, scalability, spillovers, sunkness, synergy) has made it difficult for the management and other stakeholders to manage it. Therefore, this paper has put a segmentation on the structure of intangible assets, dividing it to the human, structural, relational and innovation capital and presenting the interaction between them. The effect of intangible assets on financial performance exists without doubt, which was confirmed by many academic researches, showing a positive impact not just on the financial performance, but on the value of the companies as well.

One of the main problems this paper also presents is the inability to measure the return on investment in the intangible assets. Therefore, by following the accounting standards (IFRS and GAAP), the authors have proposed using a unique metric for tracking not just the return on investment in the intangible assets, but also

the level of utilizing the total intangible assets, including the intangible assets which have been internally developed. The metric called 'Return on Intangible Assets' (ROIA) gives a different approach in comparison to the existing models, such as Tobin's Q coefficient or Pulic's VAIC method for valuing the intangible assets. However, ROIA eliminates the weaknesses of the mentioned methods, by taking into account the whole structure of intangible assets and is easily calculated through the financial statements.

On the other hand, the main limitation of this metric is the uncertainty about the future period when the invested assets might be returned, which is aligned with the GAAP and IFRS, stating the uncertainty of the future economic benefit. Therefore, the authors don't recommend using this indicator for the periodic reports, but to use it as an average of a long-term period. One of the conditions for the companies to be able to reallocate the costs related to the internally built intangibles is to have a proper system and to be consistent in tracking the costs by each cost center and to properly asign the costs to these costs centers, whether these centers are defined as the projects or the departments which are involved into building the intangible assets.

In a nutshell, ROIA might provide an overview of how the company is managing the intangible assets, but is not able to deliver the specific and most accurate results for the shorter period of time. As an addition to this paper, the authors leave a blank space for the future researches in the field of analyzing the delivery effect of intangible assets and how to implement this metric for the *startup* companies or companies in an early stage of development.

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OUTSOURCING FOR REDUCING COSTS: LESSONS OF MULTI-NATIONAL PETROL COMPANY CALL CENTER

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Abstract: *The paper explores ramifications of outsourcing in order to reduce costs and potential organizational consequences of such strategic decision. Case study method was used to present an actual and real business situation of evaluating outsourcing of the call center at the large organization. The results point to a disadvantageous relation between outsourcing and reducing costs, and also revealed potential detrimental effects of outsourcing on the company's performance. This study emphasizes the risks of single-minded approach to outsourcing where the only goal is to decrease costs and no attention is paid to other drawbacks.*

Keywords*: outsourcing, cost, performance, organization, call center*

1. INTRODUCTION

Outsourcing has moved away from being just a technology management tool and has become unavoidable business strategy subject in the new millennium, but its benefits and drawbacks are still not clear to managers (Lee & Kim, 2010). At the beginning of the millennium outsourcing looked invincible and was widely applied in the corporate world because of its positive financial effects in reducing costs, increasing profitability and improving business operations (Saini, Yen & Chou, 2016). Thanks to Corona virus, now it is becoming popular again regarding call centers and possibilities artificial intelligence (AI) offers, chatbots in particular. Companies will be quicker to dispose of jobs, especially if AI and automation allow a handful of human agents to do work that previously required dozens (Ruehl, 2020).

Reducing costs seems to be the main driver behind the decision to outsource organizational units which do not contribute directly to profit, but rather to costs (Xia, Chen, Jayaraman & Munson, 2015). However, although it appears that way, cutting costs in reality is not as important as it seems (Bidwell, 2012).

In other words, tremendous savings are high on the corporate list of outsourcing expectations. Right away you visualize saving resources and money capital, but there are no clear cut solutions as proven by unsuccessful outsourcing projects (Moe, Šmite, Hanssen & Barney, 2013). Unless a company is going through crisis, outsourcing should not be understood so superficially as this great excuse to implement cost cutting measures. Such a narrow assessment of outsourcing might potentially lead to unwanted consequences businesswise further down the trough.

The goal of this paper is to enhance research examining whether reducing costs alone is the good enough reason for outsourcing and affects of such a strategic decision on organizational performance. Previous research has been ambivalent, proposing existing or non-existing relationship between outsourcing and performance (Munjal, Requejo & Kundu, 2018).

Organizations believe that outsourcing can help them improve organizational performance through primarily cutting costs to the point of becoming the only reason for outsourcing. However, costs of outsourcing are not negligible and can be hard to identify. Therefore, if the sole purpose of outsourcing is to reduce costs with no regard to other factors, then organizational performance will be jeopardized. In the end, the impact of outsourcing on organization`s performance may not be what was the desired effect in the beginning.

The empirical approach was used which draws on business practice of the call center in the Multi-National Petrol Company (MNPC). In regard to selected cost indicators, qualitative and quantitative analyses was done to show the relation between outsourcing and reducing costs, as well as outsourcing and company performance. Also, scientific articles, books and texts were investigated online. This case study method

focused on MNPC with approximately 4,500 employees and the call center with 16 agents and the manager. The aim was to gather a comprehensive knowledge of call center operations and the reasons and concerns when trying to outsource it.

The rest of this paper is presented in the following structure:

- Organizational Context
- Call Center Costs
- Outsourcing Costs
- Conclusion

2. ORGANIZATIONAL CONTEXT

The purpose of the call center is "to improve support to buyers and end consumers and to improve efficiency in communication and exchange of information within the company. Basic activities of the call center are communication with external and internal users – reception, recording, contacting and forwarding calls/messages by telephone/electronic mail, fax, regular mail, web chat…" (Marić, 2013, p. 3).

What can be concluded from the stated purpose above about the call center is its importance to internal users, not just external users. It is a reminder that customers are not just outside the company, but inside the company, too (Cooper, 2017). In fact, the petrol company's employees often contact the call center to inform themselves about various things: when is the next paycheck, how can a colleague be reached, changes in the organizational structure, sick leave, open positions, etc. They have come to rely on the call center to find out important information regarding their employment. In many instances they will contact the call center even before getting in touch with someone from the human resources.

The call center consists of 16 agents that operate in shifts (7/24/365) which mean that the call center can be reached at any time. The call center covers inquiries from 3 foreign countries where MNPC operates its retail chains: Bosnia and Herzegovina, Romania, and Bulgaria. There are 2 agents that speak Romanian handling inquiries from Romanian customers and 2 agents that speak Bulgarian handling inquiries from Bulgarian customers. There is also one team leader reporting directly to call center manager. Team leader is in charge of on-site training of agents and can answer the calls if necessary.

The importance of MNPC call center to internal users or customers, since organizations are not made of isolated individuals or groups making decisions and implementing them on their own (Pfeffer, 2010), can be observed from the list of departments on whose behalf the call center performs certain activities:

- Document Management Department
- Retail Department of Sales and Distribution Block
- Wholesale Department of Sales and Distribution Block
- Marketing Department
- Department for Internal Communication
- Health, Safety and Environment Function
- Health, Safety and Environment Operating Units in Blocks
- Business Center Department
- Information Technology Department
- Business Development Department
- Department for Corporate Security
- Center for Joint Human Resources Services
- Department for Development, Capital Construction and Material and Technical Maintenance Services

Immediately, the wide spread use of the call center internally among other organizational units is clear as much as it is self-evident that taking the call center out of this setting would be harmful to the company's daily operating capabilities.

3. CALL CENTER COSTS

Research by the Customer Contact Association (CCA), found that call centers are not recognized well enough in companies for their strategic role, which is indeed undervalued. The results showed 74% of respondents viewing contact centers as cost centers (CCA research, 2012).

The biggest two slices of the pie belongs to labor costs (Customer Service Representatives and Supervisors / Call Center Management and Analysts) which can make up about 82.5% of total costs. The percent breakdown shows where to target for improvements and, hence, our focus shall be labor costs.

According to Bocklund, the pie chart below provides a representative overall breakdown of call center costs:

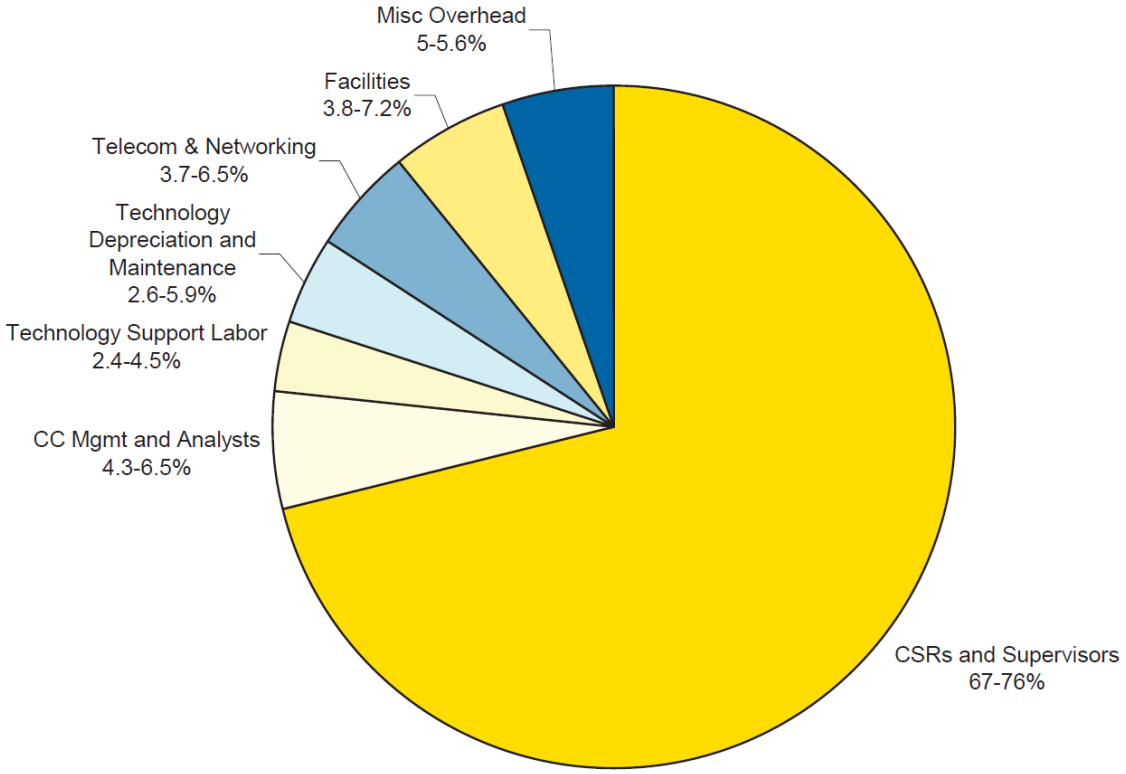

Figure 1: Cost Structure and Distribution in Today`s Contact Centers

The biggest two slices of the pie belong to labor costs (Customer Service Representatives and Supervisors / Call Center Management and Analysts) which can make up about 82.5% of total costs.

In order to simplify the analysis, when looking at all of the above mentioned costs, one of the key performance indicators which sums it all up, and is quantifiable, is cost per call – the total expenditure realted to answering all calls during a specific timeframe; in order to determine cost per call in the call center, firstly figure out a time period, then quantify all calls handled during that time and divide it with the complete call center costs incurred during the same time period (Geraghty, 2016).

As mentioned earlier, there was an idea of what the call center costs were, but there were no benchmarks that could be used for comparison and analysis. First thing was to calculate the average cost per call. The direct labor cost ranged from 46 to 67 dinars for 3 to 4 minute direct consumer call. When indirect labor was added, the cost per call increased to a range of 72 to 89 dinars per call. When occupancy, benefits, and telecommunications were added, the fully loaded costs range between 121 to 144 dinars per call. In comparison, Trizma was charging 150 dinars per call.

One of the efficient ways to depreciate cost per call and appreciate client service quality is by providing your agents with adequate understanding, coaching and means to appropriately satisfy client's needs. The general opinion was that agents are doing a great job, but there is always room for improvement. Since the plan is for them to move on to bigger and better things in the company, more training was to be provided, particularly in customer service, data manipulating, people and project management, and business writing. This will also help them in their current positions as call center agents, which will then improve the overall customer experience while reducing business costs.

Another way was to improve scheduling of the shifts and adherence to the schedule. The spreadsheet was created where each agent`s rotation was done automatically and 6 months in advance. When they had to take a day off, next agent in line (based on call center seniority) would replace them and so on. Prior to this, they had a very rigid and inflexible table to fill which caused a lot of conflicting shifts and, therefore, animosity among agents.

4. OUTSOURCING COSTS

Organization whose most important objective is the quality of its customers' brand experience, will not outsource the call center, while organizations whose aim is set on operational and cost-effectiveness will outsource the call center (Preez & Bendixen, 2019). However, call center plays a critical role in customer engagement and "customer engagement represents a strategic imperative for generating enhanced corporate performance" (Brodie, Hollebeek, Jurić & Ilić, 2011). As presented to this point, companies are usually familiar with the cost of running a certain organizational unit. However, the problem is more often with companies not being familiar with the costs of outsourcing. Insourcing is a strategy while outsourcing is a quick solution, and quick solutions in business can be costly (Kalis, 2018). Although a particular organizational unit carries the costs of running it, just like a call center, outsourcing also carries certain costs. What is more troubling is that some of those costs are not easily noticed.

A good rule of thumb for differentiating the two is that regular costs are more tangible than hidden costs. Easily noticed costs are production costs in functional area and transaction costs (Potkany, 2016). In the case of outsourcing the petrol company call center, cost per call would be the production cost since it can be found on the invoice of a service provider, while transaction costs are associated with creating a contract between a client and a service provider.

On the other hand, pinpointing hidden costs is very challenging and requires expert knowledge and practical experience (Potkany, Stasiak-Betlejewska, Kovac & Gejdos, 2016). In spite of that, avoiding looking at hidden costs is poor managerial judgment since it ranks high among damages caused when outsourcing call center, right after brand damage and increased complexity.

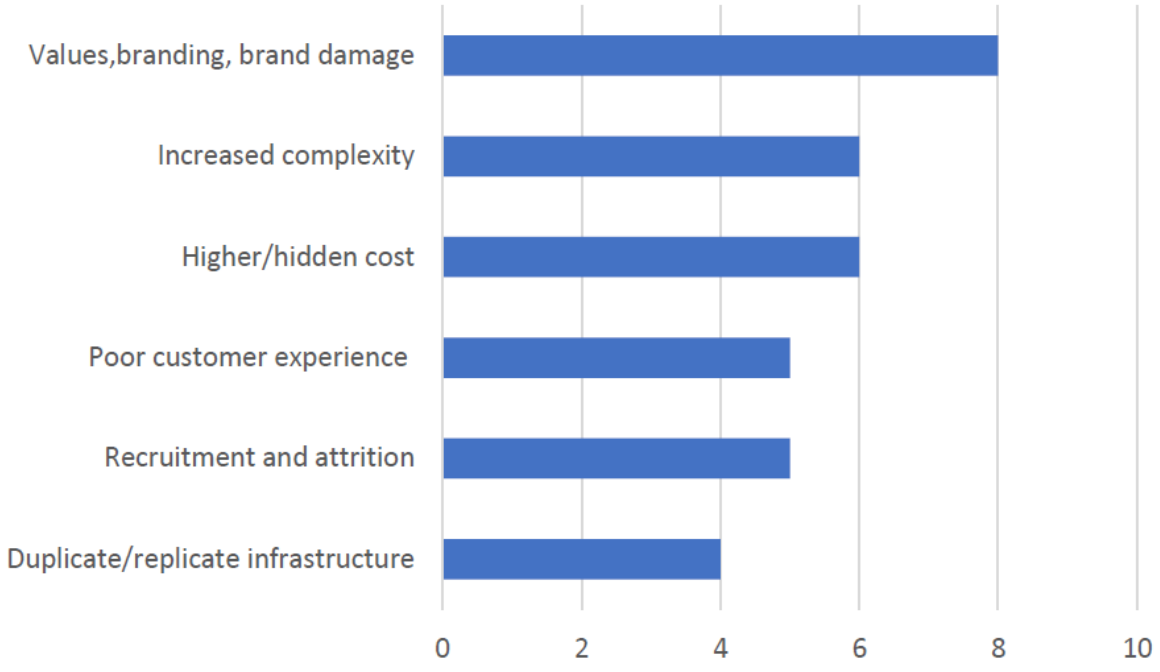

Figure 2: Outsourcing contact centers – Internal branding challenges and consequences

Hidden costs are vendor selection costs, transition costs, hidden transition costs, costs of controlling quality of processes and costs of contract management (Potkany, Stasiak-Betlejewska, Kovac & Gejdos, 2016). In the case of outsourcing the petrol company call center, costs of collecting and analyzing data, documentation and valuation, and travel expenses could be vendor selection costs. Contract fees, outplacement and retention bonuses could be transition costs. Cultural costs and cost of layoffs, less motivated and productive employees, could be hidden transition costs, and they are (hidden among hidden costs) even harder to pinpoint. Cost of new or updated software and hiring new employees could be costs of rump-up or in other words – controlling the quality of processes. Finally, invoicing and auditing costs could be costs of managing the contract. The chart below represents percentage added onto the cost per annum for each of the hidden costs associated with the outsourcing deal.

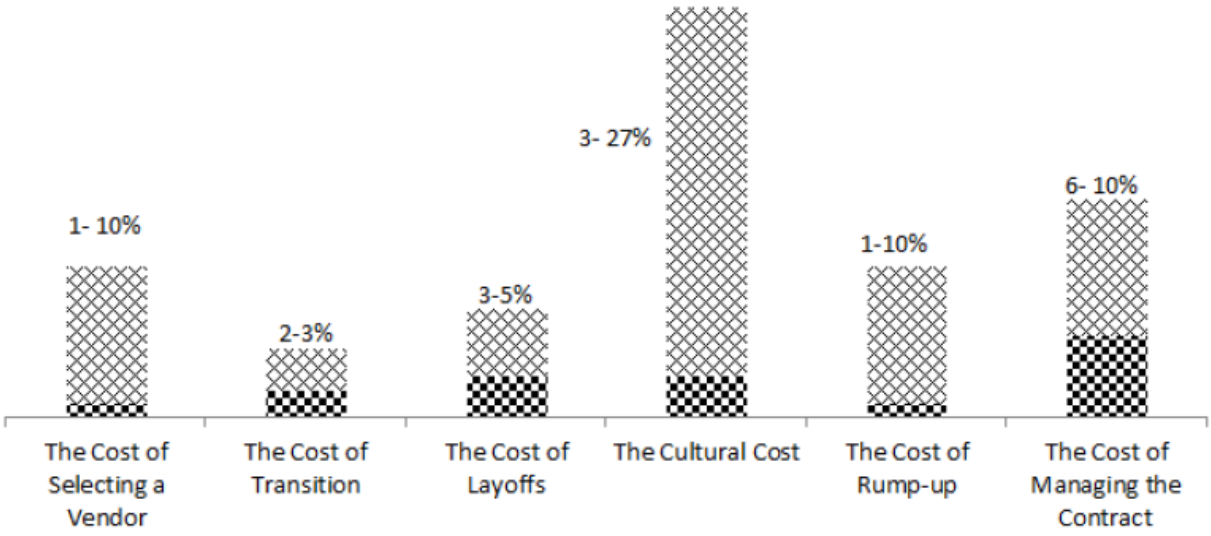

Figure 3: Outsourcing in Conditions of SMEs – The Potential for Cost Savings

As can be observed from the chart, the cost of selecting a vendor, the cultural cost, the cost of rump-up and the cost of managing the contract can end up making up the most of hidden costs.

The Cost of Selecting a Vendor

Task group was formed by the petrol company to select a vendor for the call center services instead of hiring an outside consultant. One might wonder whether there was a cost at all since the process of vendor selection was internally with the group of employees already being paid by the petrol company which is exactly why this is a hidden cost. Although costs were internalized, they were still there – travel expenses (not all members of the task group were in the same city), collecting and analyzing offers (longer work hours), administration (tender committee), etc. Obviously, only in-country vendors were eligible because of language specifics.

Ultimately, as the result of the selection process and all of the costs associated with the process, the best candidate for outsourcing the call center turned out to be the company Trizma. However, as mentioned previously, Trizma had higher cost per call than petrol company`s call center.

The Cultural Cost

The cultural cost can be the highest, as well as the most intangible and the hardest to quantify. They can also keep accumulating over a long period, much longer than a year. Organizational culture is a medium through which experiences, values, rituals and routines are shared, and culture depends heavily on physical presence (Hendry, 1995). The petrol company`s call center is a textbook example of an organizational unit deeply entrenched in the company culture, and there is no call center service provider that could come even remotely close to emulating this performance trait.

On several previous occasions, most poignantly when the ownership structure was changed, organizational culture of the petrol company has proven to be seriously vulnerable when employees become suppliers or consultants and did not belong to the “core” any more. For the few this may turn out to have the positive effect, but for many more it represents rejection and is likely to have quite the opposite effect. So, potentially you are dealing with a lot of insiders who are actively disengaged and probably entertaining the idea of harming the employer (Tupia, 2010). One clear setback can be found in motivation to perform up to the par. Simply, those on the outside have a hard time relating to the well-being of those inside. As a result, loyalty to the organization takes a direct hit and the prevalent feeling of those on the outside is that of betrayal.

The Cost of Rump-Up

One of the basis for outsourcing can be access to new technology (Gonzalez, Gasco & Llopis, 2010). Usually, the cost of rump-up is whittled down to the cost of updating technology. What is easily overlooked when considering outsourcing is the necessity to update internal technology in order to harness the technology used by outside provider.

The petrol company updated CRM (Customer Relationship Management) software, and installed advanced telephones and headphones, before thinking about outsourcing call center services. Nonetheless, the cost was incurred.

The Cost of Managing the Contract

This cost is derived from substantial attentiveness on managing the outsourcing contract. Instances of this management encompass placing the operation on their own premises; tight supervision of the employment habits of the outsourcer; keeping complete control and access to all key performance data, and not forcing conduct penalties on the outsourcer, by preserving inside responsibility for operating outcomes (Preez & Bendixen, 2019).

It took time to build trust between the petrol company and the outsourced provider of the call center, and the company kept a watchful eye on every aspect of the service which came at the considerable cost. In the beginning, only a part of call center services was outsourced regarding the loyalty program. However, there were quite a few complaints from customers, much more than there used to be before outsourcing. This led to some changes to the contract in order to improve the process. Ultimately, instead of transferring more of call center services to outsourced provider, less was left under its jurisdiction.

5. CONCLUSION

In the case of MNPC, it was realized that reducing costs is not a good enough reason for outsourcing the call center. In fact, it became obvious that outsourcing the call center would cause far more damage than savings. The very idea that outsourcing would lower or eliminate costs was disproved. On the other hand, the negative relation between outsourcing and organizational performance was so compelling to the management that the decision was not merely to give up on the outsourcing idea, but to integrate the call center further into key organizational processes in order to make them more efficient.

The most important development following this decision was incorporation of the call center into the group for crisis management. However, the team had to prove themselves. The foreign consulting company was brought in to simulate an actual crisis to see the response. The scenario was that several air planes had to land in emergency because of inadequate quality of our fuel. The call center was as the forefront of the situation because all the simulated calls came through it. The company`s reputation was on the line and the response had to be quick and effective. The manager was going back and forth between the call center and the crisis room. Suffice it to say that all this was happening while the regular call center operations were in full swing. When the exercise was over, representatives of all business units had to meet with the general manager and the consultant to brief them on their impressions. The call center received highest marks and commendations as the “strongest link in the chain” by the consultant. This was a final nail in the coffin of the outsourcing idea.

So, contrary to the popular opinion, it was not easy to outsource the call center. As it was presented in the case of the petrol company, it turned out to be costlier to outsource the call center, and which would result in the serious drop of customer service quality. In addition, employees of the call center are an invaluable resource who are expected to grow with the company and assume advanced positions in the future, and are closely tied with the long-term plans. Also, call center`s importance to internal customers can be overlooked; and in the case of the petrol company internal customers are every bit as important as external customers.

As you may assume by now, the biggest obstacle while doing the research were confidentiality problems. It proved difficult to obtain the permission from the management to use some of the data collected for the purpose of analyzing call center`s performance. Considering that I was using the petrol company as a real world example to support the theory, it would have been more effective and direct if I was allowed to use all the material prepared for the management.

Another limitation is in generalization of findings which is inherent to a case study method, but can offer extensive insights into complicated social systems and is advocated in social sciences (Feagin, Orum & Sjober, 1991). Some business schools favor case study method as the best tool for teaching.

Potential research alternatives in developing this paper further could include researching companies which had the same call center outsourcing issues; see what analyses they performed and what was a final outcome, and then make parallels with the case of MNPC call center.

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