ENVIRONMENTAL AND SOCIAL IMPACT OF DIGITALIZATION

ENVIRONMENTAL AND SOCIAL IMPACT OF DIGITALIZATION

ANDROID APPLICATION FOR RECORDING SIGNED CONSENTS FROM GDPR REGULATION

Nenad Badovinac[1*]
[1]University of Belgrade, Faculty of organizational sciences
*Corresponding author, e-mail: nenad.badovinac@gmail.com

Abstract: *The General Data Protection Regulation (GDPR) defines the regulations on the protection of personal data of individuals from the European Union (GDPR 2016/679/EU). Countries like Serbia, where individuals from the European Union do business, should also apply this law (GDPR, 2016). According to Article 3, the GDPR regulation (GDPR, 2016) seeks to harmonize the protection of fundamental rights and freedoms of individuals related to the activities of personal data processing. The idea presented in this paper is a conceptual model of an android application that should enable individuals to actively manage the fundamental rights provided by the GDPR regulations. This android application will speed up and simplify the process of recording signed Consent, sending requests to companies (controllers) (EU-GDPR, 2018) in order to get the information about purposes of the personal data usage. It will then simplify the fulfillment of the individual's right to erase personal information or to transfer it to third parties. In addition, the android application runs the process of recording possible violations of privacy. All these processes will be integrated into the Android MyGDPR application that will be available to the user on the smartphone. The application has an integrated interface linked to the internet forum where this GDPR regulation is discussed. In order to complete the process of managing the fundamental rights of personal data security, communication with the consulting team of legal experts dealing with the issues of GDPR regulations, through this android application, is available to the individuals.*

Keywords*: GDPR regulations, mobile applications, android.*

1. INTRODUCTION

Modern information and communication technology has accelerated the flow of personal data on the Internet. Therefore, there is a need to use this technology for the protection of personal data. From the May 25th 2018, there will be current GDPR regulations concerning the protection of personal data (Directive 95/46/EC). This is a law relating to: rules for the protection and processing of individuals personal data, the protection of fundamental rights and the freedom to manage personal data and the guarantee that personal data can be freely exchanged within the European Union (GDPR, 2016). In short, GDPR deals with ways of processing personal data. GDPR - The General Data Protection Regulation is to allow people to control their personal information (MA Healthcare Ltd, 2017). Most articles of the GDPR regulations relate to companies (controllers) and ways in which they need to process individuals personal data (EU-GDPR, 2018). The GDPR regulation defines the rule that before the data usage, the company will allow an individual to sign an agreement by which he/she gives the company the right to use his/her personal data. Since individuals will be signing different Consent for many companies, it will be harder to keep records of all signed Consents over time.

The idea of this work is to create a conceptual model of Android smartphone application that will serve for recording of signed Consents and will simplify the management of rights. This Android application should help individuals in the management of personal rights and establishing contacts with legal consultants dealing with GDPR regulations.

2. INDIVIDUAL RIGHTS DEFINED BY GDPR REGULATIVES

The GDPR regulation defines the rights related to the protection of individuals personal data. Individuals in different companies will sign different Consents. By the regular organization of the signed Consents a user will be able to record and make it easier to use his rights. Individuals rights provided by GDPR regulations (GDPR, 2016) are:

- Consent - According to GDPR, a company that collects individuals personal data must indicate for what purpose it collects them. Companies need to ask for the consent from individuals for data collection and processing. By signing the document, the individuals gives his consent to the company.

- Right to access by the data subject - At any time, individuals may request information about where and for what purpose the data is used.
- Right to erasure (right to be forgotten) - Individuals has the right to request the deletion of personal data kept by the company. This means that he/she can withdraw his original consent.
- Right to data portability – Individuals may require from a company that processes his data to send it to a third party.
- Violation of privacy - If an unlawful use of personal data occurs, a company is obliged to notify individuals within 72 hours.
-

3. MYGDPR APLICATION METHODOLOGY

It is anticipated to develop the mobile application for the Android platform, because it is the system that is most represented on the mobile phone market with 85.1% of the market share (F.Richter, 2017). Android mobile applications will simplify the process of registering issued consent and managing individuals requirements for: changing personal data, deleting personal data, transferring personal data to third parties. The methodology of the MyGDPR application is shown in Figure 1. The user logs in to the mobile application with his user login and password. At the first sign-up, the user enters his/her personal information and thus registers for the application. A company official gives a user the consent for the signature. When a user signs the agreement he makes a photo of a signed consent using his mobile phone. The application stores the photo and processes data recognized by the OCR algorithm. The application has an interface to the Internet forum and to a legal service specializing in GDPR regulations.

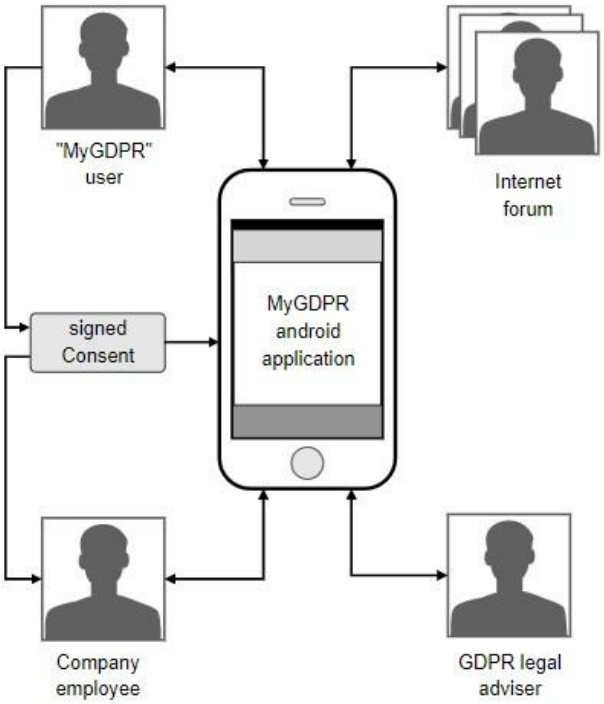

Figure 1. Diagram of subjects' activities in the MyGDPR workflow process

The application enables the user to contact the companies from which he can claim fulfillment of his rights in accordance with the GDPR regulations. The rights provided by the GDPR can be achieved through the MyGDPR application, which are (GDPR, 2016):

- For the "Consent" right - in the MyGDPR application, the user will be able to take a photo of the signed Consent document that will be OCR read and written in the database. The date of signing the Consent and the purpose for which the data is collected will be written all together with the Consent.
- For "Access Right" – Individuals can search through the MyGDPR application which companies have got his/her personal data and contact them via an email service embedded in a mobile application.
- For "Right to Forget" - MyGDPR application provides easy contact with companies in case individuals wants to delete concrete data.
- For the "Right to data portability" - the application allows the user to request the company to forward specific personal information to a third party.
- Violation of privacy - MyGDPR application will record any company's notification of in the event of leakage or unauthorized use of personal data.

4. THE CONCEPTUAL APPLICATION MODEL

The application has several input data, such as: the signed Consent that has been photographed and read by the OCR algorithm and the list of personal data that the user links with the scanned Consent. These will be those personal data for which the user has signed the Consent. Extraction of text data from digital photos is a key prerequisite for the accuracy of personal data, therefore it is important to choose the optimal OCR algorithm (A. Chiatti et al. 2017). Smartphones allow the executation of the text recognition process. There are many OCR algorithms where for the specific purpose should be used the one which takes a photo of a signed document using a camera embedded in a smartphone, recognizes the text and forwards it to MyGDPR application (JC. Burie et al. 2015).

Table 1 Subjects' privilegies in the process

Entity	Writes	Reads	Executes
A user of MyGDPR application	Yes	Yes	Yes
Company employee (controller)	Yes	No	No
Forum users	No	No	No
Legal adviser for GDPR	Yes	No	No

Table 1 shows the privileges of individuals entities. A user has the ability to add personal data to the database. He can access the forum and send messages to companies (controller) and legal advisers. Data is recorded in the database, such as: personal data, sent and received messages, complete user activity in the forum. A user can exercise his rights in the application. A company employee (controller) can only share messages with MyGDPR application. Forum users do not have access to the application. Legal advisers can write their expert opinions in the database (M. S. Malkari et al. 2018).

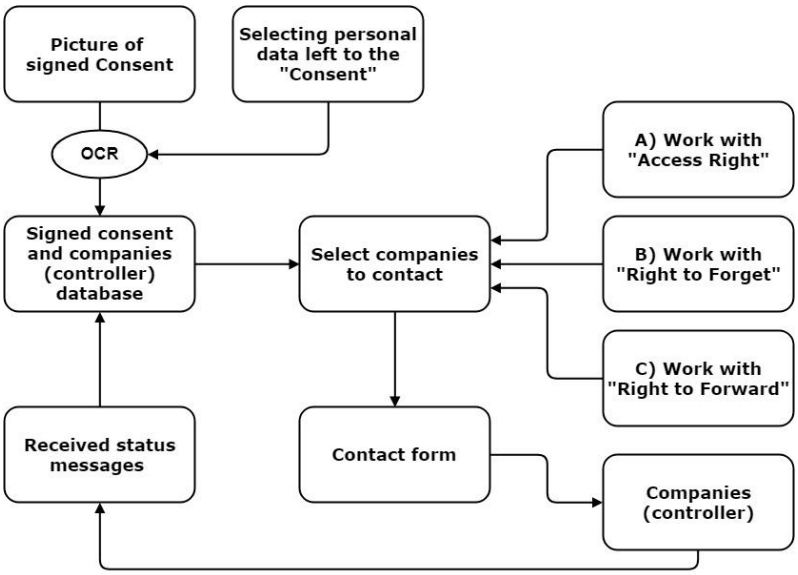

Figure 2. The conceptual application model

Figure 2 shows the conceptual application model. The first step is to take photographs of the signed consent. The scanned document is recognized by the OCR algorithm and the user marks the data from the list for which the Consent was signed. Data is stored. By selecting the A, B or C functions from Figure 2, the user is offered a list of those companies (controllers) that have signed the Consent. Choosing the right and selecting a company will launch a contact form with a pre-defined message sent by the application to the selected company. After sending the notification, the company is obliged to fulfill the request. The feedback will be recorded in the program module "Messages" and the database, and the user will be notified of the status of his rights. The Privacy Recovery feature allows the user to record notifications from the company.

5. MODEL IMPLEMENTATION

MyGDPR application model is shown in Figures 3a, 3b and 3c. Figure 3 shows the basic screen, with the "Input Consent" function. This feature allows you to scan and input signed Consents into a database. On this screen, the user of the application can choose the type of rights he wants to use. The user can manage "Messages". By choosing "Forum", he/she is allowed to access the user forum and follow the discussion on GDPR regulations. There is a function "Entering personal data" as well. Figure 3b shows a mobile application screen that can be called by the "Input Consent" function. A user assigns a list of personal data

that is stored in the database to the scanned Consent. Figure 3c shows a screen that is called when the user wants to search the database of all companies that have signed the agreement and select the companies in which he wants to exercise his rights. When selecting companies, the user needs to click on "Send Requests". At that moment a pre-defined email message is sent to companies that will reply in the timeframe prescribed by law.

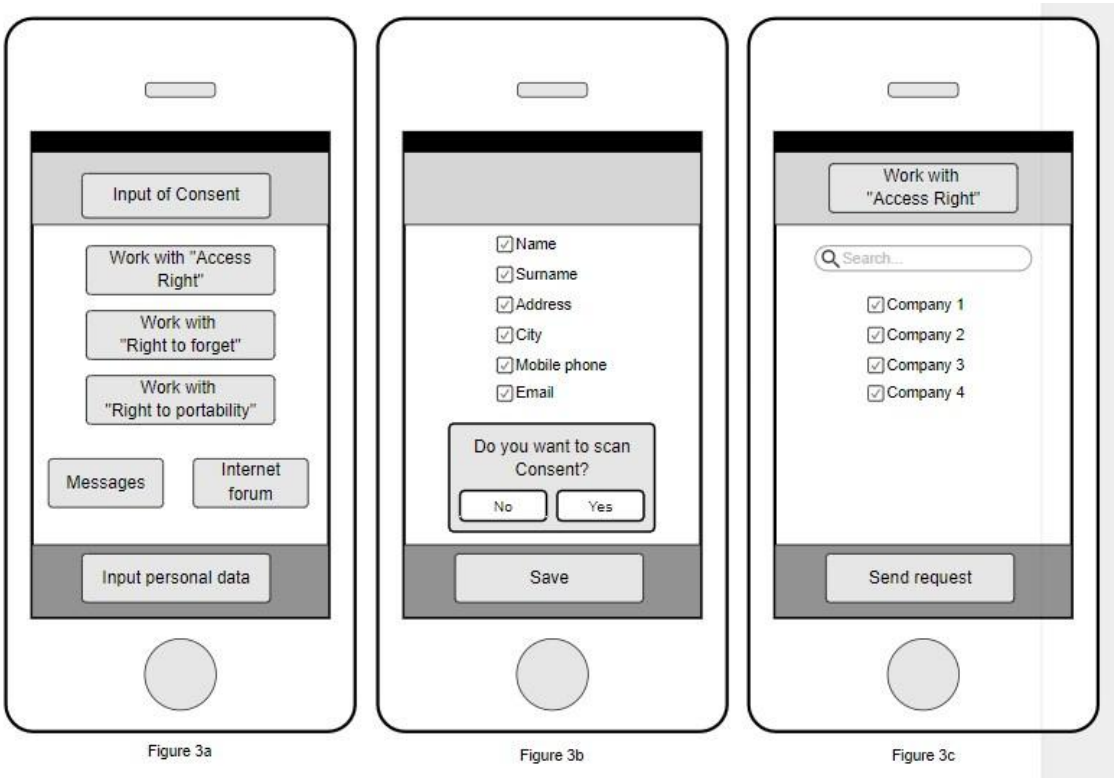

Figure 3a, 3b and 3c. Show MyGDPR application design

6. DISCUSSION

The presented application offers the user the opportunity to use his rights defined by GDPR regulations. A link to an internet forum for sharing comments and suggestions will motivate the user to further exploit his rights. Forum users can more easily share knowledge and experiences about their rights defined by GDPR regulations. The idea presented in this paper is an Android application that in an intuitive way offers users the ability to record the signed Consents and help to fulfill the rights prescribed by the GDPR regulations. Using advanced algorithms, with minimal modification, it is possible to install an additional fuzzy configuration which, by consulting external databases, could provide the user with a timely reminder to activate certain rights. With an adequate business plan, this application can definitely be widely used, from which investors could make money. For the security of personal data, this system needs to be protected, because many applications communicate with each other and thus exchange personal data. This requires the use of authentication techniques (Heloise Pieterse et al. 2018). For system security, it is necessary to use a software module that will log in to the system in case some personal data is accessed by a third party. The software module in charge of the security of the data should be used to control suspicious applications requesting permission to access personal data (P. Berthomé et al. 2012). For example, it is important to control the operation of the camera that takes pictures of the signed consent on which personal information is placed.

7. CONCLUSION

The purpose of the mobile application presented in this paper is to raise user awareness of his/her rights brought by GDPR regulations. A mobile application can best organize the record of the signed Consents and the reminder's functionality to his or her rights. After creating a business plan, it will be easier to get in touch with a potential investor who would invest in the development of this application. Following the discovery of the investor, the next step needed to realize the idea is to consult legal experts in the area of GDPR regulations that would give their final opinion. After that, the development and publication of the application is possible.

REFERENCES

A. Chiatti, X. Yang, M. Brinberg, M. Jung Cho, A. Gagneja, N. Ram, B. Reeves, C. Lee Giles (Decembar, 2017): "Text Extraction from Smartphone Screenshots to Archive in situ Media Behavior", K-CAP, DOI: 10.1145/3148011.3154468

Directive 95/46/EC (1995) of the European Parliament. Council:October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data. Retrieved from: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:31995L0046&from=en

EU General Data Protection Regulation (2018) (EU-GDPR): Retrieved from: http://www.privacy-regulation.eu

General Data Protection Regulation 2016/679/EU (2018). GDPR portal: Site Overview. This website is a resource to educate the public about the main elements of the General Data Protection Regulation Retrieved from https://www.eugdpr.org/

GDPR Uredba (2018) 2016/679. Retrieved from http://esigurnost.org/wp-content/uploads/2018/01/GDPR-Uredba-2016.679.pdf

Heloise Pieterse, Martin Olivier, Renier van Heerden (2018): "Smartphone Data Evaluation Model: Identifying Authentic Smartphone Data", Digital Investigation. DOI: 10.1016/j.diin.2018.01.017

JC. Burie, J. Chazalon, M. Coustaty, S. Eskenazi, M.M. Luqman, M. Mehri, N. Nayef, JM. Ogier, S. Prum and M. Rusinol (2015): "Competition on Smartphone Document Capture and OCR (SmartDoc)", 13th International Conference on Document Analysis and Recognition (ICDAR), 978-1-4799-1805-8/15/

MA Healthcare Ltd Keeping it secure: data security in residential care, (February, 2018). Downloaded from magonlinelibrary.com on February 6, 2018. NRC | vol 20

P. Berthomé, T. Fécherolle, N. Guilloteau and J.-F. Lalande (2012): "Repackaging Android Applications for Auditing Access to Private Data", Seventh International Conference on Availability, DOI: 10.1109/ARES.2012.74

M. S. Malkari, P. R. Gopalani, G. N. Basutkar, R. D. Garud, P. P. Rukari (2018): “An Android Application for Smart College”, International Research Journal of Engineering and Technology, ISSN:2395-0056

F.Richter (2017): “World smartphone operating system market share”, Retrieved from: Gartner, https://www.statista.com/chart/4112/smartphone-platform-market-share/

DIGITAL AGE AND SUSTAINABILITY OF THE ENVIRONMENT IN THE FIELD OF HIGHER EDUCATION

Nedeljka Živković*[1]
[1]Belgrade Business School-higher education institution for applied studies, Serbia
*Corresponding author, e-mail: nedeljka.zivkovic@yahoo.com

Abstract: *The aim of this paper is to present the research of the impact of higher education in the sustainability of the environment in the contemporary digitalization process. The higher education area represents an important segment in sustainability of the environment protection via raising the awareness of students as future experts in the process of transformation and adjustment of organizations. The paper places an emphasis on the importance of the transformation of the environmental protection management system in the process of digitalization and sustainability of the environmental protection in the higher education area. A series of specific features of one institution of higher education in the system of higher education is brought to the attention. Furthermore, based on the data availability, the application of the use of standard ISO 14001 in the organizations in various geographic areas is also presented. The following segment of the paper is dedicated to the importance of adjustment of organizations in the process of digitalization of environmental protection through the higher education area, especially because higher education institutions are specific institutions which must participate in the process of digital transformation of entire economy. The demand for overall participation in the environmental protection is justified and binding.*

Keywords*: environment, higher education, higher education institutions, digital age, ecological management*

1. INTRODUCTION

Higher education provides a significant contribution to the digital transformation of the ecologic management. The consequence of the environmental disturbance became prominent as of the middle of 20th century. In present conditions it is unequivocally clear that the contemporary technology is not in correlation with the level of the environmental protection which causes tremendous consequences for the environment. Ecological categories of the level and manner of environmental protection have become of great importance. The fundamental idea of the digital age for sustainability of the environment in the higher education area starts with the development and raising of the ecological awareness with students as future developers, engineers, designers and other skilled people who acquired higher education and who will represent the backbone of the systematic management of the environmental management system in institutions of higher education in the times to come. *Weert and Kendall (2003) state that "the progress of computer sciences in higher education initiates compact studies of the environmental protection".* Current natural environment is the consequence of insufficient and non-systematic work in past. Therefore, the expectations from higher education institutions to participate and promote the importance of ecological protection at digital age as macro-goal are higher. Based on the report of the Association for the Advancement of Sustainability in Higher Education from 2014, in the USA there were 1,274 programs of study dealing with the education on environment and sustainability, as stated in the report AASHE (2014). The basic goal of the environmental management system in the higher education area is to introduce and apply business rules with regards to the natural business environment, especially by efficient actions aimed at preventing the emergence of pollution, uncontrolled and excessive consumption of natural and energy material and resources influencing the pollution of the environment, with the development of effectiveness and efficiency of business operation in accordance with these goals in future.

2. THE IMPORTANCE OF SUSTAINABLE DEVELOPMENT OF THE ENVIRONMENT IN THE HIGHER EDUCATION AREA

Contemporary natural environment results in major global changes threatening the resource sustainability due to insufficient and non-systematic work in past and present on preservation and protection of the environment. *Filipović and Đurić (2009) emphasize that "the management of satisfactory ecological quality of products is a part of the quality management and environmental management".* The fundamental goal of the application of the standard of the ISO 14000 series is to support the environmental protection as well as the preventive actions to the influence of pollution pursuant to the principles of sustainable development. The environmental management system (EMS), ISO Survey (2015) is the manner of contribution presentation of every organization in the protection and influences to the environment pursuant to the strategy, politics and

goals of the organization as well as the policy and goals of environmental protection. The production of products and provision of services are developed by the people within the environment, as stated by Goetsch and Davis (2016) The environment management system should establish mechanisms for the process of transformation and choose the option of determination of goals and implementation of determined policy as well as the prevention of environmental protection and accomplishment of consistency. The system of digitalization transformation as a part of the environmental management process is the responsibility of each organization in the function of accepting the responsibility and gaining trust of all interested parties as well as the fact that the top management is responsible for the fulfillment of requirements on changes of the environmental protection with the higher level of application of preventive than of corrective measures. The number of certified organizations which are certified by 14001 standard in the world is presented in Table 1.

Table 1: 9 world countries with 14001 certificate (Bevilacqua, Ciarapica and Giacchetta, 2012).

Geographic area:	**The number of certified organizations**
China	6159
Italy	2745
Spain	2505
Germany	975
Korea	938
Sweden	729
Romania	702
Turkey	505
Switzerland	503

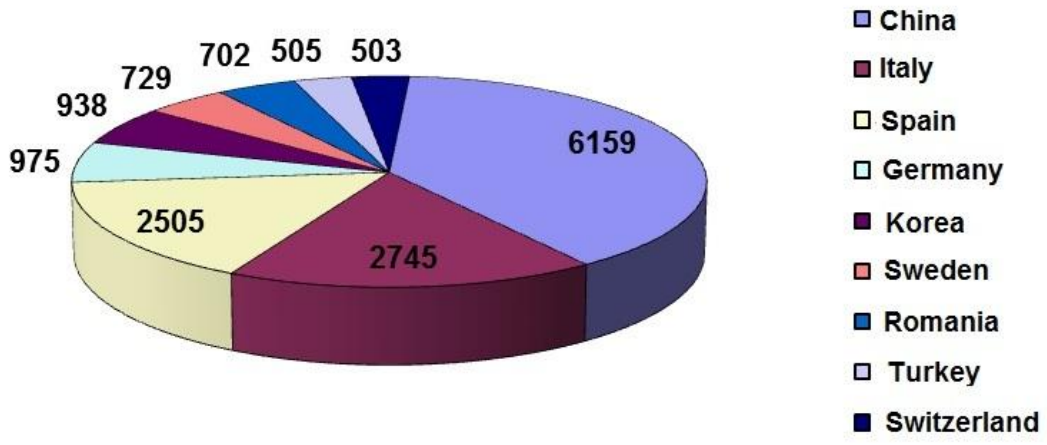

Image 1: Graphic representation of 9 world countries with 14001 certificate

Even though the number of certified organization is rapidly growing, it is still smaller than the number of certified organizations with regards to the application of the standard of ISO 9000 series. The response should be the raising of the awareness about the importance of environmental protection and effective and efficient management in this field. Raising the awareness of students through the process of higher education may contribute to the improvement of the ecological management system and have positive results. Products-services are the subject in focus of human activities and mutual actions. The road to digital transformation and consistency with requirements of natural environment and environmental protection is accessed to in a systematic manner. The systematic analysis and application of corresponding regulations, rulebooks and other documents result in clear criteria.

2.1. The role of digitalization in the environmental protection management system in the higher education area

Recently, the term ecological management has become increasingly present. Nowadays for an organization to survive at the market it is not sufficient just to produce a product or provide services which satisfy the quality features at the market and competent price. Therefore, each organization must find satisfactory solutions among economic and ecologic requirements as well as the readiness to fit into the digitalization process by establishment of the environment management system. A specific field of environmental management system refers to the part of process of overall changes related to waste, water, air, pollution, noise, etc. The tendency of the environmental management system is to provide, by compliance with and application of corresponding requirements and transformations, the application of requirements regarding the environmental conditions as well. The system of higher education provides significant support and incentive to organizations so that they could fit in the part of the process of digital age. *(Maletič, Borojević, Petrović, Maletič and Senegačnik* (2017) emphasize that "*when it comes to the quality of education, it should be pointed out that this quality represents a dynamic and multidimensional concept which does not refer only to the model of education but also to the mission and goals of the educational institution as well as to specific standards which are applied in education*". The role of higher education in the management system in the sphere of environmental protection helps the top management of an organization to provide the following:

- Structure of tracking the market demands;
- Activities for tracking own influences to the environmental protection;
- Establishment of good relations with all interested parties (stakeholders);
- Continual efficiency improvement;
- Motivation of all employees for accepting changes.

Each management system has its own specific properties, but all of them are based on following activities:

- Policy and goals;
- Planning;
- Functioning;
- Performance measuring;
- Continual improvement;
- Management review.

The environmental protection management system helps organizations in the adjustment within the transformation process to establish mechanisms for their own impacts on the preservation of the environment. The role of higher education in the environmental protection management system is based on the increase of the awareness of future experts and prevention of certain activities and processes with negative impact on the environmental systems. Realistic goals are determined and necessary operational measures for the accomplishment of these goals are introduced. Higher education institutions play an important role in the accomplishment of comprehensive goals in the process of adjustment to digitalization. Pursuant to legal and other acts, sustainability of activities of the impact to the environmental protection helps every organization identify its performances in the field of preservation of the importance of environmental protection. The environmental protection management system establishes mechanisms as a response to increasing demands of the environmental protection. The environment represents the surrounding of the organization as follows:

- water;
- air;
- natural resources;
- people and their mutual relations;
- flora;
- fauna

Produced products or services have an impact on the quality of the environment. Contemporary technology and industrial revolution have a major negative impact on the environment. The greatest consequences of negative impacts are present at industrially most developed geographic areas: USA, Western Europe and also other countries in recent decades. Higher education institutions should encourage organizations, in the application of contemporary technology, to improve environmental protection through the digitalization process. As time passes, more and more organizations invest great efforts to show their contribution to solving the problem of transformation in the environmental protection by establishing mechanisms for control and reduction of negative consequences. It is important to emphasize that the development of a more strict legislation and economic and other measures influence the environmental protection as well as an increasing concern of the interested parties of an organization.

3. THE SUSTAINABILITY IN THE HIGHER EDUCATION AREA USING CONTEMPORARY TOOLS OF FUTURE

Planning, design and environmental protection may provide organizations with enormous positive changes by application of the standard on environmental protection. The basic purpose of the standard is to control the risk of pollution of the environment. The series of ISO 14001:2015 (ISO 2015) standard is relatively generally accepted application, not like ISO 9001, but more than other standards. The standard is also systemic because it requires audits, reviews, goals, etc. The standard is compatible with legal and other requirements, which in the Republic of Serbia means that the requirements, as normative requirements, are on a very high level.

The application of the standard and certification are important for each organization. The adoption and application of the standard function as a generally accepted model at international level as the model of the environmental management system which emerged as a consequence of increased responsibility for the environment. By applying the standard, each organization has consistency and evidence of responsibility toward the environment. Moreover, the organization proves the application of international rules and regulations as well as creation of market reputation. The basic goal of the standard application is to create an international model of rules about the environment. Even though the application of the standard is voluntary for organizations, many individuals among interested parties demand the application of the standard for environmental protection. With implementation and application of the standard, the mechanisms for tracking of the process and activities with negative impact on the environment are established, and then realistic goals and necessary operational measures for prevention of the environment are designated. Basically, the standard requires the top management of an organization to establish and implement the environmental policy. The strategy and policy of environmental protection should be documented and accessible both to employees and to general public. *Lee (2002) points out that "in future, the majority of organizations will be forced to comply with legal and other regulations, as well as with the* requirements *of interested parties for the implementation of ISO 14000 standard".* It is completely realistic that there are negative consequences, that there are products or services at the market with negative impact on the environment due to their processes and activities. Organizations should aim at achieving double effect, from both economic and environmental aspect. Therefore, the proper manner of perception and understanding of these issues is to implement and apply ISO standard of 14000 series.

3.1. Environmental protection in the role of higher education

Ecological education represents an identification of scope of activities of the society in general. It provides very complex knowledge of ecological issues of the contemporary society. It also develops negative and critical attitude toward degradation of the environment and natural surroundings. The basic principle of ecological education is to raise ecological awareness with students about the preservation of the environment. With regards to the development of technology and technological progress, ecological environment must be more present and prominent especially with students as future experts. From the aspect of ecological awareness with students, the education through higher education aims at raising the awareness about the need and mandatory ecological protection and it is expected that students be future leaders of the implementation of environmental protection development. Filipović, Đurić and Teodorović (2008) point out that the research of the importance of environmental protection may enable building and lifting of the awareness about healthy surrounding of a man's life and work which consequentially impacts human activity. Higher education may indicate to the roads of human action and provide necessary knowledge about the laws of nature and transformation into digitalization of the environmental protection.

Students with acquired and applied knowledge should be involved into positive actions with the aim of environmental protection. Students may greatly contribute to the role of environmental protection and natural surrounding by organizing ecological actions and improving ecological awareness. Educational institutions are the backbone of education in this field. Education for the environmental protection is the process which may influence people in terms of the development of their intellectual, spiritual and physical abilities, which insist on the sustainable development and functioning of the human society as a community. The introduction of the ecological topic into the basic scientific processes of today represents a crucial segment of education for the environment.

3.2. The model of the environmental protection management in the higher education area

According to the standard, the model of environmental management may be classified into the following categories:

- Environmental protection policy,
- Planning,
- Application and implementation,
- Audits,
- Top management review,
- Continual improvement.

The strategy, goals and policy of the environmental protection refer to the methods and curricula related to the environmental protection. The planning refers to the establishment of the mechanism for the analysis of the environmental aspects. The application and implementation refer to the organization of activities which are of importance for the environment. The audit refers to the process of tracking and measuring as well as of taking preventive and corrective measures with significant impact on the environment. The top management review significantly contributes to effectiveness. The continual improvement comprises continual improvement of all activities and processes. The education system represents a traditional service-providing activity.

Based on the standards, strategies and policies of the environmental protection in the higher education area, it should be provided that all mechanisms for the introduction and continual improvement of the management system in the sphere of environmental protection are established. As previously said, higher education institutions are specific organizations which are regulated by law on higher education, which requires from the top management dedication, compliance and application of legal and other regulations so that it would be clear primarily to immediate users – students, as well as other interested parties. The top management of each organization must introduce mechanisms for the subject and field of application of the environmental management system as follows:

- Corresponding impact on the environment,
- Consistency with legal and other regulations,
- Activities referring to continual improvement of pollution prevention,
- Provision of model for the establishment of general and specific goals,
- Sufficient documentation, application and sustainability of all aspects in the sphere of the environment,
- Notification for all employees, both in teaching and non-teaching process,
- Availability, audit and measures
- Environmental protection policy should be communicated to all employees and they must be introduced to the rules, regulations and actions in the sphere of environmental protection.

3.3. The aspects of the environment with reference to higher education

Each organizational unit, in this paper higher education institution, should introduce mechanisms for the identification of all aspects related to the environmental protection as well as for faster transformation of digitalization in economy in general. In the sphere of studies at the level of graduate studies, master studies, specialist and PhD studies, special attention is dedicated to environmental protection and studying of this field. Many higher education institutions have specialized programs of study in the sphere of environmental protection. The major impact of higher education is to transfer scientific knowledge as well as to create a permanent program for successful battle with all forms of danger to the environment. The creation of highly competent professionals contributes to the creation of the foundation for successful design and planning of the development of ecological security and safety. The basic role of programs of study which deal with ecological knowledge should be to identify the research and scientific approach in the sphere of environmental protection and also to raise the level of higher education ecological knowledge. In order to implement the model of sustainable ecological community, it is necessary to transform all fields in the sphere of environmental protection.

Based on the standard, in essence, there is no a unique frame for the identification of environmental protection aspects. Apart from all the aspects which each organization may control (this especially refers to production companies) and since the subject of this paper refers to the service-providing scope of activities as providing and transfer of scientific knowledge, each organization should consider also those aspects it may influence. In the identification of environmental aspects, the top management should determine the criteria and methods for those of importance. Even though there are no unique methods for determination of important ones, it should be focused on those which achieve the best results and which are consistent in application. I the review and analysis of information referring to important aspects of the environment, the top management should take into consideration the need for preservation and archiving information of importance for the environmental protection.

3.4. The application and implementation of digitalization of the environmental protection system in the higher education area

Kopnina and Cocis (2017) say that the increased interest in ecological education resulted in raising ecological awareness of students even by short educational programs with eco-centric value included. The top management in organizations should establish the policy of obligatory establishment and functioning of an efficient and effective environmental protection management system and by digital transformation organizations should fit in the contemporary manner of functioning and operation of organizations. The identification of goals represents the concept based on which the subject and the field of application are designated. Essentially it means that is should be determined what type of data is requested and in what manner they will be collected in the process of application and implementation of an efficient environmental protection management system. Pursuant to the ISO 14001 standard organizational systems therefore higher education institutions as well should be actively oriented toward an efficient and effective process of environmental management. Therefore, it is important to define:

- Resources:
- Orientation;
- Policy;
- Responsibility and authorizations.

According to the standard, in order to accomplish a successful application of the environmental protection management system the support of all employees is required. With regards to that, these functions do not refer only to those activities which are immediately related to the environment but also to all the activities with indirect impact on the environmental protection. Students and employees may find the strong orientation toward the environmental protection extremely important. This orientation is connected with the management and more efficient activities within the environmental protection management system by organizing processes and procedures for continual training for all employees from the field of:

- Teaching process and
- Non-teaching process

As previously stated, the consistent implementation of legal and other requirements is of crucial importance. The top management of a higher education institution should establish a strategy, policy and goals of environmental protection. Basically, the responsibility and authorizations refer to the top management so that it could define responsibilities and authorizations for the application and sustaining of the environmental protection management system. These activities refer to the processes of the environmental protection management system as follows:

- Planning
- Design
- Application
- Sustainability and
- Continual improvement in the application of the environmental management system.

The top management must appoint the representative of the top management for managing the system of environmental protection. The representative of the top management directs the activities referring to tracking of the application of the activities of the environmental protection with continual improvement. Simultaneously, the rule of timely reporting to the top management about decisions and actions as well as about key responsibilities in the system of environmental protection should be complied with.

As stated Ušćumlic and Babić (2011) International Standards (ISO) for the management system (quality – which is the most frequent, environmental protection, food health safety, information security, risk, social responsibility etc. may be applied at organizations of all sizes and scopes of activities regardless of the type and business orientation. Their application is voluntary and their aim is to help organizations create effective and efficient management systems through their requirements and instructions. Some of these standards comprise requirements according to which the certification of corresponding management systems is done. Other standards are designed as recommendations or instructions which should be followed in business activities, but they are not planned for the purpose of organization certification, so these are primarily standards which supplement standards designed for the organization certification. According to the requirements of mentioned standards, organizations may certify their management systems individually or they can integrate them in a unified system (IMS –integrated management system).

These standards affect the increase of the organization capability regarding the evaluation and improvement of all processes and activities in the sphere of environmental protection management systems in all organizations and therefore in higher education institutions, too. The necessity of international standards is very prominent, since all organizations operate within the global economy by selling or purchasing products

and services from the sources outside domestic market. ISO standards specify basic requirements for the management system which the organization must fulfill so as to show its capability to produce its products (services included) in a consistent manner and thus to increase the satisfaction of users and comply with the valid legal regulation.

In the process of application of ISO standard the top management of a higher education institution (management body) adopts the procedures by sustaining and application of the standard in the higher education institution, which comprise:

- Management system planning,
- Management,
- Standard application provision,
- Manners of all performances improvement.

The readiness of the management and controlling structures for the acceptance of essential importance of the requirements of standardization in higher education institutions is of crucial importance in the mechanism of organization and operation of all higher education institution systems. The characteristics called certification is an essential mechanism of the organization manner, overall functioning of all processes and it should be a constant vision and mission of the higher education institution. The fundamental organization means for complete integration of high and constant improvement of activities and all processes is the compatibility with other systems in the organization, i.e. with information system as one exceptionally important subsystem in organizations. Improvements are accomplished not only by applying the standard requirements for which the management system is certified, but also similar standards which are not intended for the certification and function as a supplement to certified fields, management systems for which the system certification is not executed, and also by applying the model of business excellence. The acceptance and implementation of standardization challenges in all parts of the operation process of a higher education institution is the adjustment to an easier and faster approach to the Bologna Convention and the postulates it is based upon. Since a higher education institution is a specific institution with many sensitive processes, it is necessary to control all aspects influencing the management system intensively.

4. CONCLUSION

The aim of this paper is to research the importance of sustainability of environmental protection via the process of digitalization as well as the importance of raising the awareness of students in the higher education area. The scope of activities of higher education is specific, therefore it requires the introduction of certification as a model for business excellence in the process of digitalization in the sphere of environmental protection. The higher education institution have significant share of participation in the process of digitalization and transformation and it is, as a rule, a very complex approach, which is difficult to measure and improve. The feedback obtained from the service users represents an important resource of tracking of the higher education institution operation in the process of digitalization and environmental protection sustainability. They may be used for tracking of the trend of satisfaction of all interested parties (students, employees at higher education institutions, relevant ministries, owners, high-school population, social community, etc.) as well as for the comparison with the competition, understanding of user expectations, determination of priorities for improvement, etc.

The ISO 14001 international standard was created as a result of increased concern for environmental protection. The basic purpose of the standard is to control the risk of pollution of the environment. The series of ISO 14001 standard has relatively generally accepted application, not like ISO 9001, but on a higher level than other standards. The basic function of the standard application is to identify aspects, perceive risks, establish control and track performance of each organization with regards to the environment. The purpose of this standard is to use the information obtained by tracking and measuring via review for the purpose of improvement of educational service providing in the sustainability of environmental protection. It is in the interest of the entire higher education institution and higher education system to establish an effective and efficient system of environmental protection management in the process of adjustment to contemporary technologies via the process of digitalization.

A higher education institution must provide an adequate space and work environment to meet certain technical-technological, urban and other conditions necessary for smooth performance of teaching process during the transfer of scientific knowledge to future experts –students in the process of adjustment to the digitalization using the application of contemporary tools of future. For contemporary execution of the teaching process it is necessary for the space and work environment of the higher education institution to comply with health and safety standards. The rulebooks on technical standards of a higher education institution stipulate that the premises of a higher education institution as a public institution must meet the required aspects with regards to the environmental protection. Since the higher education institution is a specific scientific institution contributing to the development and raising of the students' awareness in the

sphere of sustainability of the environmental protection as well as of the adjustment process to the contemporary technology, it may have a significant impact on the environment. Taking into consideration the development of technology and technology progress, the ecological awareness must be more present and prominent, especially with students as future experts. From the perspective of ecological awareness, the main impact of higher education must be aimed at raising the awareness with students. The strategy of environmental protection is of essential importance for the whole region and planet as a whole and it represents one of the most important tasks of the human society, and on an individual level, the participation of higher education institutions represents a small piece in the mosaic of the accomplishment of this goal.

REFERENCES

Association for the Advancement of Sustainability in Higher Education (AASHE). (2014). Annual Report. Retrieved from http://www.aashe.org/annual-reports/

Bevilaqua, M., Ciarapica, E., F., & Giacchetta, G., (2012). *Design for Environment as a Tool for the Development of a Sustainable Supply Chain* London: Great Britain. Springer.

Filipović, J., Đuric, M, (2009). *Osnove kvaliteta*. Beograd: Fakultet organizacionih nauka.

Filipović, J., Đurić M., & Teodorovic A., (2008). *Menadžment i kvalitet u obrazovanju*. Kopaonik: 56. Naučno-stručni skup psihologa Srbije, Razvoj i standardizacija u psihologiji.

Goetsch, L., D., Davis, B., S., (2016). *Quality Management for Organizational Excellence* (8th ed.). New Jersey: U.S.A. Pearson.

International Organization for Standization. (2015). ISO Survey 2015. Retrieved from https://www.iso.org/standard/60857.html

International Organization for Standization. (2015). ISO 14001:2015. Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:14001:ed-3:v1:en

International Organization for Standardization. (2015). Retrieved from https://www.iso.org/iso-9001-quality-management.html

International Organization for Standardization. (2015). Retrieved from https://www.iso.org/iso-14001-environmental-management.html

Kopnina, H., Cocis, A., (2017, July). *Environmental Education: Reflecting on Application of Environmental Attitudes Measuring Scale in Higher Education Students*. Basel: Switzerland.

Lee, K., M., Environmental Management: *Integration environmental aspect into product design and development,* ISO Bulletin, September 2002, International Organization for standardization

Maletic, D., Borojevic, T., Petrovic, N., Maletic, M., & Senegacnik M., (2017, September) *Quality of higher environmental education for sustainability* XLIV Symposium on operational research, SYM-OP-IS 2017.

Uščumlic, D., Babić, J. (2011, October) *Novi metodi menadžmenta i marketinga u podizanju srpske privrede* „Model poslovne izvrsnosti kao alat za unapređenje poslovanja preduzeća“, Beograd: Ekonomski fakultet.

Weert, T., J., V., Kendall, M. (2003, July). Lifelong *Learning in the Digital Age: Sustainable for all in changing world.* Lifelong Learning Working Track in the IFIP Conference. Pori: Finland.

DIGITAL DISRUPTION OF AGRICULTURE 4.0

Jovan Parušić*[1], Uroš Šošević[2], Dejan Stojimirović[2]
[1]Agremo
[2]University of Belgrade, Faculty of Organizational Sciences, Serbia
*Corresponding author, e-mail: jovan.parusic@gmail.com

Abstract: *This document covers the digitalization of agriculture as an important which as a goal has prevention and neutralization of global problems caused by agricultural expansion and operations, such as CO2 emissions and global warming. Authors point to the high-tech solutions for the issues in question presented in the use of innovative technologies such as cloud-based software, drones, IoT, blockchain, big data and AI. Paper explains the magnitude of global problems caused by agricultural expansion and the benefits of integrating modern technologies into the agricultural ecosystem. Research and personal experience and expertise in the industry by the authors are included, along with the latest trends from the ecosystem. Paper will indicate the importance of ICT in modern Agriculture and creation of planet-saving value chain.*

Keywords*: Digitalization, Agriculture, Farm Management, Drones, IoT, Blockchain, Big data, CO2, Global Warming, soil, AI*

1. OVERVIEW

In the last decade, there have been constant calls to different planet-saving operations and projects. Humanity is evolving and adapting in order to survive. One of the most important paths of planetary change is the expansion of digital era and exponential growth in the ICT area. The high pace of tech development has been brought by the need for improvement in environmental and planet-saving operations. Different technologies are being developed as a way to slow down the environmental changes caused by agricultural operations. Such uncontrolled operations occurred due to the increasing population number, hunger and climate changes. Therefore, we will focus on agriculture as one of the main pillars of global sustainability and its most recent transformation attempts. We want to explore the importance of smart sustainability based on an implementation of digital tools and decision-making based on the data analytics. This paper will point to environmental issues and the possible solution based on the latest developed technologies.

2. ENVIRONMENTAL ISSUES

Several interconnected environmental issues are considered as high-class threat to plant. We would like to emphasize some of the main issues connected to agriculture:

- CO2 emissions caused by deforestation and meat and dairy production
- The scarcity of agricultural resources and arable land
- Population growth

2.1. Deforestation and co2 emission

Carbon dioxide (CO2) is a heat-trapping (greenhouse) gas, most commonly released through human activities such burning fossil fuels, deforestation, land clearing for agriculture and degradation of soils (NASA, 2018). It is very important to emphasize that land can also remove CO2 from the atmosphere through reforestation, improvement of soils, and other activities (The United States Environmental Protection Agency, 2018). At the global scale, CO2 is the key greenhouse gas emitted by human activities with estimation of 65% of all emitted gases (The United States Environmental Protection Agency, 2018) as shown on the Figure 1.

Research shows that agriculture participated in 10% of the EU's total greenhouse-gas emissions in 2012. Decline in livestock numbers, more efficient application of fertilizers, and better manure management reduced the EU's emissions from agriculture by 24% between 1990 and 2012 (European Environment Agency, 2018).

On the other hand agriculture in the rest of the world is moving in the opposite direction, as global emission from crops and livestock production grew by 14% in a period between 2001 and 2011. This was driven by increased global food demand and changes in food-consumption patterns due to rising incomes in some developing countries (European Environment Agency, 2018).

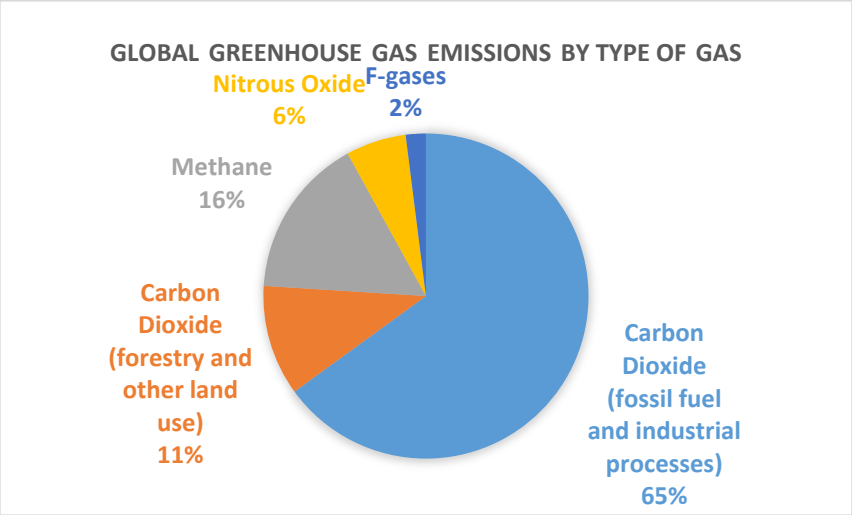

Figure 1: Details about the sources of global greenhouse gas emissions (IPCC, 2014)

In the research of greenhouse-gas emissions presented by European Environment Agency 2018, we can see that livestock and fodder production each generate more than 3 billion tons of CO2 equivalent. There is a general opinion followed by several initiatives, that by reducing food waste and our consumption of meat and dairy products, we can contribute to cutting the greenhouse-gas emissions of agriculture.

Measurements show a constant rise of CO2 levels in last decade, and an annual increase of CO2 - Figure 2 and Figure 3.

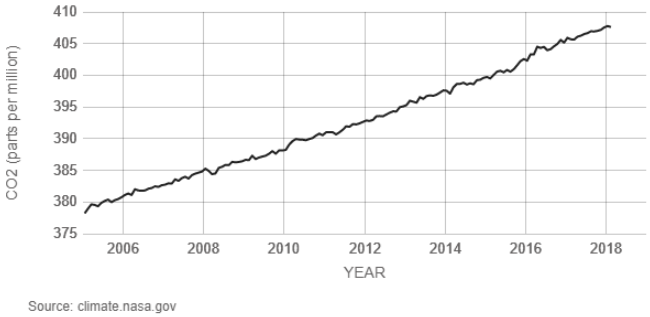

Figure 2: Monthly measurements (average seasonal cycle removed). (NASA, 2018)

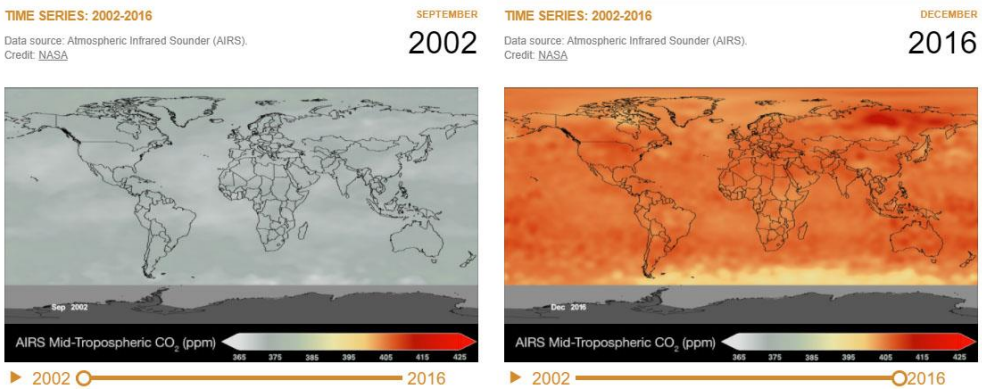

Figure 3 : Changes in distribution and variation of the concentration of mid-tropospheric carbon dioxide in parts per million (ppm). (NASA, 2018)

In many researches, agriculture has been considered to be a main driver of deforestation (Gibbs et al., 2010) – another source of the CO2 threat. Recent studies show that drivers vary on the continental and regional level, but nevertheless, that is not changing the fact that tropical forests are disappearing at a rate of ca. 13

million hectares per year, which is approximately the size of Greece (EU Commission, 2008). Agriculture as a deforestation driver in Africa is changing net forest area of 15000km2/yr.; in Latin America 42000 km2/yr.; Sun-tropical Asia 13000 km2/yr. (FAO, 2010)

Given the central importance of food in our lives, a further reduction of greenhouse-gas emissions from agriculture remains quite challenging. If we consider that agriculture is estimated to be driver for near 80 percent of deforestation worldwide and that commercial agriculture is the driver of 66 percent of deforestation in Latin America, (Kissinger, Herold & De Sy, 2012), we are free to say that such trend will continue, and that catastrophe is inevitable even if education and control measures are introduced together with huge efforts in consumer education and food waste management.

In the John Hopkins's Center for livable future report, which was prepared in advance of the United Nations Conference of the Parties 21 (COP21) in Paris, Kim (2015), Neff (2015), Santo (2015) and Vigorito (2015), presented the facts explaining that if global trends in meat and dairy consumption continue at the same pace, global mean temperature rise will exceed 2°C, even with intense emissions reductions across non-agricultural sectors. The immediate radical measures resulting in substantial reductions in wasted food and meat and dairy intake, particularly ruminant meat (e.g., beef and lamb), are imperative to mitigating catastrophic climate change. The urgency of these interventions is not represented in negotiations for climate change mitigation.

2.2. The scarcity of agricultural resources

Reduction of meat and dairy consumption represents a huge challenge, due to consumer behavior and global emissions targets which will make more difficult for the animal-agriculture sector to operate as it has been. Let's assume that in future all targets reached, and all paper-ambitious plans are achieved. We have to think about what are the other consequences of such actions.
Challenges arise in developing countries, due to the scarcity of quality land, soil nutrients, and water. Global assessment of all land types shows that 25% of lands are highly degraded, 8% are moderately degraded, 36% are stable or slightly degraded and % are ranked as "improving. The rest of the earth's land surface is either bare ca. 18% or covered by water ca. 2% (The State of the World's Land and Water Resources for Food and Agriculture, 2011). Same reports, says, that "1.6 billion hectares of the world's best, most productive lands are currently used to grow crops. Parts of these land areas are being degraded through farming practices that result in water and wind erosion, the loss of organic matter, topsoil compaction, salinization and soil pollution, and nutrient loss."

2.3. Higher demand and population growth

It is imperative that we take in the consideration the forecast explaining that over the past years, agricultural production has increased, and studies predict that aggregate agricultural consumption will be increased by 69% in a span from 2010 to 2050. The scarcity of land and water resources have placed a number of key food production systems around the globe at risk, posing a profound challenge to the task of feeding an expected world population growth from 7 billion to 9 billion people by 2050. (Pardey, Beddow, Hurley, Beatty & Eidman, 2014).

We have to think how we will reimburse for the gap in food value chain caused by the lower production and consumption of meat and dairy products and population growth by 2 billion people. This could lead to increase in the sector of agronomy crop and vegetable consumption, which will result in higher demand for agronomical resources.

3. SUMMARY OF THE AG ISSUE

Projections to 2050 suggest the emergence of growing scarcities of natural resources for agriculture (Alexandratos and Bruinsma, 2012). Fight for these resources could lead to their overexploitation and unsustainable use, degrading the environment and creating a destructive loop whereby resource degradation leads to ever-increasing competition for the remaining available resources, triggering further degradation and increased CO2 emissions (FAO,2017). FAO predictions say that fewer opportunities are left for further expanding the agricultural area. Moreover, much of the additional land available is not suitable for agriculture. Bringing that land into agricultural production would carry heavy environmental, social and economic costs (FAO, 2014).

4. DIGITALIZATION OF SOIL

The introduction of planned measures for reduced production of meat and dairy products could potentially lead to a closed loop. Less meat and dairy will mean increased crop, fruit and vegetable consumption. We can assume that without proper measures, in theory, agriculture will grow horizontally. Considering the already present scarcity of arable agricultural land resources, such actions could lead to more deforestation and continuous growth of CO2 emission, as shown in Figure 4.

Figure 4: Potential "boomerang effect" caused by preventive agricultural measures

We believe that solution for such situation is the introduction of Digitalization of Soil. With the help of adequate regulative, Digitalization of soil should include merging various technologies which would allow us to gather more information, create historical records and intelligent forecasts based on collected data. This kind of system would bring the intelligent decision making in farming.
Some of the benefits of proposed system are:

- Better quality of crops and higher yields per square meter
- The decrease of negative environmental impact & prevention of soil erosion
- Reduction of water & pesticide usage

4.1. Incorporating the Blockchain

In theory, the goal would be to treat 1 square meter (sqm) of soil as a Soil Basic Unit (SBU) – congruent, square shape with sides of 1m by 1m. SBU cannot be divided into smaller units, similar to the pixel. Every SBU has 4 vertices. Each vertex is defined by geo-referenced data – point's longitude and latitude.

Every SBU inherits its name from its 4 vertices, (vertex 1 lat/lon; v2 lat/lon; v3 lat/lon; v4 lat/lon;), e.g. (44.966069, 19.856436 ; 44.966070, 19.856436; 44.966069, 19.856437 ; 44.966070, 19.856437).

Here we would like to introduce Blockchain, as a centerpiece of the system, as we will treat every SBU as a distributed ledger. SBU will work as a database updated independently by each node included in the network. Nodes will be data collecting platforms such as a cadastral database; drone analytics platform; IoT communication platform; farm management software, etc. Every single node on the network processes every transaction, coming to its own conclusions and then voting on those conclusions to make certain that the majority of network agrees with the conclusions.

This will allow the ecosystem to manage a historical diary of records for every square meter – SBU. By doing this we are leaning towards efficiency and maximizing yields of SBU. It is in line with the agricultural strategy of vertical growth.

Depending on how we want to present the data, it can be stored on blockchain in one of three ways:

- Unencrypted data - can be read by every node in the network, and is fully transparent.
- Encrypted data - can be accessed only by participants with a decryption token. The token allows access to the data on the blockchain and can prove who added the data and when it was added.
- Hashed data - can be presented together with the function that created it, to show the data wasn't tampered with.

Blockchain technology will create a continuously growing historical list of records – blocks, for each SBU. Every input collected by platforms (nodes) in the network is realized as a transaction and is stored in a block. That means that when a tractor's GPS or a seeder control unit, which is also an IoT device, sends some data such as variable seeding rate back to its mother platform, every seeding rate per SBU will be stored on SBU's blocks.

This means that we want to create a historical record for every square meter of soil, and every action (transaction) of every agricultural operation that took place on that SBU and information extracted from it. Some of the information stored on a block could be:

- Type of a crop
- Sowing rate
- Yield
- Weed pressure
- Stresses occurring – diseases, irrigation, pest
- Fertilizer rates
- Applied herbicides
- Moisture
- Minerals

4.2. IOT technology

Internet of things (IoT) is all devices connected to the Internet, which communicate and exchange date with each other or with cloud-based data-collecting platforms. IoT can be a sensor, vehicle, home appliance or any other piece of electronics, and is used to improve processes by collecting data, analyzing it and performing an adequate action. Communication and exchange of data through a network is crucial for IoT functionality. The IoT network consists of a device or a sensor with a communication module, communication protocol, edge device or a router and a cloud data center. In agriculture IoT devices are used as sensors on the field measuring climate conditions – moisture of ground, air humidity, temperature; detecting pests – pest traps, improving pest control and saving the yield by monitoring insect activities.

Some agricultural hardware producers, such as John Deere, are incorporating specialized IoT devices into their products. One of the examples is a piece of their planting equipment – row unit. In this example, John Deere's seeder has a sensor which communicates with a driver, by showing pressure applied to each seed as it's planted. Sensors will send the pressure information, but it will also provide data about the softness of the soil. The farmer then can adjust the pressure, in order to plant the seed on the right depth, and on the right distance. John Deere's sensors can also communicate with its mother cloud platform where all data are processed and stored. E.g. variable seeding rate for each sqm – seeding distance, and seeding depth. The same principle works with sprayers, where a device will communicate the herbicide prescriptions and spraying maps.

Automatic sensor communication with cloud-based mother platforms are allowing us to automatize and improve processes – such as irrigation, spraying, seeding, harvesting etc. Besides improving processes, this technology is making them Intelligent, as processes are based on sensor-collected data.

Storing valuable information such as spraying maps, yield maps, soil moisture, seeding rates, as individual transactions on blockchain blocks for each SBU, will provide us with historical overview and conditions for intelligent decision making based on historical data.

4.3. Drone analytics

One of the main challenges for farming is large cultivated areas and inefficient crop monitoring. Until recently, the most advanced form of monitoring was satellite imagery. The main limitation of such practice was a high price, fixed interval of taking images, and cloud interference which could lower the quality and precision of the output. Drone technology solves that problems and offers a variety of crop monitoring possibilities at a lower cost. It can be utilized for any of the vegetative or reproductive growth stages in the crop life cycle. Unlike satellites, drones have a versatile function in precision agriculture operations. Besides collecting data they could be used for aerial spreading of seeds and spraying. One of the advantages of drone tech is an integration of various sensors which could be used for data collecting:

- RGB sensor
- Multispectral & Hyperspectral sensor
- NIR sensor
- Thermal sensor
- Gyroscope

Collected data is transferred into orthomosaic maps, which are eligible for analysis and extracting the drone analytics. Today, digital solutions can provide valuable data and evaluate sources of stress for every sqm based on the compiled orthomosaic (Agremo, 2018). Data could show population and number of plants on the field or different types of stress that are affecting the field and the plants. As all of the drone data is georeferenced with a timestamp, storing such information on an SBU block as a new transaction is pretty straightforward. A good example of the transaction would be the measured plant density for the SBU. E.g. 10 plants/ sqm, which we could compare with the seeding map created by an IoT device.

4.4. Decision making

Accumulation of data from various sources improves the agricultural knowledge base. Storing all data in blocks will allow us to have a historical overview of all the actions performed on each SBU. Imagine what we could do if we knew historical data for every square meter of agricultural land, ranging 50 years back. We could know all the crop cycles, yields, problems, stresses; each agricultural take measure, with every tool used in the process, following the weather conditions. Huge amounts of data would be a challenge to process, but by introducing AI and machine learning, historical data could get its bright future. All transactions from the past would be used for intelligent decision making, analyzing trends, the anticipation of the agricultural needs, potential threats and creating forecasts as shown in Figure 5.

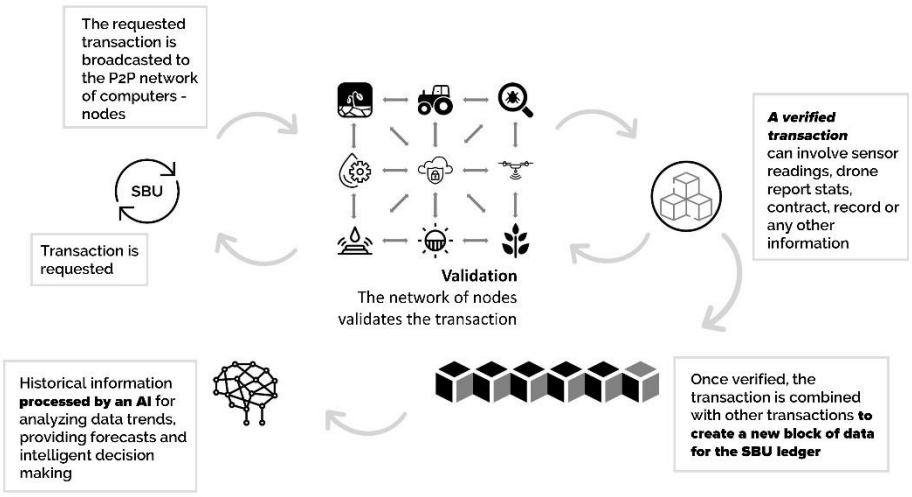

Figure 5: The intelligent agricultural decision-making system

With such system, agriculture could tackle many of the existing and future threats - increase yields and productivity per square meter, lower emission of CO2 and deforestation rates, avoid soil erosion, regardless the population growth. The system would also enforce sustainability rules, as every transaction would be verified by the vast network of nodes.

5. CONCLUSION

After lining up the facts presented in this paper, we can easily understand the magnitude of the problem humanity is facing. We strongly believe that severity of the problem will exponentially grow unless we don't stand united around the idea of sustainable development. We want to implement a chain of modern technology as tools in that process. Continuous development of modern technology and ICT will not only guarantee the improvement of the tools covered by this document but also emerge the new tools which will bring more efficiency and effectiveness in the process of digitalization. This should lower the cost of global implementation of such tech and improve the general knowledge about the problems we are fighting against. Digital disruption of agriculture explained in this paper, besides the needed technology and funds, will also require a strong support of political establishment in creating a positive atmosphere, regulations, and ecosystem for this process, which hopefully will be established.

REFERENCES

Agremo. (2018). Drone analysis overview. Retrieved from https://www.agremo.com/overview/analyses_overview.html

Alexandratos, N. & Bruinsma, J. (2012). World agriculture towards 2030/2050: the 2012 revision. ESA Working Paper No. 12–03.

Brent Kim, MHS; Roni Neff, PhD, SM; Raychel Santo; Juliana Vigorito. (2015). The Importance of Reducing Animal Product Consumption and Wasted Food in Mitigating Catastrophic Climate Change. *John Hopkins center for a livable future*

COMMISSION OF THE EUROPEAN COMMUNITIES. (2008). Report: *Addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss, IMPACT ASSESSMENT*

European Environment Agency. (2018). Retrieved from https://www.eea.europa.eu/signals/signals-2015/articles/agriculture-and-climate-change

Food and Agriculture Organization of the United Nations – FAO, Food and Agriculture Organization. (2010). 2010a.Global Forest Resources Assessment 2010. FAO Forestry Paper 163.

Food and Agriculture Organization of the United Nations – FAO. (2017). Report: *The future of food and agriculture – Trends and challenges*

Gibbs H.K., Ruesch A.S., Achard F., Clayton M.K., Holmgren P., Ramankutty N., Foley J.A. (2010). Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s

Inviromental panel on climate change - IPCC. (2014). Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc.ch/report/ar5/wg3/

Kissinger, G., Herold, M. & De Sy, V. (2012). Drivers of deforestation and forest degradation: A synthesis report for REDD+ policymakers

NASA. (2018). Carbon dioxide Retrieved from https://climate.nasa.gov/vital-signs/carbon-dioxide/

Philip G. Pardey, Jason M. Beddow, Terrance M. Hurley, Timothy K.M. Beatty and Vernon R. Eidman. (2014). A Bounds Analysis of World Food Futures: Global Agriculture Through to 2050*. Australian Journal of Agricultural and Resource Economics, 58, pp. 571–589*

The State of the World's Land and Water Resources for Food and Agriculture, (SOLAW). (2011). Report: *Managing systems at risk. Food and Agriculture Organization of the United Nations*, Rome and Earthscan, London.

The United States Environmental Protection Agency. (2018) Retrieved from https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

ENVIRONMENTAL AND LOGISTIC ASPECTS OF INTRODUCTION OF ELECTRIC AUTOMOBILES

Davorin Žnidarič*[1], Marjan Senegačnik[1], Drago Vuk[1]
[1] University of Maribor, Faculty of Organizational Sciences
*Corresponding author, e-mail: davorin.znidaric@gmail.com

Abstract: *The present paper is regarding with the introduction of electric automobiles. Various aspects of electric automobiles use are considered as are environmental, logistic and economic ones. There is included also a brief historical review of the development of electric cars. Particular emphasis is given to the comparison of environmental impacts of electric and internal combustion engine powered cars as well as on logistic problems connected with the introduction of electric cars. There is included a brief review of the current situation in the European Union with the special emphasis on the situation in the Republic of Slovenia.*

Keywords*: Electric automobiles, environmental aspects of automobiles, air pollution, greenhouse gases, charging stations network*

1. INTRODUCTION

Electric automobiles in the period of last years have made an important breakthrough. Only a couple of years ago an electric automobile observed on the street seemed almost an exotic example attracting views of passers-by. Currently electric automobiles have become quite normal vehicles and can be seen on roads every day. Nevertheless, the share of electric vehicles in European countries is still very low – the share of battery electric vehicles sold in the European Union market in 2017 was 0,54 % for battery electric vehicles (BEV) and 0,64 % for plug-in hybrid electric vehicles (PHEV) (EAFO, 2018). This may seem a marginal share, however in 2012 the shares on the market were 0,12 % for BEV and 0,07 % for PHEV and at least for BEV in the period 2012-2017 a continuous growth of the market share can be observed (EAFO, 2018). Therefore, nevertheless the current share of electric vehicles is low when considering such a trend important changes can be expected in the period until 2030. In Slovenia in the year 2017 there was share of electric vehicles approximately 0,1 % – estimated number of about 1200 electric cars in comparison to the total number of personal automobiles in use which is about 1,1 million in 2017 (RTVO SLO, 2017; SURS, 2017). According to certain estimations there is expected that the number of electric automobiles in Slovenia in 2030 will be about 200.000 (Kolednik & Pavšič, 2017). Such an increase in the number of electric cars will demand also important changes in certain other sectors particularly in the field of electric energy supply. There can appear problems connected to production of sufficient quantities of electricity as well as regarding the development of an electricity network with a sufficient number of charging connections.

2. HISTORY OF ELECTRIC CARS

It is interesting to present a brief historical review of electric automobiles. According to the great increase of the number of electric automobiles in the last years there sometimes appears a wrong opinion that electric automobiles are one of the latest inventions. Contrary, electric automobiles have almost exactly the same long history as automobiles with internal combustion engine. In 1884 Thomas Parker constructed the first usable electric automobile and in 1885 Carl Benz presented the first commercial car with spark ignition engine (Guarnieri, 2012; Owning an electric car, 2010-11; Elwell-Parker, n.d., Daimler, n.d.).

In the period about 1900 and also until the beginning of 1920s electrical automobiles were completely competitive with gasoline automobiles. The production of electric vehicles in United States achieved its peak in 1912 (Business insider, 2015). Electric vehicles surpassed cars with internal combustion engine in silent and clean operation as well as in easy driving. Their weak points – short driving range and long time necessary for battery charging – at that time were not so outstanding as cars were used mainly for short urban driving (Guarnieri, 2012). However, some important changes happened around 1920 (Guarnieri, 2012):

- Due to the improvement of road network longer intercity driving became more interesting
- Some technical improvements (particularly invention of electric starter in 1912) facilitated driving of internal combustion engines powered cars
- Lowering price of gasoline according to the discovery of new oil deposits in various regions of United States.

All these facts supported the use of cars with internal combustion engine. This was already the period of the beginning of massive production of automobiles in the United States and until the beginning of 1930s the role of electrical automobiles became only marginal. Electric cars were used for certain niche purposes. There was observed certain interest for electric vehicles during the oil crisis in 1970s, however, it had not important consequences (Owning an electric car, 2010-11). Situation has begun to change in the 1990s mainly according to environmental demands. This was the beginning of something that could be called the rebirth of electric automobiles. Particularly after 2010 the number of electric automobiles has begun to increase substantially and practically all automotive companies have included electric car models in their production programs.

As mentioned the main motives for the return of electric automobiles in mass use were mainly environmental. However, the most important fact that enables the recent breakthrough of electric automobiles was a great progress in the development of batteries with much better characteristics.

3. ENVIRONMENTAL ASPECTS

3.1 Emission in the atmosphere

Environmental care was without a doubt one of the most important motives for promotion of electric vehicles. Automotive emissions are one of the most important contributors to the atmospheric pollution. However, when regarding noxious impacts of substances emitted in the atmosphere (automotive emissions but also emissions from other sectors as are energetics, industry, individual heating devices) these substances can be divided into two groups:

i) Air pollutants and
ii) Greenhouse gases.

Nevertheless, these substances are often related or certain substance (by example tropospheric ozone) may belong to the both groups these two groups should not be mutually replaced as there exists difference in the mode on which individual substance harms to the environment.

Air pollutants are substances which exhibit direct noxious impact on living organisms by example they cause poisoning, suffocating, promoting development of diseases etc. Elevated concentrations of pollutants in the air present a threat to the human health and are harmful to the environment. Pollutants which derive from automotive emissions are carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter and ozone (Mondt, 2000; Schäfer & van Basshuysen, 1995).

Greenhouse gases are substances present in the atmosphere which can absorb infra-red radiation and thus increase the ability of the atmosphere to retain heat. This process is to certain degree natural. However, the problem present additional emissions of greenhouse gases caused by human activities which are known as anthropogenic greenhouse effect and are responsible for the disruption of natural equilibria and global warming. More than half of the anthropogenic greenhouse effect is ascribed to the emissions of carbon dioxide (Botkin & Keller, 2003). Among the most important sources of carbon dioxide emissions are traffic and energetics.

Both heavy air pollution in urban areas as well as prognosis of considerable temperature increase present serious environmental threat and this was a reason to search systematic solutions of lowering automotive emissions.

When considering air pollution there has been for decades invested a lot of effort in control of emissions. There have been developed very efficient catalytic converters which enable considerable lowering of emissions. Therefore, a typical car produced in the year 2000 emits only 5 % of pollutants in comparison with a car produced in the beginning of 1970s (Mondt, 2000). Catalytic converters reduce emissions of carbon monoxide, hydrocarbons and nitrogen oxides, meanwhile emissions of particulate matter are reduced by filters. However, in spite of this poor air quality in urban areas still presents a considerable problem worldwide. Reasons are high traffic density and the fact that during short urban driving catalytic converters cannot achieve the adequate temperature for full efficient operation (Mondt, 2000). Two of the most problematic kinds of pollutants are particulate matter (particularly in the cold part of the year) and tropospheric ozone (in summer) as their boundary levels are often exceeded (ARSO, 2017). The consequence of the elevated levels of particulates in the air is that many European cities have just limited entrance of automobiles with compression ignition (diesel) engines. The problem of particulate emissions has been for many years connected only with compression ignition (diesel) engines. The conventional (indirect injection) spark-ignition (Otto) engines have much lower emissions of particles which are in comparison with diesel engines treated as almost negligible. However, the situation has changed

considerably in the last years with the introduction of direct injection (DI) spark-ignition engines. These engines exhibit much improved performance and reduced fuel consumption what is beneficial also from the environmental point of view. However, unfortunately DI spark-ignition engines exhibit similar or even higher particulate emissions as diesel engines (Kirchstetter, Harley, Kreisberg, Stolzenburg & Hering, 1999 in Fruin, Winer, & Rodes, 2004; Miguel, Kirchstetter, Harley & Hering, 1999 in Fruin et al. 2004, Senegačnik, Vuk & Petrović, 2017).

Particulate matter – especially black carbon fraction of PM 2,5 category (finer particles with the diameter less than 2,5 μm) present a serious threat for the human health. According to the results of Global Burden Disease analysis it has been estimated that air pollution with particulates is responsible for approximately 3 millions of premature deaths worldwide every year (Curry Brown, 2013). Exposure to particulates is harmful not only for respiratory tract but there is still stronger evidence of its influence on the development of cardio-vascular diseases (Curry Brown, 2013, Suglia, 2007). Short-term exposure to increased particulate concentrations enhances a frequency of cardio-vascular incidences as are hearth ischemia, hearth infraction, arrhythmia, hearth failure or stroke (Brook, 2004, Brook et al., 2010, Dominici et al., 2005). There has been observed a positive correlation between particulate level in the air and incidence of necessary defibrillator discharges (Peters et al., 2000). On the other hand long-term exposure to elevated levels of particulates promotes development of atherosclerosis and therefore presents an increased risk of cardio-vascular mortality (Dockery et al., 1993 in Brook et al., 2004, Pope et al., 2004). As mentioned the problem of particulates is more severe in winter according to higher emissions (besides other sources also the contribution of heating devices is added) and temperature inversions.

In the summer another pollutant is problematic – tropospheric ozone. It should be emphasized that ozone is not component of exhaust gases but it is formed by photochemical reactions in the atmosphere from nitrogen oxides and hydrocarbons. Hydrocarbons and nitrogen oxides are both components of exhaust gases. They are already by themselves harmful to human health, however, boundary values of both pollutants are seldom overcome. By example, when regarding air quality reports for Slovenia, there have been practically never reached boundary levels neither for hydrocarbons neither for nitrogen oxides but on the other hand concentration of ozone often exceeds limiting value (ARSO, 2017). Ozone is harmful for the respiratory tract and particularly affects people suffering from asthma.

From the facts stated above it can be evident that polluted air in urban areas presents a prominent health threat and the contribution of automotive emissions to this problem is considerable. Therefore, the use of electric automobiles could efficiently help to lower emissions of pollutants. Electric automobiles are zero emission vehicles – they do not produce any tail pipe emissions. Of course certain emissions are generated when electricity is produced in thermal power plants. However, even in such case the emissions are at least moved from the exhaust pipe of a vehicle to the chimney of a power plant. As power plants are usually not located in the centres of cities this will help to improve the urban air quality and considerably lower the health risk.

On the other hand, the situation is different in the case of greenhouse gases emissions. Both automobiles and thermal power plants are important sources of carbon dioxide – the most important greenhouse gas. The global warming contribution depends on the quantity of greenhouse gases emitted in the atmosphere and there is not important where these emissions happen. Therefore, it seems – contrary as in the case of pollutants - that there is no profit of substitution of internal combustion engines powered cars with electric cars when the majority of electric energy is produced in the thermal power plants. The situation is different when electricity is produced from carbon neutral sources but the capacity to produce such a kind of electricity is often limited. When electric automobiles are charged from the public electricity network the carbon footprint depends on the national electricity production structure. Thus significant differences are observed between individual countries. In those countries which generate the majority of electricity from thermal power plants also in the case of electric automobiles indirect emissions of carbon dioxide cannot be avoided. Therefore, the carbon dioxide (CO_2) emissions intensity of electric energy production in Greece is as high as 829,9 g CO_2/kWh The situation is much better in those countries which produce a majority of electric energy from carbon neutral sources as are by example in France (nuclear power plants) – 34,8 g CO_2/kWh or in Sweden (hydroenergy) where emission intensity is as low as 10,5 g CO_2/kWh. European Union average is 275,9 – all data are for the year 2014 (EEA, 2017).

3.2 Environmental impact of batteries

When considering environmental impact of automobiles like any other product the entire life cycle should be considered – production, use and decomposition. In the case of electric automobiles there is particularly emphasized the environmental impact of batteries. Modern electric automobiles use particularly lithium ionic

batteries. It is estimated that in the future between 75 and 90 % of electric cars will use lithium ionic batteries. Production of the adequate number of batteries will require between 65.000 and 145.000 tons of lithium carbonate (Li_2CO_3)(Conot, 2011).

Lithuim is unevenly distributed – main sources are in the Southern America (Argentina, Bolivia and Chile), Australia and China. Lithium is mainly produced from brine. The production of 1 ton of lithium requires about 750 tons of brine and about 24 months. The procedure uses also great amounts of water and energy – production of 0,05 g -1 g of lithium requires about 1000 litres of water. As lithium rich regions are usually arid such water wasteful process is also questionable from the environmental aspect of view. Lithium can be produced also from sea-water but the procedure is more expensive (Battery University, 2018; Huš, 2016).

Lithium can be also produced from spent batteries – about 20 tons of spent Li-ion batteries are necessary for 1 ton of lithium. Unfortunately, the existing recycling technologies do not allow the production of pure enough lithium for the second use in batteries (Battery University, 2018).

In lithium ion batteries lithium ions moves from the electrodes – the cathode is usually lithium doped cobalt oxide, the anode is carbon (graphite) and the electrolyte is lithium salt in organic solvent (Electronics LAB, n.d.).

4. TECHNICAL AND LOGISTIC ASPECTS

4.1. Charging stations

Charging stations can be divided into individual charging stations (in private houses –garages) and public charging stations. According to charging time stations can be divided into classical charging stations (slow charging) and fast charging stations. Some characteristics of various charging stations are shown in Table 1.

Table 1: Characteristics of different types of charging stations (PP Plan-net, 2018).

Charging power/ kW	***Charging speed/kWh h^{-1}***	***Necessary voltage***	***Typical use***
3,7	*24*	*Single-phase*	*Households*
7,4	*48*	*Single-phase*	*Households, companies, public parking places*
22	129	*Three-phase*	*Public parking places*

Rapid charging enables 80 % charging of the battery capacity in 20 to 30 minutes – depends on the charging voltage and current as well as on the capacity of the battery. This mode of charging is appropriate when it is important to charge battery in a short time – by example during driving on long distances. In the case of short distance driving when the charging time is not crucial (by example overnight charging) it is more appropriate to use slow charging mode (also from the view point of costs). Some technical specifications of charging station Chademo EV Charger are shown in Table 2.

Table 2: Technical specifications of Chademo EV Charger.

Type of voltage	Three-phase
Voltage	380 V
Frequency	45-55 Hz
Total harmonic distortion (THD)	<5 %
AC entrance Power factor	0,99
Input overvoltage protection	323 + 5 V
DC output voltage – nominal output voltage	750 V
Output current	200 A
Regulation precision	<0,5 %
Steady current	<1 %
Output charging voltage	350-750 V
Short-circuit current	<30 A
Output power	200 kW
Working temperature	25 ^{o}C – 50 ^{o}C

AC-alternating current, DC – direct current

4.2. Electrical connectors for charging stations (transformers)

In the case of household (domestic) charging with relative low power (3,7 kW or 7,4 kW) there is no necessity of special transformers.

Household connector with maximal output power 3,7 kW requires a power cable with cross section of 4 mm^2 for single-phase voltage and a 16 A fuse.

Connectors with higher powers (7,4 kW or 11 kW) require power cables with larger cross sections (6 mm^2). In the case of 7,4 kW power variant a 32 A fuse for single-phase is necessary, meanwhile for 11 kW a 3 x 16 A fuse system for three-phase connector is necessary. Costs of such charging stations are (without mounting) between 800 and 1500 Euros. Costs of public charging stations are over 5.000 Euros for pillar (Schrak, 2018; PP Plan-net, 2018).

When planning larger charging capacities with different charging stations (AC, DC, fast charging stations with greater charging power) separate transformers should be used because of greater energy use. These transformers should be connected to the medium voltage network.

Standardized types of transforming stations are used: 50, 100, 160, 250, 400, 630 and 1.000 kVA. The costs of 400 kVA station are, by example, about 22.000 Euros, and the total costs of a building of such a transforming station can rise up to 55.000 or 60.000 Euros (Elektro Ljubljana, 2018).

As urban charging networks in majority of cities currently do not exist the question arises where, when and how many charging points will be built. Nevertheless, additional charging stations and medium voltage networks will be necessary.

Meanwhile locations of individual charging stations (by.example stations in individual houses in the countryside and suburbs) do not present an outstanding problem the situation is expected to be different in densely populated urban areas. In the case of large residential buildings (by example skyscrapers) nowadays it is often difficult even to find enough parking places for cars with internal combustion engines. As the number of electric automobiles is currently very small their charging does not present a considerable problem yet. However, in the future when it is expected that the share of electric automobiles will rise up to at least 10 or 15 % it seems an unrealistic task how to assure adequate number of charging stations for all these vehicles.

There will be important also to regulate the standardization in the field of electrical automobiles charging. The most important standards in this field are (Kordiš, 2018):

- SIST EN 61008
- SIST EN 61851
- SIST EN 62196
- SIST IEC 14443
- SIST IEC 61851 and
- SIST IEC 15118.

These standards include communication levels between automobile and charging station, types of connectors – but there exist certain differences between European Union, United States and Japan. Various charging modes are used – direct current (DC) and alternating current (AC), there are also differences in connectors – couplings used both on cars as well as on charging stations.

As has been emphasized there is particularly desired to use renewable sources of electricity for battery charging. Into this purpose for charging stations with small power (3,7 kW or 7,4 kW) solar systems could be used. Such photovoltaic systems could in favorable conditions replace electric energy from the public network. When using direct current (DC) systems there would not be necessary to transform direct current into the alternating current and there will be no necessity to use inverter which will lower the costs. In the case of energy surplus the excess electricity can be emitted in the public network.

4.3. Energetic aspects

As has been mentioned above short driving range is probably the weakest point of battery electric vehicles. In spite of the important development in battery performance during the last years energy density of batteries is still poor when compared with energy density of fossil fuels. A brief comparison of a spark-ignition engine using gasoline and a battery electric engine is presented:

- Gasoline has energy value of approximately 47 MJ/kg. Modern spark-ignition (Otto) engines achieve efficiency of 40 % (older engines 30 %). In the case of the 50 litres of a tank volume this means cca. 38 kg of gasoline with energy potential of approximately 1,8 GJ of available energy from which 720 MJ (or 530 MJ in the case of older engines) is practically used for transportation and ensures the vehicle's

driving range between 700 to 950 km. Compression-ignition (diesel) engines exhibit higher efficiency and therefore can achieve still longer driving range (Huš, 2016).

- Electric engines have considerable higher efficiency than internal combustion engines – by example at the Tesla Model S about 80 %. For driving range of 700 km it will be necessary 660 MJ of energy (or 900 MJ for 950 km). 7616 of NCA 18650 batteries can contain 324 MJ which assures driving range of 400 km. To reach driving range of 700 km or 950 km there would be necessary 12364 cells or 18099 cells , respectively. Such a high number of cells would present a spatial problem as well as a considerable increase of a vehicle's mass (Evannex, 2017, Huš, 2016).

5. PRESENT SITUATION

5.1. Electromobility in European Union

The total number of new registrations of electric automobiles in the European Union according to the data of EAFO is shown in Figure 1. Both battery electric vehicles (BEV) and plug-in hybrid vehicles (PHCV) are included (EAFO, 2018). Therefore, it can be seen that the number of new registered cars has increase in the period 2012-2017 almost ten times – from 23146 electric cars in 2012 to 217461 electric cars in 2017 (EAFO, 2018).

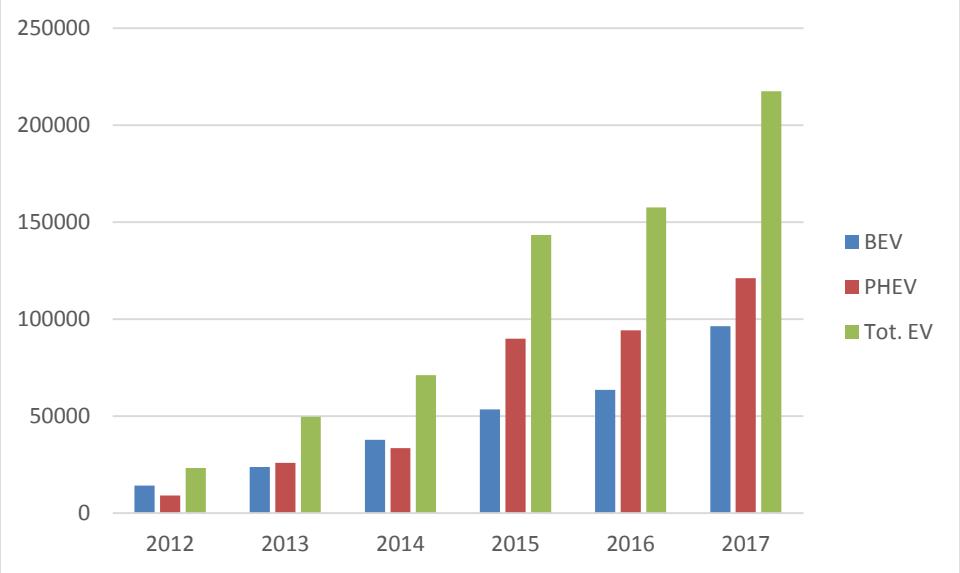

Figure 1: Total number of new registrations of electric automobiles in the European Union for the period 2012-2017: BEV – battery electric vehicles, PHEV – plug-in hybrid vehicles, Tot-EV – total number of electric vehicles (EAFO, 2018).

In Figure 2 the share of electric vehicles in the European Union market is shown. There can be observed approximately 7,5 times increase in EV share (from 0,19 % in 2012 to 1,44 % in 2017) (EAFO, 2018).

5.2 Electromobility in Slovenia

The number of electric automobiles in Slovenia is still very low (according to the data of DEVS – Slovenian Society of Electrical Vehicles only about 500, some other estimations are bit higher but not more than 1200 vehicles) (RTV SLO, 2017). Therefore, it is not surprising that network of charging stations is relatively undeveloped. Actually the number of stations in comparison with the number of vehicles is not so small – according to the data from the end of the year 2016 there were 228 charging stations with 553 plugs. This means that the ratio of electric cars and charging stations is approximately 3:1 and the ratio of electric cars and plugs is almost 1:1. The problem may arise according to the uneven distribution of charging stations as they are concentrated in the vicinity of motorways and Ljubljana (Pavšič, 2017).

According to certain opinions the relative small number of electric vehicles in Slovenia is ascribed to low degree of environmental awareness. However, when comparing prices of electric cars and average income of a Slovenian middle class family such an opinion is only partially true. It seems that economic reasons are the main obstacle for the greater prevalence of electric cars.

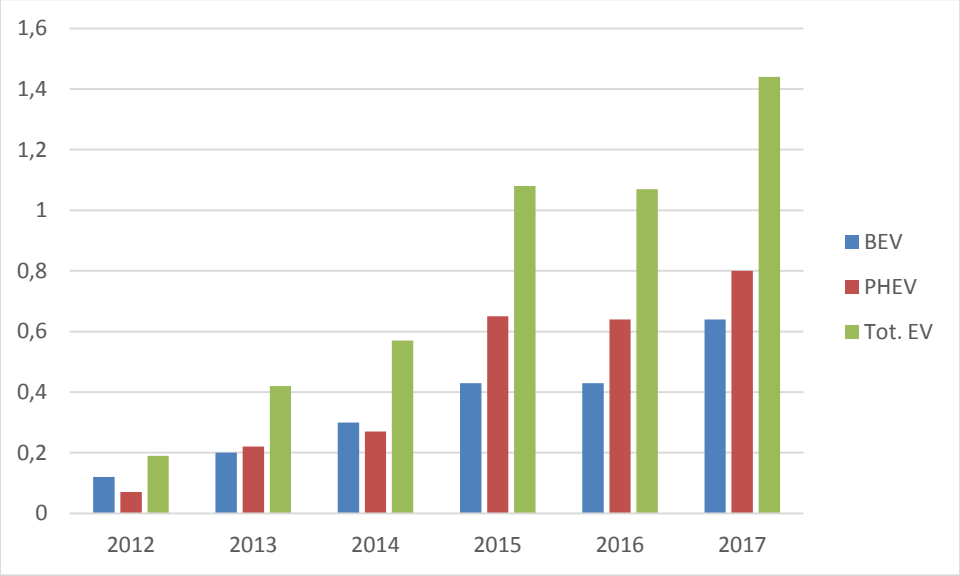

Figure 2: Market share (in %) of electric automobiles in the European Union for the period 2012-2017: BEV – battery electric vehicles, PHEV – plug-in hybrid vehicles, Tot-EV – total number of electric vehicles (EAFO, 2018).

The prices of electric cars are still too high for the capacity of an average Slovenian household nevertheless the maintenance (services, fuel/energy) of electric vehicles is less expensive than in the case of cars with internal combustion engines. As economic aspects are usually the most important for an average user or owner of the car it is reasonable to compare some data. The cost of energy consumed for 100 km of driving for an electric car vary – depending on the tariff between 1 Euro and 2,5 Euros (EVSVET, 2018). The costs are therefore several times lower than in the case of gasoline, diesel and even gas fuel. However, the costs of an electric automobile are still too high in spite of subsidies of the Slovenian ecological fund (3000 – 7500 Euros, depending on the category, age of the car etc.). There should be also included technical and logistic problems as are shorter driving range, time of battery charging, life time of battery. All these aspects present considerable obstacle for the enforcement of electric vehicles in everyday practice.

Besides this there presents considerable uncertainty for potential future owners or users of electric cars also the fact that it is not known how long will the subsidies apply as well as how long it will exist the possibility of free charging of batteries on public stations.

6. PROPOSALS AND CONCLUSIONS

In cities like Ljubljana and Maribor it is possible to build charging stations at the entrance in the city for external visitors with electric cars. It will be possible to organize public transport to the center of the city from the charging stations at such guarded parking lots. In such a way it will be possible to reduce traffic density in the center and thus avoid traffic jams.

Charging stations in the centers of cities are problem by themselves because of necessity of building of additional voltage support system (transformers) as well as because of spatial restrictions.
In the case of a greater number of users of electric cars there will be reasonable to plan charging stations in underground garages. Besides this it will be possible to build charging points also in large parking lots at shopping centers, sport halls, stadiums etc.

When constructing new residential neighborhoods the placement of charging infrastructure will mainly not present a problem. The situation is different in the case of those urban areas where all the infrastructure is already build and subsequent construction of charging capacities is difficult or even impossible.

Because of the increasingly restrictive environmental legislative and limited natural reserves of oil it can be expected that in the future electric automobiles will gradually prevail over the automobiles with internal combustion engines. This fact will bring certain problems which have to be sold as well as a number of new challenges.

As has been mentioned one of the main questions is how in countries like Slovenia assure enough electric energy. It is particularly desired to use electric energy from renewable sources as only in this way it will be possible to reduce the carbon footprint. Another problem is the necessary upgrade of the electricity network.

It is also not real to expect that in the future the electric energy for charging of automotive batteries will be so cheap as it is currently. Today it is possible to charge batteries at a very low price or sometimes even for free because of promotion of electric cars use. However, when the share of electric cars will reach a certain value it is not realistic to expect that this will continue. It should be mentioned that also in the price structure of gasoline or diesel fuel the considerable share present taxes or duties. It can be expected that in the future also electric energy used for charging batteries will be according to certain duties considerably more expensive than electricity used in households.

REFERENCES

ARSO (2017). Bullettin of the Environmental Agency of the Republic of Slovenia – monthly air quality reports for the year 2017 (published in Slovene: Bilten Agencije Republike Slovenije za okolje).

Battery University (2018). Availability of Lithium. Accessed on April, 25, 2018 from http://batteryuniversity.com/learn/article/availability_of_lithium

Botkin, B.B. and Keller, E.A. (2003) *Environmental Science: Earth as a living planet*, John Wiley & Sons Inc.

Brook, R.D., Franklin, B., Cascio, W., Hong, Y., Howard, G., Lipsett, M., Luepker, R., Mittleman, M., Samet, J., Smith, S.C.Jr., & Tager, I. (2004). Air pollution and cardiovascular disease: A statement for healthcare professionals from the expert panel on population and prevention science of the American heart association. *Circulation,* Vol. 109, pp. 2655-2671.

Brook, R.D., Rajagopalan, S., Pope C. A., Brook, J. R., Bhatnagar, A.; Diez-Roux, A.V.,Holguin, F., Hong,Y., Luepker, R.V. Mittleman, M.A., Peters, A., Siscovick, D., Smith, S.C.Jr, Whitsel, L., Kaufman, J.D. (2010). Particulate matter air pollution and cardiovascular disease – An update to the scientific statement of the American Heart Association. *Circulation*, Vol. 121, pp. 2331-2378.

Business insider (2015). The fascinating evolution of electric cars. Accessed on January, 8, 2018 from http://www.businessinsider.com/electric-automobile-history-2015-12/#they-even-had-key-advantages-over-gasoline-and-steam-powered-cars-in-the-early-1900s-2

Conot (2011). Baterija - srce električnega avtomobila. (In Slovene). Accessed on April, 24, 2018 from http://www.conot.si/index.php/elektricna-mobilnost/baterija-srce-elektrinega-avtomobila.html,22.3.2018

Curry Brown, A. (2013). *Health Effects of particulates and black carbon*. Transport and clean air seminar, U.S. EPA, December 2013. 7. Accessed January 20, 2017 on https://www.epa.gov/sites/production/files/2014-05/documents/health-effects.pdf

Daimler (n.d.). Company History: Benz Patent Motor Car: The first automobile (1885-1886). Accessed on January, 8, 2018 from https://www.daimler.com/company/tradition/company-history/1885-1886.html

Dockery, D.W., Pope, C.A., Xu, X et al. (1993). An association between air pollution and mortality in six US cities. *N Engl J Med,* Vol. 329, pp. 1753-1759.

Dominici, F., McDermott, A., Daniels, M., Zeger, S.L., & Samet, M.J. (2005). Revised Analysis of the National Morbidity, Mortality and Air Pollution Study: Mortality among residents of 90 cities. *Journal of Toxicology and Environmental Health, Part A,* Vol 68 (13-14), pp. 1071-1092.

EAFO (2018): European Alternative Fuels Observatory – Electric vehicles. Accessed on April,19, 2018 from http://www.eafo.eu/eu#eu_pev_sales_vols_graph_anchor

EEA (2017). Overview of electricity production and use in Europe. Retrieved on January, 10th 2018 from https://www.eea.europa.eu/data-and-maps/indicators/overview-of-the-electricity-production-2/assessment

Electronics Lab (n.d.). How to rebuild a Li-ion battery pack. Accesed on Aprile 19, 2018 from https://web.archive.org/web/20120217001508/http://www.electronics-lab.com:80/articles/Li_Ion_reconstruct/How%20to%20rebuild%20a%20Li-Ion%20pack.pdf

Elektro Ljubljana (2018). Transformer stations and price of connections – Private communication with Mr. Z. Artnak, Elektro Trbovlje..

Elwell-Parker (n.d.) Thomas Parker. Elwell-Parker limited. Accessed on January 8, 2018 from http://www.historywebsite.co.uk/genealogy/Parker/ElwellParker.htm

Evannex (2017). *Understanding Tesla s lithium ion batteries*. Accessed on April, 25, 2018 from https://evannex.com/blogs/news/understanding-teslas-lithium-ion-batteries

EVSVET (2018). EV Svet – Svet električnih vozil (in Slovene). Accessed on April, 23, 2018 from http://evsvet.eu/

Fruin, S.A., Winer, M.A., & Rodes, C.A (2004). Black carbon concentration in California vehicles and estimation of in-vehicle diesel exhaust particulate matter exposures. *Atmospheric Environment,* Vol. 38, pp. 4123-4133

Guarnieri, M. (2012) "Looking back to electric cars". *Proc. HISTELCON 2012 – 3rd Region-8 IEEE HISTory of Electro – Technology Conference: The Origins of Electrotechnologies*: #6487583. doi:10.1109/HISTELCON.2012.6487583. ISBN 978-1-4673-3078-7.

Huš, M. (2016). Litijevi umazani pomočniki, Monitor 2016 (in Slovene). Accessed on March, 23, 2018 from http://www.monitor.si/clanek/litijevi-umazani-pomocniki/175027/

Kirchstetter, T.W., Harley, R.A., Kreisberg, N.M., Stolzenburg, M.R., & Hering, S.V. (1999). On-road measurement of fine particle and nitrogen oxide emissions from light- and heavy-duty motor vehicles. *Atmospheric Environment,* Vol. 33, pp. 2955-2968.

Kolednik, A., & Pavšič, G. (2017). Tudi Slovenija bo prepovedala avtomobile na bencin in dizel. Siol.net – Avtomoto (in Slovene). Accessed on January, 16, 2018 from https://siol.net/avtomoto/novice/tudi-slovenija-bo-prepovedala-avtomobile-na-bencin-in-dizel-451171

Kordiš, A. (2018). Načrtovanje, vzdrževanje in preverjanje polnilnih postaj (in Slovene). Accessed on April, 25, 2018 from https://www.linkedin.com/pulse/na%C4%8Drtovanje-vzdr%C5%BEevanje-preverjanje-polnilnih-postaj-za-ana-kordi%C5%A1/

Miguel A.H, Kirchstetter, T.W., Harley, R.A. & Hering, S.V. (1999). On-road emissions of particulate polycyclic aromatic hydrocarbons and black carbon from gasoline and diesel vehicles. *Environmental Science and Technology,* Vol. 32, pp.450-455.

Mondt, J.R. (2000). *Cleaner cars: the history and technology of emission control since the 1960s.* Society of Automotive Engineers, Inc..

Owning an electric car (2010-11). Electric Car History. Accessed on January, 8, 2018 from https://web.archive.org/web/20140105043545/http://www.owningelectriccar.com/electric-car-history.html

Pavšič, G. (2017). Država mora sprejeti strategijo prehoda na alternativna goriva. Siol.net – Avtomoto (in Slovene). Retrieved on January 15th 2018 from https://siol.net/avtomoto/zgodbe/elektricni-avti-v-sloveniji-koliko-jih-potrebujemo-leta-2030-da-drzava-uide-penalom-iz-bruslja-449808

Peters, A, Liu, E, Verrier, R.L., Schwartz, J., Gold, D.R., Mittleman, M., Baliff, J., Oh, J.A., Allen, G., Monahan, K. & Dockery, D.W. (2000). Air pollution and incidence of cardiac arrhythmia. *Epidemiology,* Vol. 11, pp. 11-17.

Pope, C.A. Burnett, R.T., Thurston, G.D, Thun, M.J., Calle, E.E., Krewski, D. & Godleski, J.J. (2004). Cardiovascular mortality and long-term exposure to particulate air pollution – Epidemiological avidence of general pathophysiological pathways of disease. *Circulation*, Vol. 109, pp. 71-77.

PP Plan-net (2016). Vrste polnilnic, priključkov, polnjenja in električnih avtomobilov (in Slovene). Accessed on January, 12, 2018 from http://www.polnilne-postaje.si/vrste-polnilnic-prikljuckov-in-polnjenja-in-elektricnih-avtomobilov

RTV SLO (2017). Število električnih in hibridnih vozil se je v letu dni več kot podvojilo. RTV SLO MMC – Gospodarstvo (in Slovene). Accessed on January 15, 2018 from https://www.rtvslo.si/gospodarstvo/stevilo-elektricnih-in-hibridnih-vozil-se-je-v-letu-dni-vec-kot-podvojilo/430031

Schäfer, F., van Basshuysen, R. (1995): *Reduced Emissions and Fuel Consumption in Automobile Engines,* Springer Verlag, Wien - New York, 1995

Schrack Technik (2018). Polnilne postaje (in Slovene). Accessed on April, 25, 2018 on https://www.schrack.si/trgovina/elektromobilnost/polnilne-postaje.html

Senegačnik, M., Vuk, D., & Petrović, N. (2017). Black carbon and its impact on air quality and on development of cardio-vascular diseases. V: Arsenijević, O. (ur.), et al. *Odgovorna organizacija: (konferenčni zbornik)*, 36th International conference on organizational science development: Responsible organization, Portorož, March 22nd - 24th, 2017. Maribor: Univerzitetna založba Univerze. 2017, 929-938

Suglia, S.F., Gryparis, A., Wright, R.O., Schwartz, J., & Wright, R.J. (2007). Association of black carbon with cognition among children in prospective birth cohort study. *American Journal of Epidemiology,* Vol. 167 (3), pp. 280-286.

SURS (2017). Statistical office of the Republic of Slovenia. Registrirana cestna in motorna vozila in prikolice, Slovenija, 2016 (in Slovene). Accessed on January, 15, 2018 from http://www.stat.si/StatWeb/News/Index/6602

E-WASTE MANAGEMENT: ENVIRONMENTAL AND SOCIAL IMPACTS

Tijana Milanović[1]*, Gordana Mišev[2], Maja Milanović[3]
[1] Belgrade Business School – Higher Education for Applied Studies
[2] Ministry of Mining and Energy, Serbia
[3] Freelance translator
*Corresponding author, email: tijana.milanovic@bbs.edu.rs

Abstract: *One of the biggest issues of environmental policy in the Republic of Serbia is unsystematic and inadequate waste management, especially when it comes to hazardous waste. Continuous growth of society generates the accelerated development of modern technologies, leading to greater production and usage of diverse electric devices and equipment without which the everyday life is unimaginable. Therefore, electric waste is inevitable by-product of technological revolution. Raw materials used in the production of electronic equipment also have negative influence, causing the expansion of electronic and electric waste problem which, consequently, to a large degree contributes to the total environmental pollution. Redistribution of responsibility between the producer and the consumer should contribute to the full affirmation of ecological awareness about catastrophically negative influence of electronic and electric equipment on the environment and human health.*

Keywords: *technological revolution, digitalization, e-waste, environmental protection, green industry*

1. INTRODUCTION

The increase of waste represents the overall economic activity of a state, and, it could be said to be in direct correlation with its national economy. Therefore, the formation of waste depends on the level of industrial development, social environment, life standard and other parameters that determine the amounts of generated waste of a state on annual level. Very often, the activities of people have negative influence on the environment. But also, the special issue is the advanced generation of all waste types, and along with revolution of information technology, the rapid growth of the amounts of electric and electronical devices waste represents true challenge for every country and the world in general.

According to the Article 5 of the Law on Waste Management (*The Official Gazette of the Republic of Serbia, No. 36/09 with amendments*), hazardous waste *is the one that as a result of its origin, composition or concetration of unsafe substances can cause danger to environment and human health and it contains at least one of hazardous features in accordance with special regulations*. The waste classification is done in accordance with the Rulebook on Categories, Testing and Classification of Waste (*The Official Gazette of the Republic of Serbia, No. 56/10*). The Rulebook, inter alia, is used for implementation of the European Waste List (EWL – Commission Decision No. 2000/532/EC with amendments). With the EU Decision No. 1600/2002/EZ (Commission, 2002) regarding the establishment of *The Sixth Environment Action Programme* (EAP) it has been emphasized that the basic principle of sustainable waste management is the separated management of waste produced by economic activities. Ecologically acceptable and sustainable waste management requires the integrated system of waste collection, recycling, reuse and disposal.

The European Commission defined several “specific waste streams” also including the electric and electronic waste. In order to prevent the creation of hazardous waste within the specific waste streams, several EU Directives prohibited the use of hazardous substances for fabrication of products, among which are included the electric and electronic waste, as well. The waste of electric and electronic products refers to household appliances and technologies (TVs, computers, mobile telephones, analog, plasma and LCD screens, music devices, fridges, freezers, air conditioning devices, etc.). Because of their containing components, most of the aforementioned products are considered to be hazardous waste (Serbia, 2010). Apart from recycling materials (metal, rubber, cables and glass) with their own utility value and without the hazardous waste features or unsafe substances (heavy metals, greenhouse gases, mineral oils, asbestos, freon), the electric and electronic waste can also have great number of dangerous and harmful substances. In accordance with *The Regulation of products that become special waste streams after use* ("Official Gazette of the

Republic of Serbia", No. 54/2010, 86/2011, 15/2012, 41/2013 - Rulebook and 3/2014) the electric and electronic products are classified according to the type of electric and electronic equipment in the following manner:

Table 1: Types of E-Waste

E-waste types	
1st class	**2nd class**
Large Household Appliances	Small Household Appliances
3rd class	**4th class**
IT and Telecommunications Equipment	Oprema široke potrošnje za razonodu
5th class	**6th class**
Lightening Equipment	Electric and Electronic Devices
7th class	**8th class**
Toys for Recreation and Leisure-time Activities	Medical Auxiliary Devices
9th class	**10th class**
Surveillance and Tracking Instruments	Slot Machines

Collection and treatment of hazardous electronic and electric waste requires the precise planning and clear defining of rules and duties of all participants in the management chain of this type of waste. Considering the fact that the expiration date of electronic devices is short and usually are thrown away afterwards, but also it is difficult to reuse and recycle them, e-waste is one of the areas with the reported highest growth.

2. E-WASTE GENERATION

There is not an area that has not been influenced by technological changes: trade, energetics, sports, industry, catering, health and intellectual services, etc. Rapid development and cheap production of technologies has contributed to the fact that almost every household in the 21st century contains electric and electronic devices. Before the digitalization process, there was the era of mechanical recordings and magnetic sound carriers (film, magnetic recording on wire and tape, vinyl record, video cassette). For the last thirty years, we have witnessed the gradual crossing over of all types of communication from classical, analog to digital technologies. With the era of digitalization, computers and internet, we got accustomed that everything can be available any time, any place and with accessible prices. As a result of greater accessibility of electric and electronic devices and equipment, the number of household appliances has increased. The development of industry has also been followed by modernization and digitalization in order to keep up with global tendencies and changes. Malfunctioning devices are rarely taken to repairs, because usually people just replace them with new items being this simpler and more economical solution. Due to the advanced development of IT sector, the average expiration date of computers and mobile telephones has decreased from six to two years. Even though household appliances have longer expiration date, each year the technology market is growing bigger. The incredible development of electronic industry combined with short expiration date of devices have lead to abrupt escalation in generating the increasing amounts of e-waste. Waste electric and electronic equipment (WEEE) or e-waste has become the growing challenge for countries around the world.

Obtaining raw materials for the production of electric and electronic device has also a negative influence. These raw materials used for production are mainly gained through mining which leads to great amount of harmful gases. Over 1,000 thousand different materials are used in production of electronic devices and their components (chips, printed circuits, disk drives, etc.). Many of these are poisonous and contain diluents based on chlorine, bromine compound, polyvinyl chloride, heavy metals (lead, mercury, arsenic, cadmium), plastics and gases (BEWMAN 2011). The aforementioned substances, if not handled with care, can be harmful to human health and the environment. Instead of producing more efficient, long-term equipment less hazardous for human health and the environment, the rapid development of technologies causes the use of cheaper and less quality resources which consequently means shortening of expiration date of products and increasing e-waste generation. Every year, each country uses hundreds of thousands, and maybe even hundreds of millions of electric and electronic devices. When talking about the Republic of Serbia, the import of used electric and electronic products, unless being for personal needs, is prohibited. However, the production and the import of new items has been steadily growing. As stated in the records of The Chamber of Commerce and Industry of Serbia, the number of enterprises in Serbia in year 2015, was 325,094 which in comparison to 2008 is 21,150 enterprises more (that is 7,0% more). In year 2016, the

investments in IT sector were based on the support from over 2,000 domestic IT enterprises dealing with production or distribution of hardware, software or IT services that have over 20,000 employees (SITO, 2016). Due to technological changes and internet services development, the role of electronic communications has expanded on all segments of society. According to the data from the Environmental Protection Agency (SEPA), in 2016, the producers put up on the market for sale approximately 9578,2 tons, that is 12,845,433 of electronic and electric devices were turned into specific waste streams upon their use. The majority of devices belongs to IT equipment (7,764,913) with the short expiration date, meaning that those are the products which households, but also companies, tend to change more frequently for new products (Agency, 2017). One of the causes of consumer society is mass production. The market game has put the emphasize on obtaining the bigger profit by lowering the selling prices, that is by offering the cheapest possible products. The consumer society, the product of globalization, together with the use of television, internet and other media influence, has been increasingly expanding and influencing on all areas of life. In economy, consumerism refers to the economic policy with aim to enhance the spending, and in accordance to which free choice of consumers should dictate the economic structure of society (Trendafilovic, Radonjić, & Filipović, 2013). Products such as cars, electric machines, television sets have become something ordinary and easily accessible in almost every household. The importance of quality of a product has been replaced by its quantity, turning this into the prerequisite upon choosing certain goods, and this way of thinking has very much expanded with digitalization process.

Digitalization has entered into all business spheres, but it has also been selling as a product itself. The number of digital devices, systems and applications is significantly large and the list of new products that we could expect on the market in the future is endless. With the development of industry, the number of companies with increasing products, including the EE products, is growing. As a result of faster software development, the most frequent changing devices nowadays are computers and computer equipment. Back in 1994, it was estimated that 20 millions of computers all over the world were obsolete, while the total amount of electronic waste was estimated to be 7 million tons. In 2004, the number had gone up to 100 millions of computes. Nowadays, the numbers are significantly higher and keep rapidly growing. When it comes to the EU member states, the annual amount of generated e-waste is estimated to be 14 – 15 kg per capita (Pavlović, Tadić, & Popovic, 2011). Furthermore, the European studies show that the amount of e-waste has been increasing 3 – 5 % per year, which is 4 times faster than communal household waste. This e-waste makes 5% of the total waste amount, with increasing growth rate per year. In accordance with estimations of the United Nations Environment Programme (UNEP 2005), each year 50 million tonnes of e-waste is produced in the world, and majority of that ends in developing countries. Leading continents in annual production of this hazardous waste is North America (about20 million tons), followed by Europe and Asia (about 14 million tons each) while other continents reach up to about 5 million tons (E-reciklaža, 2012). When it comes to the Republic of Serbia, 40 thousand tons of e-wast is generated annually (2016), which is four times more than in year 2012 (Agency, 2017).

If e-waste cannot be avoided, it is necessary then to reuse it, and to recycle and regenerate anything considered to be a useful resource. Electric and electronic waste recycling has been increasing during years reaching the level of approximately 19,000 tonnes (Chart No. 1) in 2013, which is about 2 kg of e-waste per capita keeping the Republic of Serbia still at the beginning. According to the National Plan, it has been conceived that recycling of this kind of waste should reach the level of 4,5 kg per capita by year 2018. Nevertheless, that level was reached back in 2016.

Table 2: Electric and Electronic Waste (Agency, 2017)

Year	Disposed Waste (t)	Treated Waste (t)	Exported Waste (t)	Imported Waste (t)
2011	/	7084	793	/
2012	62	10601	1381	/
2013	/	18998	2799	/
2014	0,1	20972	240	/
2015	/	27351	2311	/
2016	56	37004	3293	/

If the adequate handling of products after their production and its life-cycle are not being taken into consideration, that can further lead to the production of electronic equipment which can leave behind toxic substances and harmful gases upon recycling, especially if the appropriate techniques for e-waste management are not being applied. E-waste recycling is not an easy task since it contains hazardous substances, as well as those that require special procedures while handling them. According to some estimations, less than 10% of e-waste is recycled in Serbia. The negative statistics

leads directly to conclusion that the largest percentage of e-waste ends on communal or wild landfills, which also says a lot about the insufficient public awareness regarding negative consequences of inappropriate treatment and e-waste disposal on landfills.

3. E-WASTE MANAGEMENT IN SERBIA

In the Republic of Serbia, the ministry in charge with environment issues the licenses for hazardous waste management. Each operator that deals with waste management (collecting, transport, treatment, storage or waste disposal) should have the waste management license, and in case of preforming more than one different activities regarding the waste handling, the operator should get the integral license (Serbia G., 2009).

Until March 2018, 2,144 waste management licenses were issued in Serbia. The first time, license is issued for the period of five years time after which it should be renewed. Out of the number of enterprises with waste management licenses, 746 of them treat secondary raw material on different technological levels, while only 129 deal with hazardous waste. Among these enterprises there are also companies for electric and electronic waste recycling. However, the complete recycling process is not being done in these factories. Recycling requires great financial investments, special infrastructure and sophisticated technology with up to a value of several million euros, which on the one side creates possibility for growth of the, so called, *green industry,* additional job places and investment development, but on the other side it means great (financial) challenge for the economy of a country that is still without full capacities. Since the recycling represents the perspective aspect of a country's economy, with inevitable progress in the future, the implementation of contemporary methods for electric and electronic waste streams management is necessary as stimulus for operates to further develop this type of industry.

Table 3: Waste Management License (SEPA, 2018)

	Ministry			**AP Vojvodina**			**Local Self-Govrenmnts**
	total	non hazardous	hazardous	**total**	non hazardous	hazardous	non hazardous
Collecting	750	712	205	64	59	17	163
Transport	852	818	186	79	75	17	180
Storage	143	115	106	98	89	50	648
Treatment	138	112	98	79	77	31	529
Disposal	3	3	1	3	2	2	34
Total licenses by authority		1131			178		835
Total issued licenses	**2144**						

The process itself for obtaining a waste management license is very slow and requires extensive documentation that a future operator is in obligation to present. This includes working plans, programs and waste management methods (Serbia G., 2009), consents and permits from different authorized institutions, financial guarantees and administrative fees. Depending on the type of a license, the duration of documentation collecting can even be several months. Also, the process of issuing the license can be very slow and it is the obligation of the ministry in charge to start the procedure of request processing within a month, under the condition that all necessary documentation was previously collected and provided by operators. Only after this, the process of license preparation can start. The waste producer, the owner or any other waste holder are obliged to keep a daily track about the waste and submit annual reports to the Environmental Protection Agency, alongside with the *Document about the waste movement* and the *Annual Report* that should be filled via on-line application, but also in written form on a paper and all of this makes the process of e-waste management more complicated and duplicated. For this reason, it is necessary to establish clear and shorter standard operating procedures (SOP) defined for electronic and electric waste, but also the advanced IT system available both to entities and natural persons.

Waste management involves collecting, transport, treatment, storage and waste disposal. The waste equipment should be storaged in such a manner to avoid squashing, crashing or destructing in any

other way, or mixing with some other substances. This way the reuse and recycling are set up without any large costs. The collector does not dismantle the waste equipment, but rather gives it to the operator or the collecting operator. The operator's duty is to apply recycling and provide the reuse of entire equipment. The e-waste treatment is done with best available treating and recycling techniques. E-waste treatment rooms should be spacious enough for adequate storage of dismantled spare parts which can be classified as recyclable or non-recyclable material. The recyclable parts are all with the usage value (plastic, metal, cables, aluminiun, glass) and are given to the authorized operators for the further treatment. The non-recyclable parts in the Republic of Serbia as well as the hazardous substances are disposed into the special packages and exported. Hazardous waste management, including the storing at the place of its origin and the transporting, always involves a certain risk, which includes the environment pollution (of land, sources of water including subterranean waters), fires and release of toxic gases into the atmosphere. More than 38 different chemical elements can appear as the product of e-waste management process, and some of which can be really harmful for the environment and should be destroyed inside special plants since there is no possibility for their further use.
Organizing and functioning of sustainable collecting net is one of the main problems in establishing the efficient management system of electronic and electric products waste. The other problem refers to the effective recycling process that requires great financial investments, which are economically unsustainable without the help from state subventions.

3.1. Financial Instruments

The main sources for financing the environmental protection in the Republic of Serbia are the state budget and fee income. In accordance with the *Regulation on Products that become specific waste streams upon use*, everyone who puts on the Republic of Serbia's market the products that upon use become the specific waste stream (TV sets, fridges, tyres, accumulators, batteries, vehicles, oil, etc.) are obligated to pay the quartal fee, that is the ecological fee. This system is also know as: *payed by the pollutant*. In practice, this fee is payed once a year after the Serbian Environmental Protection Agency (SEPA) delivers the necessary data to the Ministry of Environmental Protection regarding the produced/imported amounts of electric and electronic products, based on which the Ministry further calculates the appropriate fee and brings the resolution about the payment. The fee amount varies since it dependes on the type of e-waste. In year 2015, income tax of the environment area were 167, 19 billion dinars (rsd), which makes it the 11,1% participation in the GDP. When it comes to the EU, and member states with less than 10% participation: Slovenia had 10,6%, Greece 10,3% and Bulgaria 10%. On the opposite side of the scale much less participation had Belgium (4,7%), France (4,8%), Luxembourg (4,9%), Germany (5%) and Sweden (5,1%). However, the devastating fact is that energy tax is more than ¾ of total elcological fee income (76,7%); transportation fee is 19,8%, while the pollution and resources fees are only 3,5% (Euroaktiv, 2017). On the other hand, the state provides necessary financial funds (incentive measures) for e-waste management process through obligatory fee payment for produced and imported products that after their use turn into e-waste. Every year, the Ministry releases the Rulebooks on types and quantity of incentive measures for all waste types including the EE waste, which is the way to repay the funds received from the producers of products that become specific waste streams upon use. These are economic instruments used to show to economy entities and citizens that there are also financial benefits in environmental protection investments. According to SEPA data, the Image No 1 shows the structure of incentives given between 2010 and 2016 (SEPA, "Environmental Protection Entities", 2018):

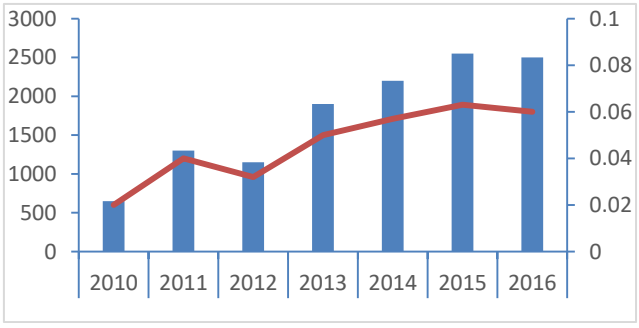

Figure 1: Incentive resources for 2010-2016

The waste managment has three goals: decreasing the waste amounts; adequate waste collecting and waste recycling, that is waste reuse. Providing the incentives for e-waste treatments is necessary measure, since the recycling itself requires great financial investments, mainly because recycled products are more expensive than products from natural resources. Recycling has ecological, economic and social meaning and it accomplishes the following: saving natural resources (all materials are of natural origin and can be found in nature in limited amounts), energy savings, environmental protection and new job positions (the so called, *circular economy* or *green industry* create the need for new job positions).

4. DIGITALIZATION CHALLENGES

Understanding the importance of Information Technology, developed countries (mainly the USA and the EU) have chosen to enhance the growth of IT sector for the last two to three decades. Choosing the liberalization of telecommunication market and the increasment of competition in all IT areas, we have achieved the global telecommunication market and endless competitions between increasing number of telecommunication companies (Mišev & Kaloserovic, 2017). With this trend of progressive digitalization and technological innovations in general, one of the issues is how to decrease e-waste generation with scrutiny and advancement in quality of technological procedures that produce electric and electronic items. From rapid obsolescence of products, that is from shorter market renewal cycles with new models, the ones that benefit the most are producers. Being the result of digital technology, is the thing these products have in common. Nowadays, everything is digitalized, from television and radio signals (sounds), bank services, on-line shopping to written documents. The inevitable steps to be taken in digital economy development start from investing in infrastructure, with aim to introduce the broadband internet in every household in Serbia, through forming the e-administration, to initializing an incubator for start-up companies. Speed and range of digital transformation affects almost every industry, which futher causes new IT companies with aim to provide the integration of new technologies. Innovations happen very fast (so called *industrial revolution*), and within a few years digitalization will affect the development of many areas. Digitalization process will ensure that industrial production becomes completely automated. This, basically, means that the number of employees hired on a production will decrease, while as the number of products and services will increase. The functioning of a modern society cannot be imagined without computers and the supporting IT equipment. The development of telecommunication and information technologies, that is the hyper production of means of communication, furnishes the increased availability of modern telecommunication means, also leading to the increased number of users (Stanojević, Mišković, & Mišev, 2017). Digital technologies fundamentally transform organizations, with the pace of technological change exacerbating the challenge. For these reasons, organizations must have a coherent strategy that includes a plan to reskill workers. Whereas previous technological revolutions (most notably the industrial revolution) played out over a relatively long period of time, the speed of digital transformation is such that companies need to act fast (WEFORUM, 2018). This influence is seen in cost cuttings of economy entities business running (which automatically increases their competitiveness), but also in making completely new ways for doing the existing economy activities and starting the new ones (Mišev & Kaloserovic, 2017). The most affected industries will have the impact on some of the employees, more than on the others (the low qualified ones, or those not willing to learn more). Job positions, such as those in sale, finance and administration, are threatened by automation. The industries in which the number of job positions is expected to increase are: architecture, engineering, informatics and mathematics (ManpowerGroup, 2017). All production procedures are unimaginable without the use of electronic and electric equipment and devices, and their increase is mostly expected in developing countries, including Serbia.

When, for any reason whatsoever, IT and similar electric and electronic equipment becomes outdated and useless, it is turned into e-waste that should be taken care of. Electric devices producers are the cause of the problem, but they can also be it's solution by taking the responsibility for their goods during their entire life-cycle: from the production day, until the time when they are turned into waste. They need to finance the treatment costs of their own products that become specific waste streams upon their use, while as the consumers should be given the opportunity of returning their old electronic equipment to the producers without any charges. Nevertheless, paying the ecological fee is not the sufficient financial instrument to deal with this kind of issue. The unnecessary technology should not be thrown into garbage, but rather handed over to licensed recycling centers or back to the

manufacturers, which is something that should be introduced as obligatory through primary waste separation in every household. On the other side, the producers need to:

- Manufacture ecologically acceptable products, that is, the technological procedures need to be more sensible and done with more responsibility towards the environment and public health;
- Manufacture the higher quality and long-lasting products;
- Receive back their products in order to reuse and safely recycle them.

Just as there is a notable rise of ecological vehicles production in the world which, at this stage, cost more than the classic vehicles, that is those with fossile fuels, the production of electric and electronic devices and equipment is also conceivable with faster technological progress of industry. The good example for this is the company *MicroPro* that presented the first ecological computer six years ago. The Irish company brought to public view the computer made out of wood *Iameco v3*, which could be named "the most ecological computer in the world". Almost the entire computer is recyclable, while 20% of it is set for direct recycling without any additional procedures and the wooden computer case of Imeco emits 70% less CO2 than "regular" desktop or laptop computer (B92, 2012).

Considering the fact that the market game is not being useful to the environmental protection, the state needs to manage this area. Nevertheless, only since the last decade of the 20th century, has legislation in the field of the environment started to deal with ecological features of industrial products and principles of projecting the new products. It is becoming obvious that the producers with their ecological engineering solutions are paving the way to new directives that increasingly impose ecological and technical standards. Considering the market game that dictates the cheaper production, for gaining more profit, it is impossible to regulate this field without any legal basis. *Energy Labelling Directive* (2010/30/EC) has brought significant energy savings and has undoubtedly contributed to technical progress within the sphere projecting the electric products of mass consumption. The energetic efficiency classes were defined with this Directive. In order to prevent the negative influences of complex industrial products during the developing phase, the European Commission brought back in year 2003 (and supplemented it in 2009) the *ErP Directive* (*Energy-related Products Directve 2009/125/EC*), the framework for setting the criteria in area of ecologically oriented projection of products that spend energy during the exploitation phase. Its aim is to improve the eco-features of a product and the quality of life environment, as well the rational use of energy products. However, the EU has gone even further with its *Directive RoHS 2 (EU) 2015/863* with which the use of the following substances is limited (Glišović, 2016):

- lead (Pb)
- mercury (Hg)
- cadmium (Cd)
- hexavalent chromium (Cr6+)
- polybrominated biphenyls (PBBs)
- polybrominated diphenyl ether (PBDE)
- bis (2-ethylhexyl) phthalate (DEHP)
- butyl benzyl phthalate (BBP)
- dibutylphthalate (DBP)
- diisobutyl phthalate (DIBP)

It has been confirmed that aforementioned substances might have negative influence on recycling, human health and environment during the e-waste treatment. In accordance with the RoHs2, the products are tagged with CE label (fr. *Conformité Européenne*) and their use is under scrutiny of the *Executive Agency for Implementation of Trade Standards*. The application of the RoHS 2 Directive certainly helps in decreasing the ecological consequences and in protecting human health. Development of new alloys and technologies has enabled the advanced companies to, on their own initiative, harmonize with RoHS (Glišović, 2016) requests. Application of these Directives implies the use of alternative raw materials which would make recycling not only more profitable, but also more ecological.

5. CONCLUSION

Instead of producing the long-lasting and efficient equipment that is with less negative influence on the environment, due to the advanced technological progress, the trend of hazardous substances use for electric and electronic equipment production remains unchanged further leading to increased amounts of e-waste that is the hazardous waste with the fastest rate of generation on global level. The accumulation of e-waste is the consequence of increased technological progress, especially in the area of informatics and telecommunication. Therefore, it is necessary to establish the sustainable system of e-waste management in Serbia in ordered to reduce its long-lasting devastating impact on

the environment and public health. The e-waste management includes the complementary use of different procedures in order to provide safe and effective e-waste management, from the moment of collecting, transporting, separating of useful components, recycling up until final waste disposing. In order to form the quality and clear information system, there needs to be a complete change in current organizations of those companies dealing with this kind of business. If producers and manufacturers would be willing to obtain certain product components with recycling, rather than keep obtaining them on the market, that would largely contribute to promotion of e-waste recycling and therefore to its reduction. It is impossible for this area to develop properly without clear and systematic acts of the state. The efficient administration is one of the leading drivers for the improvement of quality, efficiency, economy and transparency of public bodies. The system should provide the improvement of environment standards followed by producers, importers, distributers, vendors and final users during the life-cycle of electric and electronic products, but also after their use. E-waste management implies the use of advanced business procedures that further establish following functions:

- Supporting the operators in business procedures of e-waste management (development of financial instruments);
- Simplifying the administrative procedures and reporting (IT system development);
- Easier and modern tracking systems for waste movement (scrutiny) using the modern applications;
- Data analysis, problem recordings and support of the changes (through legislation, public informing and improvement of social responsibility).

In the Republic of Serbia, the collecting of hazardous waste from households is currently separated, but it is only in some municipalities and cities. Electric and electronic waste with valuable materials are largely separately collected by authorized operators of unofficial sector. However, the further scrutiny of electric and electronic waste, collected in this way, is still limited. Collecting hazardous electric and electronic waste from area of economy, especially from households, by authorized operators is just at the beginning and because of numerous procedures and obstacles the progress of this sector is very slow. For the development of e-waste management, the Directive WEEE 2012/19/EU was adopted in 2014, with principle aim to collect 45% of residues of sold electronic equipment since the year 2016; and 65% of sold equipment, or 85% of generated electronic waste since 2019. The Republic of Serbia is in the European integration process and is obliged to harmonize its legislation with the EU's and therefore achieve to goals. Firstly, ecologically acceptable products should gain more space on the Serbian market; secondly, organized and systematic solutions for e-waste management issue should be accomplished. Nevertheless, globally, on the one side, solutions need to stimulate producers to make eco-products, while on the other, considering the fact that the market is flooded with "obsolete" technology, producers should fulfill their responsibilities by building recycling plants within their companies. Perhaps, the motive could be eco-fee exemption of a company, for certain amount of collected and treated e-waste (the so-called "old-for-new" system), as a stimulus to households to dispose e-waste adequately in shops for technological devices and equipment. At the moment, regulation power of the market does not help in dealing with ecological damage caused by electronic and electric products that become specific waste streams upon use, which is why the legislation is necessary. Apart from the waste management, the legislation could also contribute to development of a product's general ecological profile. It is certain that technological innovations will have the driver's role for the future development. Digitalization has great social and economic impact, however, it also has the greatest negative impact on ecology, meaning that it directly provokes environment damage which requires faster and more efficient e-waste management. Therefore, state should offer higher financial motivations, and not just to operators whose job descriptions include this, but to producers as well. On one side, this would close the circle in production and marketing of electric and electronic equipment, while on the other in collecting and e-waste recycling. Digitalization inevitably leads to automation of business processes and consequently to reduction of job positions. However, foreign companies that apart from production sector of electronic equipment and devices, also have special sector for recycling, provide new job positions which require new knowledge and perspectives. The green industry can contribute to reduction of negative consequences of digital transformation on employment, as well as the negative impact it has on the environment and human health.

Talking about the environment, it is necessary to raise the awareness of citizens for them to pay more attention on eco labels during shopping and that way contribute to the market game of ecologically acceptable products. But also, for people to become aware of the consequences that electric and electronic devices, which are outdated and considered to be waste, might have on human health if not treated in accordance with e-waste management regulations. Increased waste generation is directly

related to development of consumer society. Therefore, as the consequence of consumption development, numerous ecological issues, which also have impact on sustainable development, arise. For this reason, providing more information about ecological issues is fundamental for people to understand the ecological processes and for them to recognize the modern life problems, their lethal impact on human safety and health, but also the survival of natural resources in the future. The aim of public awareness are the changes in behavior and taking the active role in challenges of recognizing and solving numerous issues in protection of the environment. Therefore, the ecological marketing requires sustainable and socially responsible products and services, which are achievable as the result of consumers' behavioral changes. Finally, within the symbiosis of society and economy, social corporative responsibility as ecologically responsible business doing could be seen as part of overall social responsibility.

REFERENCES

Agency, E. P. (2017). *"Waste Management in the RS in the Period 2011-2016".* Retrieved 3 20, 2018, from http://www.sepa.gov.rs/

Agency, E. P. (2017). *"Products that after use become special waste streams in 2016".* Retrieved 3 28, 2018, from http://www.sepa.gov.rs/index.php?menu=5000&id=13&akcija=showExternal

B92. (2012). *"Ecological computer from wood"*. Retrieved 3 27, 2018, from https://www.b92.net/tehnopolis/vesti.php?yyyy=2012&mm=08&nav_id=633762

BEWMAN. (2011). *"*Electrical and electronic waste*"* Niš: The Metamorphosis Foundation within the project "Balkan Network for Advocacy on e-Waste" (BEWMAN).

Commission, E. (2002). *The Sixth Environment Action Programme (EAP) 2002-2012.* Retrieved 3 27, 2018, from http://ec.europa.eu: http://ec.europa.eu/environment/archives/action-programme/intro.htm

E-reciklaža. (2012). *"How Much Electronic Disposal Is"*. Retrieved 3 5, 2018, from http://www.ereciklaza.com/vesti/koliko-ima-elektronskog-otpada-66/

Euroaktiv. (2017, 4 6). *"Serbia in front of the EU by Ecological Taxes".* Retrieved 3 27, 2018, from http://www.euractiv.rs/odrzivi-razvoj/11201-serbia-ispred-eu-po-ekolokim-taksama

Glišović, S. (2016). *"EU Directive with implications for eco design", UDC 7.05 (4-672EU), DOI: 10.7562 / SE2016.6.02.11, .* Niš: University of Niš, pp. 129-133.

ManpowerGroup. (2017). *"Revolucija veština".* Retrieved 3 10, 2018, from http://www.manpower.rs/perch/resources/revolucija-vestina-wef-17.pdf

Mišev, G., & Kaloserovic, M. (2017). "Telecommunications in the service of national economy" . *Technique and practiceVŠTTS, Čačak,, ISNN: 2217-2130, COBISS.SR-ID: 174754812* , pp. 87-88.

Pavlović, V., Tadić, V., & Popović, M. (2011). *"Sustainable management of e-waste in Serbia", Dosije, ISBN 978-86-83411-55-9.* Belgrade: Belgrade Open School and Heinrich Bel Foundation, p. 4.

SEPA. (2018). *"Environmental Protection Entities".* Retrieved 3 27, 2018, from http://indicator.sepa.gov.rs/pretrazivanjeindikatora/indikatorilat/plomino_documents/b5a1ae1eee2e47a5b9b7760b167bbe95/

SEPA. (2018). *"Review of valid waste management licenses".* Retrieved 3 13, 2018, from Environmental Protection Agency of the Republic of Serbia: http://www.sepa.gov.rs/index.php?menu=20174&id=20055&akcija=ShowExterna

Serbia, G. R. (2009). Law on Waste Management . Republic of Serbia: Official Gazette of RS, No. 36/09.

Serbia, G. R. (2010). Waste Management Strategy for the period 2010-2019 . Belgrade, Republic Serbia: Official Gazette No. 29/10.

SITO. (2016, 10 18). *Home IT: Where and How?* Retrieved 3 10, 2018, from Analytical online site SITO (Serbian IT Observatory): http://www.sito.rs/rs/news/detail/97/Domai-IT-kuda-i-kako

Stanojević, P., Mišković, V., & Mišev, G. (2017). *"National Logistics and Security", monograph, ISBN: 978-86-80144-17-7, COBISS.SR-ID: 253928460.* Belgrade: Faculty of Security, Belgrade.

Trendafilovic, I., Radonjić, A., & Filipović, T. (2013). *"Characteristics and consequences of the consumer society", UDK: 316.324.7,.* Zaječar: Faculty of Management Zaječar, pp. 79-80.

WEFORUM. (2018). *"Understanding-the-impact-of-digitalization-on-society"* . Retrieved 3 29, 2018, from http://reports.weforum.org/digital-transformation/understanding-the-impact-of-digitalization-on-society/?doing_wp_cron=1522334624.6592810153961181640625

ENVIRONMENTAL AWARENESS, ATTITUDES AND CAUSAL BEHAVIORAL PATTERNS: AN OVERVIEW WITH A GLANCE AT ENVIRONMENTAL IMPACTS OF DIGITAL ERA

Nikoleta Šarenac*[1], Marko Ćirović[1], Nataša Petrović[1]
[1]University of Belgrade, Faculty of Organizational Sciences, Serbia
*Corresponding author, e-mail: nikoleta.sarenac@fon.bg.ac.rs

Abstract: *Considering the increased influence of environmental negative effects that are exponentially affecting daily lives of all fellow humans around the globe, this paper tries to present the research that had an aim to spot and assess the relations between* environmental knowledge awareness, attitudes and causal behavioral patterns in regards to positive and negative environmental practices. *This was done through research conducted by distributing a questionnaire for which 294 answers were collected. Statistical analysis was performed and results are presented through three research questions, which imposed itself within the pre-research process. Namely, the research concentrated on assessment of connections: 1) between accepting goals of environmental protection and paying attention to negative environmental influences; 2) between education levels and contemplation of global environmental crises, and 3) between education/income and environmental beliefs of respondents and understanding the environmental impact of ICT technologies and digital era impacts. Analysis was done using the statistical software package SPSS and results are presented and given in the final chapters of this paper.*

Keywords*: environmental awareness, environmental attitudes, environmental behavioral patterns, environmental policies, environmental actions*

1. INTRODUCTION

As far as industry has been developing, it was always followed by the repercussions reflected in negative environmental effects, problems and challenges. Economic growth as a wishful outcome of that development has been, almost without exception taken, at least, perception-wise as an ultimate good. Hence the years of unquestionable unsustainable use of non-renewable resources, the destruction of biological diversity and the emission of greenhouse gases that have triggered global environmental crises while also increasing the gaps between rich and poor have rarely previously been challenged (Martin & Alvez, 2015). Although, there have been many improvements, such as global technology development that changed lives for the better globally, medical improvements that contributed to overall decrees in mortality rates, higher living standards for many etc., there are environmental problems that came as a consequence of the unquestionable constant growth that are now here and have to be faced by the humanity as a whole (Meadows, Meadows, Randers, & Behrens, 1972; Heylighen, Bernheim, 2000). Today's biggest environmental challenges include but are not limited to: climate change, overpopulation, global warming, pollution, natural resource depletion, waste disposal et cetera. Countless species of animals and plants have been wiped out from planet Earth, many of which have had potential for agriculture and medical use beneficial for the humans. Rapid population growth cause natural resources to be over exploited. The effects of population growth on natural resources are particularly felt in developing countries (Flower, 2015). Instead of reaching the era of abundance challenges to they are more reflected in a question how to find sustainable ways to feed new world residents as well as the millions of world residents who are malnourished and undernourished, more than ever (Chiras, 1998). This why the main goal of this paper will be to put a spotlight and examine general environmental awareness, attitudes and causal behavioral patterns that people have based on an assumption that exactly lack of substance in these categories is what usually drives environmental irresponsible and negative behavior (Kollmuss, & Agyeman, 2002).

If conditions of life are to be improved and maintained, principles of sustainability should be followed (Diesendorf, 1997; Petrović, Slović, & Ćirović, 2012). With limited amounts of natural resources that are critical to existence, humanity is faced with the issue of sustainability. To be sustainable, the rate of extraction must be decreased to the lowest level possible. Term sustainability started to appear in mid 80's in academic journals and since then it has taken a long way to make it to people's everyday lives. Most people today acknowledge the term sustainability from the definition provided by World Commission on Environment and Development in 1987 which stated that sustainability is a development that "meets the needs of the present without compromising the ability of the future generations to meet their own needs" (WCED, 1987).

The main objective of the learning process in contemplating, protecting, and resolving environmental issues has been globally accepted since the early 1970s (Shobeiri, Omidvar, & Prahallada, 2006). Newhouse (1990) considers attitudes and emotions as a motivating factor for human action, hence they influence how we behave. Researchers have done great deal in evaluating population knowledge and attitudes towards the environment within the entire spectrum of human demographics (Uzunboylu, Cavus, & Ercag, 2009; Ramsey & Hungerford, 1989; Weigel & Weigel, 1978).

The relationship between behavior patterns and attitudes towards environment remains insufficiently explored (Steg, & Vlek, 2009). Behavior patterns are recurrent ways of acting by an individual or a team toward a given object, in a given situation, or a recurrence of two or more responses that occur in a prescribed arrangement or order (Prochaska, DiClemente & Norcross, 1992). Many patterns develop through globally accepted reward and punishment mechanisms and are called learned behavior. Usually these mechanisms are referred to as "carrot and a stick" (Andreoni, Harbaugh, & Vesterlund, 2003). Behaviour patterns (outside of simple instinct) come from three general areas (Norcross, Krebs & Prochaska, 2011):

- your particular strengths and weaknesses;
- learned reactions from experience.

Behaviors begin mentally therefore training your body, mind, and emotions to do what you want. When you consider how you behave, you discover that your thoughts, your emotions, and even your beliefs are the true roots of these behaviors (Norcross, Krebs & Prochaska, 2011).

This is a reason why many authors suggest that carrot and a stick recognized on a state level as subsidies and penalties for specific environmental behavior can influence tremendously and motivate either positive or negative environmental behavior but awareness and/or attitudes as well and hence influence population-wise particular strengths and weaknesses, experiences and habits. Aim of this paper was to examine a population behavior within the Republic of Serbia and tries to examine the causal factors within them.

2. LITERATURE REVIEW

General mechanisms of motivating and demotivating environmentally responsible and irresponsible behavior are noted in literature in ethics long ago but came to research interests with more significant public eye focus, when negative environmental effects already escalated, hopefully not to the extent that is to late but rather that the time is right (Birnie & Boyle, 1994; Daly & Townsend, 1996).

Roche et al., (2015) gave general recommendation how data on this issue should be better registered and acquired in terms of data applicability. Hilborn (2004) found that moving from single species to ecosystem fisheries management together with appropriate penalties gives betterment effects in maintaining fish capital and prevents the destruction of marine habitat, and similarly was concluded from Cury (2004). Brukas & Sallnäs (2012) found that when implemented similar measures through forestry management policies also improves the overall state and quality of forestry's.

Put on the more global level, McEntee (2013) gave the overview on how agricultural subsidies in New Zelnad didn't quite balanced out the costs of the negative environmental effects, and similarly was concluded by Myers (2001), that used the term "Perverse subsidies" for the subsidies that undermine the environmental effects and later these costs are bore by the entirety of the population.

3. BACKGROUND AND MATERIAL

The lecturers of Faculty of Organizational Sciences, University of Belgrade, Republic of Serbia, conducted the survey in march of the school year 2017/2018, within the course of Environmental Management (obligatory course), and collected the sample of 294 responses to the questionnaire in regards to common and specific environmental knowledge as well as to environmental practices students employ. What is important to know here that students participating within the research were also asked to distribute, this questionnaire within their social structure which included the variety of people affiliating with different social groups that included different working statuses, age groups (parents, siblings, friends), educational backgrounds and financial capabilities.

Questionnaire was made out of three parts; first part was dealing with standard demographic questions in order to acquire data on educational, social and economic background of the respondents. Second part was there in order to acknowledge the status quo on environmental awareness and environmental attitudes of respondents, and third part was there to cross check and compare correlating environmental behavior of respondents.

In total the questionnaire consisted out of 54 questions/statements. First part was made out of 6 standard demographic inquiries. Second part that was there to evaluate environmental awareness and attitudes consisted of 19 questions/statements and the third part that was used to evaluate respondents' environmental behavior consisted out of 29 questions/statements.

For the second and third part of the questionnaire, standard ordinal Likert scale, as a bipolar scaling method, and format of a typical ten-level Likert measure of agreement and disagreement was used for measuring the respondents' self-evaluation on frequency of their specific environmental positive or negative conducts, and measuring either positive or negative response to a statement for evaluation of their awareness, attitudes and even knowledge on specific environmental issues and problems.

4. RESEARCH QUESTIONS

In order to find a matching attitude and behavior of people, we defined three research hypotheses:

Hypothesis 1 – There is a connection between accepting goals of environmental protection and paying attention to negative environmental influences of purchased products/people's daily actions.
Hypothesis 2 - People with a higher level of education more seriously understand the problem of global environmental crises.
Hypothesis 3 - People with a higher level of education/income and environmental/beliefs have higher level of understanding the environmental impact of ICT technologies and digital technologies.

5. RESEARCH AND RESULTS

Within the research two general hypotheses is were considered, but paper goes beyond this and will analyze additional results gained from the research.

The correlation between the attitude about environment and behavior acquired by Pearson Correlation method. The variable attitude refers to the answers from the questionnaire regarding the question "The goals of environmental protection are the goals which I personally value and accept", whereas the variable Behavior refers to the answers from the questionnaire regarding the question "I pay attention to negative environmental influence during the purchase of a product/people's daily actions".

Table 1: Results by statistical method Correlation

		Attitude	**Behavior**
Attitude	Pearson Correlation	1	0,432**
	Sig. (2-tailed)		0,000
	N	294	294
Behavior	Pearson Correlation	0,432**	1
	Sig. (2-tailed)	0,000	
	N	294	294

The correlation between the personal acceptance of environmental protection goals and paying attention to negative environmental influences of purchased products/people's daily actions is shown by Pearson's coefficient of linear correlation. By the process of calculation, the middle value is given: r=0,432, n=294. Pearson's coefficient which is 0,432 shows that there is a positive correlation between the two variables observed, which means that high values of X are consistent with high values of Y, in this case: The more the person values and accepts the environmental protection goals, the more likely it is that he will behave according to them and pay attention to the negative environmental influence of the product when choosing it and people's daily actions.

Another factor that is worth considering is the strength between the variables. The strength refers to whether the Pearson's coefficient is closer to 0 or absolute 1. Different authors give different interpretations regarding the strength of correlation between the variables. According to Cohen, this correlation is the middle value, which only shows that one's attitude doesn't always match his behavior.

The correlation between understanding the problem of global environmental crisis and education acquired by analysis of variance (ANOVA) used to analyze the differences among group means.

What was found within the research was that there is statistically significant influence that level of education has on how people perceive the severity of environmental problems and how well do they understand the global environmental crises, using the single-factor analysis of variance. The respondents were divided by the level of education into six groups (1st group – high school, 2nd group – student, 3rd group – bachelor's degree, 4th group – master's degree,). It has been found statistically significant difference of $p<0,05$ in results of Life Orientation Test in order to asses individual differences in generalized optimism about general state of the environment within four educational groups ($F(3, 290)=3,029$, $p=0,03$).

Categorical independent variable "Attitude about environmental crises" refers to the question "So-called "global environmental crises" are exaggerated and they are not such a problem", which means that the higher the value is the lower the understanding of severity of environmental crises is. Dependent variable Education refers to the last acquired level of education.

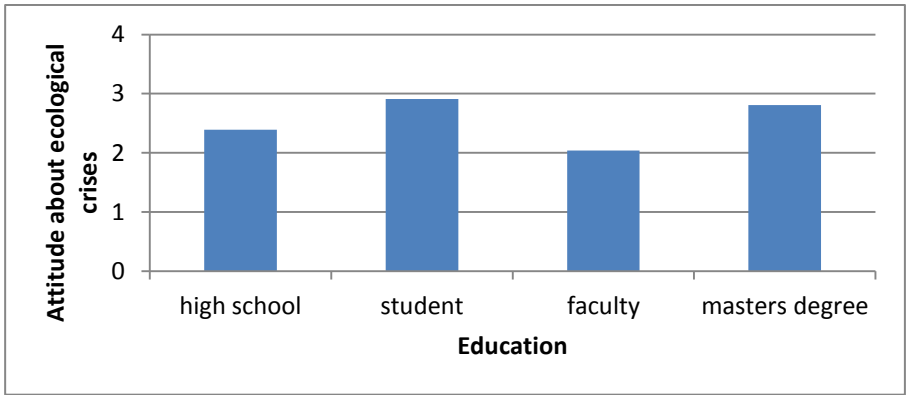

Figure 1: Middle value diagram for different educational groups

Based on the middle value diagram presents here it can be seen that the category of "students" has the least comprehensive understanding of the global environmental crises, whereas those who have acquired university degree after applying Life Orientation Test have the lowest middle value, which means that they have the most comprehensive understanding of the problem.

Finally, hypotheses three accrued as a wish to take a brief overview of how different demographic groups perceive, behave and how aware they are of the environmental impacts of ICT technologies and related activities. Namely, Hypothesis 3 - People with a higher level of education/income have higher level of understanding the environmental impact of ICT technologies and digital technologies. Hypothesis 3 was constructed as a result of the pre-research regarding that no demographic groups showed statistical significant difference in answering to questions related to negative ICT and digital environmental impacts except when the respondents' income levels were compered to their practices more concretely:

- Higher the income, higher the number of respondents which use online paying methods ($p<0,005$).

This is not enough to make any notable conclusion, regarding that although there is a statistical significance of $p<0.005$), correlation is weak and it requires further research in order to make stronger claims because response for this can be many.

And again statistical significance was noted in comparing the answers to questions that regard person actions and their wellbeing, hence statistical significance was noted in:

- Higher the respondents value their wellbeing and their offspring's wellbeing and future generations, more they care to remedy the negative influences of modern technologies (unplug the TV' computers cellphones) with a statistical significance of $p<0.01$) same as previously).

Correlation is again weak and it requires further research in order to make stronger claims because response for this can be many.

Therefore, authors of this paper have to remain agnostic about this hypothesis.

6. DISCUSSION

For the first hypothesis it can be noted that it came as true, by showing the statistically significant correlation between respondents who personally accept goals of environmental protection and paying attention to negative environmental influences of products they purchase and people's daily actions. This indicates that people who are environmentally aware respect environmental values in everyday life. Since, standard of living in the Republic of Serbia is generally lower compared to the countries within the European continent as stated by the World Bank GNI index in the annual reports (2016; 2017), research was followed by the

presumption that, when purchasing a product, consumers are mostly influenced by its price rather than by its environmental effects. That was a reason to investigate if there is correlation between household income amount and paying attention to negative environmental influences of purchased products. This doubt was incorrect, which means that there is no any relation between salary and paying attention when purchasing a product. Non the less correlation was showed as given previously, between the people with specific environmental values which in a same time accept the environmental protection goals, and their positive environmental behavior and daily activities and when making purchasing choices.

In second hypothesis, we examined if there is a correlation between the level of education respondents have and their understanding of the problem of global environmental crises. We compared six groups of respondents that fall within the next categories: with elementary school, high school, students, bachelors, masters degree and PhD. There is no statistically significant difference shown here, but what it must be noted that people with a degree of a higher education are the group that understands the most global environmental crises. Namely, the 92,86% of them are highly familiar with the problem of global environmental crises. This could be because these group are most active when it comes to acquiring non formal knowledge. Additionally, LOT analysis showed that the same group has the lowest middle value, which means that they have the most comprehensive understanding of the problem.

7. CONCLUSION

Finally other results of the research showed the statistically significant correlation between various answers respondents gave, and they will be presented here and interpreted to some extent, but not into the great detail because the authors of this paper believe that they should be a part of the analysis of the different paper regarding that this was only the pilot study and that these questions should be a part of the additional research. Mainly because the results go over the scope of the preliminary established hypothesis.

Hence 11 statistically significant correlation have been noted during examination of the respondents' answers and will be grouped in three categories:

1. Significance related to the respondents' financial background and their environmental actions;
2. Significance related to the significance of the respondents' environmental ethics and moral values and correlating behavior;
3. Significance related to the correlation between person actions and their wellbeing.

First group includes statistical significance found in following compared answers:
There was statistical significance noted within the answers related to the question that regarded the respondent's monthly household income and following answers:

- Higher the income, higher the number of respondents that have their own refill water bottle ($p<0,001$).

This is probably not related to the belief that higher income respondents take care more for the environment, but rather refill bottles are more of a trend and can be perceived as unnecessary cost for the respondents with the lower income.

- Higher the income, lower the number of respondents that purchase power saving light balls ($p<0,001$).

Again, this is probably not related to the belief that higher income respondents take care more for the environment, but rather the fact that in the Republic of Serbia people have significantly lower income than the majority of population living in Europe, preceded only by Bosnia and Hercegovina, Macedonia, Albania and Kosovo (WB 2016; WB 2017).

- Higher the income, higher the number of respondents which use online paying methods ($p<0,005$).

This is more likely the result of the banking system in the Republic of Serbia, which offers more options for those with higher income and these options are more accessible financially for those who have higher income, same applies for regular internet connection and ICT literacy. But as mentioned before this has to be a topic of a further research.

- Lower the income, higher the number of respondents use public transportation ($p<0,005$).

Here we can note that lower the income lesser the access to regular usage of personal transportation is, hence again does not have correlation to respondents environmental usage.

Second group includes statistical significance found in following answers:

- Higher respondents' affiliation with the goals of the environmental protection are higher the level of their care for the negative environmental effects of products they purchase ($p<0,0005$). This was elaborated and goes in line with the second hypothesis.
- Higher respondents' belief that the environmental crisis is a hoax lower the level of their education is ($p<0,0005$). This was elaborated and goes in line with the second hypothesis.
- Higher respondents' belief that the environmental crisis is existing one but that it is exaggerated, lower the level of their education is ($p<0,0005$). This was elaborated and goes in line with the second hypothesis.

- Higher the belief respondents have that humans have moral right to exploit the environment and its' resources, higher the belief is that humans control the environment rather than other way around ($p<0,0005$). This was elaborated and goes in line with the second hypothesis.

Third group includes statistical significance found in following answers:

- Higher the respondents value their health in regards to their environment quality, higher their interest is for the negative environmental effects of products they purchase have and daily activities they undertake ($p<0,001$). This was elaborated and goes in line with the first hypothesis.
- Higher the respondent value their health in regards to their environment quality, higher their interest is for the negative environmental effects of products they purchase have and daily activities they undertake ($p<0,001$). This was elaborated and goes in line with the first hypothesis.
- Higher the respondents value their wellbeing and their offspring's wellbeing and future generations, more they care to remedy the negative influences of modern technologies (unplug the TV' computers cell phones) with a statistical significance of $p<0.01$) same as previously), correlation is weak and it requires further research in order to make stronger claims because response for this can be many.

REFERENCES

Andreoni, J., Harbaugh, W., & Vesterlund, L. (2003). The carrot or the stick: Rewards, punishments, and cooperation. American Economic Review, 93(3), 893-902.

Birnie, P. W., & Boyle, A. E. (1994). International law and the environment.

Borlaug, N. (2007). Feeding a hungry world.

Brukas, V., & Sallnäs, O. (2012). Forest management plan as a policy instrument: carrot, stick or sermon?. Land Use Policy, 29(3), 605-613.

Chiras, D.D. (1998). Environmental Science. Retrieved from http://www.wadsworthlibrary.com/

Cury, P. M. (2004). Tuning the ecoscope for the ecosystem approach to fisheries. Marine Ecology Progress Series, 274, 272-275.

Daly, H. E., & Townsend, K. N. (1996). Valuing the earth: economics, ecology, ethics. MIT press.

Diesendorf, M. (1997). Principles of ecological sustainability. Human ecology, human economy, 64-97.

Flower, S. L. (2015). Environmental Challenges in the 21 st Century.

Heylighen, F., & Bernheim J. (2000). Environmental conditions. Principia Cybernetica Web

Hilborn, R. (2004). Ecosystem-based fisheries management. Marine Ecology Progress Series, 274, 275-278.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior?. Environmental education research, 8(3), 239-260.

Martine, G., Alvez, J. E. D. (2015). Economy, society and environment in the 21st century: three pillars or trilemma of sustainability? Retrieved from http://www.scielo.br

McEntee, M. (2013). 9. More carrot and less stick: Lessons from agricultural extension in New Zealand. From Theory to Practice; Context in Praxis, 95.

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (1972). The limits to growth. New York, 102, 27.

Myers, N. (2001). Perverse subsidies: how tax dollars can undercut the environment and the economy. Island Press.

Newhouse, N. (1990). Implications of attitudes and behavior research for environmental conservation. The Journal of Environmental Education, 22(1), 26–32.

Norcross, J. C., Krebs, P. M., & Prochaska, J. O. (2011). Stages of change. Journal of Clinical Psychology, 67, 143–154.

Petrović, N., Slović, D., & Ćirović, M. (2012). Environmental Performance Indicators as Guidelines Towards Sustainability. Management (1820-0222), (64).

Prochaska, J. O., DiClemente, C. C, & Norcross, J. C. (1992). In search of how people change: Applications to addictive behaviors. American Psychologist, 47, 1102–1114.

Ramsey, J. M., & Hungerford, H. (1989). The effects of issue investigation and action training on environmental behavior in seventh grade students. The Journal of Environmental Education, 20(4), 29-34.

Roche, D. G., Kruuk, L. E., Lanfear, R., & Binning, S. A. (2015). Public data archiving in ecology and evolution: how well are we doing?. PLoS Biology, 13(11), e1002295.

Shobeiri, S. M., Omidvar, B., & Prahallada, N. N. (2006). Influence of gender and type of school on environmental attitude of teachers in Iran and India. International Journal of Environmental Science & Technology, 3(4), 351-357.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. Journal of environmental psychology, 29(3), 309-317.

Turner, R. K. (1993). Sustainability: principles and practice. Sustainable environmental economics and management: Principles and practice, 3-36.

Uzunboylu, H., Cavus, N., & Ercag, E. (2009). Using mobile learning to increase environmental awareness. Computers & Education, 52(2), 381-389.

Weigel, R., & Weigel, J. (1978). Environmental concern: The development of a measure. Environment and behavior, 10(1), 3-15.

World Bank (WB). (2016). The World Bank Annual Report 2016. Washington, DC.

World Bank (WB). (2017). The World Bank Annual Report 2017. Washington, DC.

World Commission on Environment and Development (WUCD). (1987). Our common future. Report of the world commission on environment and development. Oxford and New York: Oxford University Press.

IMPLEMENTATION OF MODERN TECHNOLOGIES IN TRAFFIC AND THEIR CONTRIBUTION TO THE PROTECTION OF THE ENVIRONMENT

Nataša Plavša[1], Nataša Čačić[1], Jovana Pupovac[1]
University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia
*Corresponding author, e-mail : *nplavsa272@gmail.com

***Abstract**: The vast majority of larger cities in the world faces several major issues concerning traffic and transport on a daily basis. These problems range from traffic jams and congestions to noise and air pollution as well as the emission of the green-house gases that are responsible for the ever increasing holes in the ozone layer. These factors directly influence the quality of life and the accessibility of transport services in the urban communities. Our intention is to present some of the possible solutions that would reduce the harmful effects mentioned above through optimization of the transportation processes.*

Keywords**:** *traffic, internet of things, environmental protection*

1. INTRODUCTION

Emissions of harmful gases in urban areas have a negative effect on human life and health. Inadequate implementation of modern technologies in traffic is causing unexpected vehicle failures, traffic jams and poor quality of everyday life.In Serbia these problems are mostly caused by the use of inadequate equipment and outdated technology, low quality of fuel and the lack of modern solutions in practice. Half of the entire traffic fuel consumption is burnt and its toxic gases are released inside major cities. Approximately 98% of the energy market concerning traffic is oil dependent with 75% being consumed in road traffic. It is expected that the fuel consumption will have increased by 30% by the year 2030.

The drastic upset of the natural environment is directly caused by the state of the traffic systems which is a direct consequence of the changes that the society is going through. The air pollution by toxic fumes(carbon monoxide, nitrogen,sulfur oxides, hydrocarbons, lead and formaldehydes) from cars and buses is quite high even though there exists a solution for its reduction or complete elimination of some of the pollutants mentioned. According to research, cars in Serbia(and there are around 1.8 million) are twelve years old on average and most of the 240 000 vehicles that are imported annually represent European vehicle waste. Fumes from such engines are above allowed limits by health regulations both by the amount and the content of the toxic substances. Oil refineries in our country could soon become a target of an ecological ban in the European market due to their inability to invest in the new methods of processing. The amount of sulfur in diesel fuel is 20 times greater than in the countries of the Western Europe and only recently has the percentage of lead in gasoline been reduced (from 0,6 to 0,4) despite the fact that it has been completely removed from gasoline in the developed countries for quite some time. All the readings of the concentration of toxic fumes done in intersections confirm these facts(the annual amount of 8 mg/m^3 of carbon monoxideinstead of the allowed. Around 60% of air pollution in urban areas is caused by internal combustion engines. A great amount of polluting particles is produced by the friction between tires and road surface. In many countries tires that have been used up are becoming a problem that needs addressing. Also, significant amounts of used motor oil if not collected and disposed of properly, present a potential hazard, especially for world's water.

2.CONCEPT OF INTERNET OF THINGS

The traffic jams, lack of parking spaces, finding optimal routes, traffic regulation etc. are just some of the daily traffic problems that traffic participants face. Current technical achievements certainly have a great influence on the consideration and approaches to solving these problems. One of the new technologies that offers solutions to these situations is Internet of Things. It is believed that the application of this modern concept can contribute to improvement, cost reduction, and increase revenues in the field of transport.

IoT is currently one of the most advanced technologies that can find application in everyday life, from e-health, to making smart cities, buildings, classrooms, etc. IoT can be defined as a global information society infrastructure that provides advanced services by connecting physical and virtual "things" based on already developed interoperable information and communication technologies as well as those that are in the process of development. This modern concept can find great application in all modes of transport. Using IoT,

traffic participants are able to send useful information to traffic management centers, which can then use them in short-term, operational guidance, or in strategic management or management for a longer period.

The concept of the Internet has been drastically changing and over time it has become a global network that, apart from connecting computers, connects various digital devices, everyday objects, or "things". The word "thing" in the Internet Property coin represents an object from a physical ("physical thing") or information world ("virtual thing") that has the ability to be identified and integrated in communication networks, or any thing that can be assigned an IP address and provided the ability to send certain data via a global network. This is achieved by installing sensors that have several functions in the IoT system. The sensors measure and collect data on certain parameters, then they send this data over the Internet, and on the basis of these data they start the appropriate actions. A "physical matter" can be represented in the information world by one or more "virtual creatures", while the virtual thing can exist independently of "physical things". The device is part of the equipment that serves for communication, and it can also store data and process them. Devices collect information and forward them to information and communication networks for later processing. They can also communicate with other devices via communication networks with or without gates, but also directly without them. Communication networks have the task of effectively transmitting data collected by devices efficiently and safely, using existing TCP / IP protocol-based networks, but also some new ones developed for that particular purpose. The IoT reference model consists of four layers: an application layer, a layer that serves as a service and application support, a network layer and a layer that relates to the device itself.

The number of connecting devices grows at a high speed, which is in correlation with the growing number of IoT platforms. IoT platforms can be explained as a set of generic functionality used to create IoT applications and which connect IoT to Cloud, as well as output devices. IoT platforms allow applications to manage, control, and monitor devices, in order to provide an independent and secure connection between them. They access intelligence-aware information, store and transform it, securely integrate these data, and integrate with business prosecutions and systems, and control the sensors. Thanks to information and communication technologies, it is possible to connect "anytime" and "anywhere", while the IoT concept adds a new dimension to the connection of "anything", which suggests that communication is possible not only between computers but also between people without the use of computers, such as and communication between people and things, but also the very things.

3.IMPLEMENTATION OF INTERNET OF THINGS IN TRAFFIC

The most effective way to solve every problem is to eliminate its main cause. The problem in this paper is one of the most serious problems in the world, and certainly attracts the most attention when it comes to environmental protection, and that is the pollution of the environment by the emission of harmful gases. The most massive cause of this problem is of course traffic. According to a study by a Chinese university, fuel consumption will grow in the coming years, and traffic in this consumption will have a share of as much as 61%. Consequently, attention should be directed to this sector. A significant share of the total number of vehicles on the streets is taken every day by specialized vehicles for the transport and delivery of various transport, courier or postal organizations. That is why, in developed countries, digitalization and implementation of IoT is increasingly being discussed in this sector.

Today, there are already more connected devices over the Internet than people in the world, and this number is expected to rise to 100 billion by 2050. In developed countries, the Internet of Postal Things (IoPT) has already been developed, and its main purpose is in the following:

• In transport and logistics for monitoring the functioning and status of the vehicle through the supply chain. The aim of this group is to reduce fuel costs, reduce the need for manual vehicle maintenance interventions, and optimize the operation of people, systems and equipment.

• Smart postal facilities that direct systems to control energy consumption, safety and security of the facility, as well as to reduce maintenance costs.

There are three elements within the postal traffic that justify the implementation of IoT:

Large infrastructure: Postal traffic in every country has a very large infrastructure that includes facilities, and mobile equipment. Most of these elements do not 'tell' at the moment, which means they do not collect and exchange data among themselves. The density and coverage of the country by the postal network provides unlimited potential for IoT.

Experience in collecting and analyzing data: The Postal sector has always shown great competence in managing large databases. In postal traffic, some types of IoT are already used, such as RFID tags for measuring quality in postal traffic.

Customer Requirements: There is a significant growth in the customer's request regarding the provision of services and the capabilities that accompany it. It is expected to track shipments, forecast delivery dates, more options related to the way shipments are sent and the location of their delivery, as well as the simplified process of returning shipments. UPS as well as many other mail at global level already follow these trends, enabling users to choose or change delivery time.

If we take the operation of the JPPT Post of Serbia for the territory of Vojvodina for the analysis, we will see that in the fleet there are 230 vehicles of various brands, year of production, fuel consumption and mileage. On average, during one year, each vehicle has mileage of 24040km, and consumes 2223l of fuel. According to EIA (US energy information administration) analyzes, each burned gallon (3.785l) of fuel for vehicles with internal combustion engines emits 8.91 kg of CO2 in the atmosphere, which in our case means that only postal vehicles the territory of Vojvodina annually emit 5233kg of CO2 in the atmosphere. On the other hand, the cost of an average vehicle annually amounts to almost $ 35 billion for fuel alone. In order to reduce these fuel costs and, consequently, to protect the environment, we indicate the following applications of IoT which by their implementation would lead to improvement of the situation:

• Education of drivers using digital technologies in order to reduce fuel consumption by changing their driving style:

Numerous studies have shown that driving style has significant implications for fuel consumption. Gonder et al. (2012) conducted experiments on a light-duty vehicle and found that different DSs can generate a difference of approximately 30% in fuel consumption in the urban driving cycle. The difference can reach 20% in the high-speed way driving cycle. They also believe that by changing DS, aggressive drivers can reduce fuel consumption by 20%, whereas mild drivers can decrease consumption by 5–10%. As for heavy-duty vehicle, Liimatainen (2011) found that different DSs can generate a difference of approximately 20% in fuel consumption. Bingham et al. (2012) discovered that the DS can also make about 30% energy consumption difference for electric vehicle.

•Sensors for data collection:

These sensors are placed on oil filters, valves, engine pistons, exhaust pipes, etc., and thus find anomalies, detect and predict in advance when a specific part is to be replaced, or e.g. Change oil to prevent malfunction.

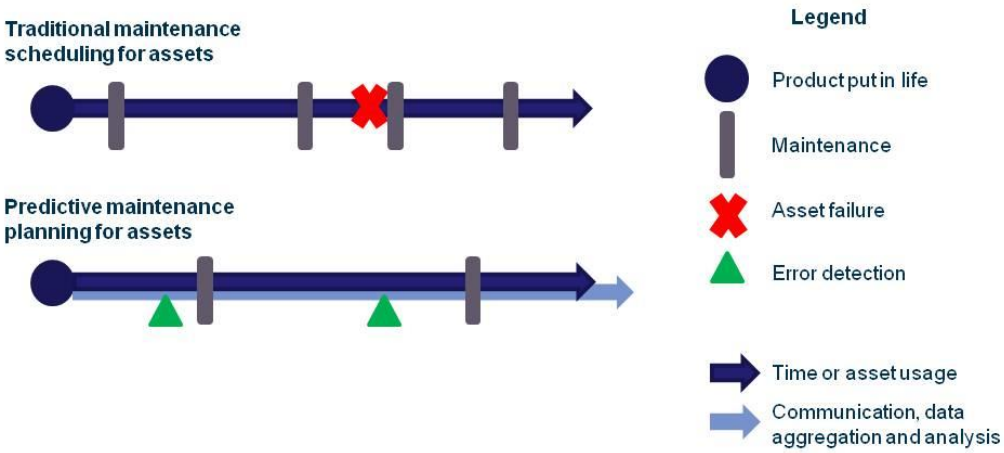

Figure 1: The benefits of predicting maintenance of the vehicle in comparison to conventional maintenance

• Connecting all vehicles over the Internet:

In transport, courier and postal organizations is currently used a static method of routing vehicles that finds the shorthest path (route) for driving before the vehicles go to work that day. Connecting all vehicles over the Internet would allow dynamic routing, such as those already tested in DHL's SmartTruck program, which work on the basis of information collected by sensors and calculates the route on the go. In this way the

route is formed and changed during the ride in accordance with the new obligations that have arisen. Sensor data are also combined with real-time data relating to traffic jams or new transport requests.

• Shared Last Mile delivery:

The growth of E-commerce also increases demand for vehicles in courier and postal organizations, which move every day mostly with the same routes. This causes not only poor efficiency in the work but also bottlenecks and problems of ecological nature in already polluted urban areas. The situation in the future will probably be even worse, as the market is liberalized and there are more and more operators and transport companies (Uber, courier organizations, etc.) every year.

Shared delivery solves many of the above mentioned problems, especially on Last Mile delivery, which usually causes the most cost, high fuel consumption, and therefore it is the biggest impact on environmental pollution. Sensors would collect vehicle location data, its movement, free parking space at the place of delivery, loading, unloading, in order to make Last Mile deliveries as efficient as possible. This mode of transport on the Last Mile section would suit both the couriers and the postal operator. Courier organizations could outsource this part of the delivery using a smaller number of larger and more completed vehicles, and thus save money on the number of vehicles, on fuel, on labor and on maintenance. Reducing the number of delivery vehicles on the streets would also contribute to local authorities that are continually striving to reduce the traffic density on the streets and CO2 emissions.

This type of delivery has recently been applied in both the Dutch and the Belgian post offices. The Belgian post estimates the savings of 30% of the total number of miles remaining, it also contributes to the reduction of fuel costs, and therefore directly reduces CO2 emissions.

Successful implementation of IoT in the postal, courier and other transport companies requires not only a strategic vision, but also careful consideration of numerous factors, such as the priority of the application of technology. It would be necessary to start developing ideas with already tried and tested applications, while the company would have to formulate a business plan to justify the adoption of this new technology.

4. GREEN SOLUTIONS AND THEIR CONTRIBUTION TO TRAFFIC

It is a fact that the biggest consumers of fossil fuels are the vehicles in road traffic and thus they are the main issue concerning sustainable development and so the application of green solutions should be our priority. By implementing innovative and more sophisticated technological solutions we are making our companies more efficient through faster and more accurate data processing, which in turn gives them the advantage in the market and that is the main goal of any company. Taking into account that the Post Office of Serbia as a state enterprise has one of the largest car parks and that its traffic network covers all of Serbia (her “last mile delivery” service), it would mean a great deal if it started implementing green solutions not just for the environment, but for its image as a prestigious company with forward thinking leaders.

One of the possible green solutions are “Oxygene” tires, developed by “Goodyear”, with revolutionary design that has live moss growing on the side of the tire. This innovative concept was presented at the Geneva car fair. The open and “smart” design of the tire tread collects moisture and water from the road necessary for the growth of the moss, which enriches the air with oxygen through photosynthesis. “Smarter” and “greener” infrastructure as well as “smarter” transportation are the key for solving the problems of mobility and development of urban areas. “Oxygene” tires(Figure 2), offer several solutions for a greener future:

Filtration of the air: with its unique tire tread, “Oxygene” absorbs moisture from the road and carbon dioxide from the air that feed the moss, which produces oxygen through the process of photosynthesis. In the city as large as Paris with its adjoining suburban areas, with approximately 2.5 million vehicles, this would mean around 3000 tons more oxygen and approximately 4000 tons less carbon dioxide in the air annually.

The recycling of the used up tires: the design of “Oxygene” tires is done by 3D printing, and the material used is rubber powder produced entirely of recycled tires. These tires present a firm solution without the potential danger of being punctured, require very little maintenance and last longer.

Generating its own energy: “Oxygene” accumulates the electricity produced by photosynthesis and uses it to power the installed electric components such as car sensors, processors of artificial intelligence and adjustable light tapes which warn other drivers and pedestrians of the change in the direction the vehicle is moving by changing its colour.

Light speed communication system: “Oxygene” uses light speed communication system or LiFi, which enables the tire to connect to internet, Internet of Things to be more precise, which allows the transfer of data between vehicles (vehicle-to-vehicle – V2V) and also between vehicles and infrastructure (vehicle-to-infrastructure-V2I) which is crucial for management systems of smart mobility. This way “Oxygene“ would increase the quality of life of citizens in urban areas as well as their health through cleaner air. It is expected that around two thirds of the world’s population will be living in cities by the year 2050. and so the need for traffic networks in urban areas will increase accordingly.

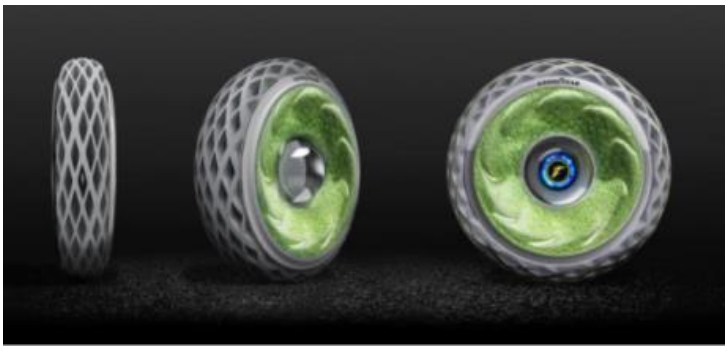

Figure 2: GoodYear's Oxygen tire

Electric vehicles are slowly but surely becoming a part of road traffic in countries like Macedonia, Croatia, Slovenia, Hungary and Romania. The use of these vehicles has yet to overcome many obstacles in Serbia. The first one being the lack of support from the state itself, considering that the price of these vehicles is considerably higher than the average in its class, and the second one being the lack of the infrastructure for charging those vehicles. In order to popularize the application of new technologies in Serbia, it is necessary for the state to encourage its citizens by providing tax allowances, loans or free parking for buying these vehicles as well as tax allowances and subsidies for companies willing to build the necessary infrastructure for the charging of electric vehicles. By being the first to support this endeavor, the Post Office of Serbia can become an example for other companies to strive for.

Israeli startup company has created a solution for the electric vehicle battery, so that the car can recharge battery without pluging in to the sistem energy grid. Representatives from the ElectroRoad suggest that the electric bands which they produce (Figure 3), can be integreded in all urban areas and high ways so they can wirelessly charge the vehicle enough, so they can get safely to the nearest charging station. Research studies have shown that driving distance of 1km on the road integraded with ElectricRoad band, can charge the car for the next 5 km of driving. Employs of ElectroRoad company think that this solution can be easily implemented using the alredy existing infrastructure of stopping lanes and in the cities the yellow signs on the road wich are reserved for the public transportation.

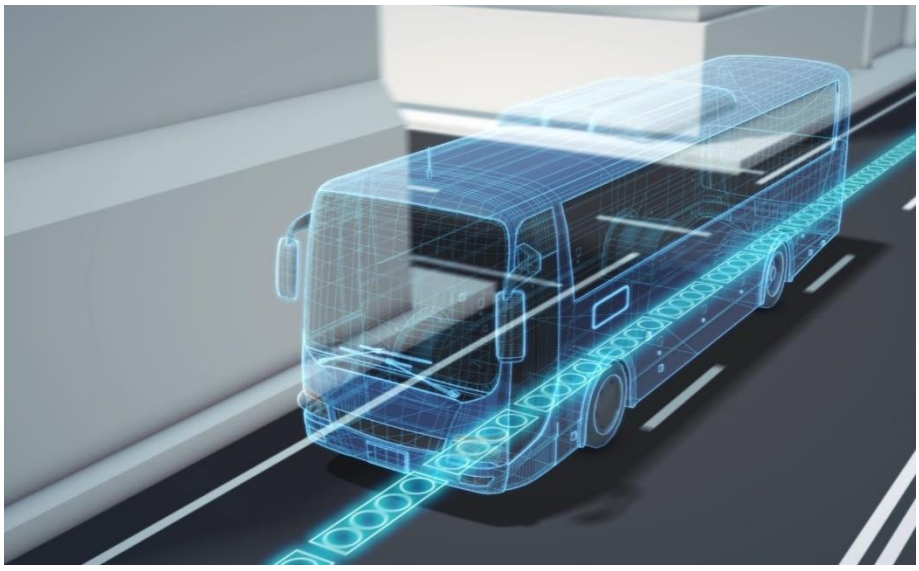

Figure 3 ElectRoad - Charge while you drive

5. CONCLUSION

Traffic means influence ecological problems in different ways and to varying degrees with minor or major consequences. In urban areas, the volume of traffic is increasing every day, which is in correlation with the increasing pollution, as well as the increase of noise in cities and residential areas. Housing settlements located just beside the roads where the traffic intensity is the greatest are the most at risk from pollution caused by traffic. In urban areas, the volume of all movements increases, as a result of the need for adequate accessibility and unlimited mobility of residents. Some of these trends lead to deterioration of the living environment, for this reason it is aimed at increasing the importance of the idea of sustainable development, which refers to the development that promotes the long-term and ecological health of cities and settlements.

IoT is currently one of the most advanced technologies that can be found in daily life. Although we are at the very beginning of the development of IoT, the experience of pioneers in the application of this technology is promising and brings safe and solid advantages. By interconnecting and analyzing data coming from its large infrastructure, post offices, as well as other transport organizations, could reduce their costs, reduce the number of vehicles on the streets, reduce emissions, optimize their processes, and therefore better respond to user and market demands . That is precisely the goal of every successful company - meeting the requirements and needs of users and all participants in the process, while achieving optimal savings and profits through an environmentally conscious business.

REFERENCES

Al-Alawi, B; Bradley, T. (2013). Review of hybrid, plug-in hybrid, and electric vehicle market modeling Studies. Renewable and Sustainable Energy Reviews. Volume 21. 190-203. doi: 10.1016/j.rser.2012.12.048

Dormehl, L. (2018). Charge as you drive on Electroad. Retrived from https://www.digitaltrends.com/cool-tech/israel-roads-wirelessly-charging/

Good Year Corporate. (2018). Goodyear unveils oxygene, a concept tire designed to support cleaner and more convenient urban mobility. Retrived from https://corporate.goodyear.com/en-US/media/news/goodyear-unveils-oxygene-a-concept-tire-designed-to-support-cleaner-and-more-convenient-urban-mobility.html

Hongjie, M; Hui, X; Denggao, H; Shuo, X. (2015). Effects of driving style on the fuel consumption of city buses under different road conditions and vehicle masses. Transportation Research Part D: Transport and Environment. Volume 41. 205-216. doi: 10.1016/j.trd.2015.10.003

Intergovernmental Panel on Climate Change (IPCC). (2014). Fourth Assessment Report (AR4). Retrived from https://www.epa.gov/sites/production/files/2015-12/documents/emission-factors_nov_2015.pdf

Internet of things news. Internet of things (IoT) a pivotal catalyst for the ict industry in 2014. 2013. Retrived from https://iotbusinessnews.com/2013/11/26/94633-internet-of-things-iot-a-pivotal-catalyst-for-the-ict-industry-in-2014/

Telecommunication Standardization Sector of International Teledommunication Union. Overview of the Internet of things. Recommendation ITU-T Y.2060. Retrived from https://www.itu.int/rec/T-REC-Y.2060-201206-I

The Statistics Portal. (2016). Internet of Things - number of connected devices worldwide 2015-2025. Retrived from https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/

United States Postal Service. (2015). The Internet of Postal Things. Retrived from https://www.uspsoig.gov/sites/default/files/document-library-files/2015/rarc-wp-15-013_0.pdf

Uzelac, A; Mladenović, S; Zoranović, D; Zdravković, S; Janković, S. (2015). Komparativna analiza IoT platformi. XLII Simpozijum o operacionim istraživanjima, 186-189.

INFLUENCE OF FOREIGN DIRECT INVESTMENTS ON THE ENVIRONMENT

Ismar Velić*[1]
[1]University of Rijeka, Faculty of Economics
*e-mail: velicismar@gmail.com

Abstract: *The aim of this paper is to determine the influence of FDI on the environment. To get an insight how FDI affect the environment, the development of an enterprise is analysed, as well as the way how the reasons and opportunities for FDI even occur. The first instance in the process of the evolution of the enterprise is capital accumulation, in other words, transfer of the part of capital back to the production process. Accumulation of capital determines the importance of profit and validates the need for cost cutting in all spheres, including the protection of the environment. The aforementioned necessity is caused by competition taking action on the market, which forces the enterprises to constant growth and progress, otherwise, it disappears. Together with the enterprise growth, there come new opportunities, such as economies of scale, and when the country`s borders become too narrow for further growth, the enterprises reach for foreign investments. That is how the FDI occur and affect the country and the environment. The analysis of practical examples certifies that the enterprises are still guided by basic principles of concentration of the capital. Not only guided, but they also use their competition advantages, which they realised by growth and development of technologies, as the levers of power, in order to make even bigger profits, not paying attention to the consequences they leave behind. The whole process is caused by a special law of surviving on the market which justifies all the sources.*

Keywords*: accumulation of capital, free competition, cost efficiency, transnational corporations – TNC, foreign direct investments - FDI, pollution haven hypothesis – PHH.*

1. INTRODUCTION

Within globalisation processes, modern economic reality is written by the activities of the current key economic subjects - TNC. TNC have gone way beyond borders and exactly in the sense of FDI. Their power and their influence very often exceed the strength of many countries, even the most developed ones. That power comes from accumulation and concentration of sources for production and thus is reflected in the form of market shares. Besides, mainstream economics discarded theories of the countries` development through planned and state-controlled development. The actual answers to the development processes from the mainstream economics were FDI and TNC. Unlike the developed countries, this answer usually refers to underdeveloped countries, due to lack of capital assets. The problem is also deepened by undeveloped regulations, by which the developing countries would protect their economic interests and their environment. Faced with the shortage of capital assets and undeveloped regulatory rules, the underdeveloped countries represent a *fertile soil* for the investments that will not be within the *social* and *environmental* frame of business. If there is a question why corporations conduct business in such manner, the answer could be found in additional costs that such form of doing business most often causes. Apart from that, extraction industries are very big polluters and in the form of FDI they come to acquire raw materials needed. However, even that is not the whole answer and it is necessary to complete it with market regulations of ruthless competition and accumulation of capital, which played the key role in the enterprise`s growth and development, defining it even today. While the competition between large enterprises is gradually disappearing and a new form of competition is appearing, which is a competition between the countries. This competition between the countries happens in order to attract the holders of the fresh capital in the form of FDI, no matter the consequences they could leave behind.

2. TRANSFORMATIONAND DEVELOPMENT OF THE ENTERPRISE

In economics, a great deal of attention is paid to perfect competition, although the market economy is also aware of the other market structures. Perfect competition and monopoly represent extreme conditions on the market and a very rare occurrence in reality. Modern economic science has to face that fact and stop observing economic occurrences within narrow frame of perfect competition. It is important to mention that still, all market forms actually evolved from the frame of perfect competition, which is disappearing as the category from the practice with the enterprise development in more mature phases of capitalism. Therefore, the development of the enterprise represents a starting point for the analysis of modern market functioning and subjects that dominate over it. In this process, profit is the key determiner of enterprise development that has to be realised at any costs (work exploitation and/or nature destruction/exploitation). Within the

enterprise development in capitalism, capital accumulation represents the first stage of development. That is to say, within capitalistic way of production there appears a conflict of interest between numerous entrepreneurs (capitalists), in which each of them tends to take as much profit for themselves as they can. Faced with the free competition law, entrepreneurs are forced to modernise and perfect their sources for production in compliance with the advancement of science and technology (Lavčević, 1953).They realise their interests based on existing sources for production and/or by perfecting of the production process by using new, more improved production sources. Therefore, capitalism was also revolutionary at the beginning and thus it gave its brightest results. For that reason, *young* Marx introduces capitalism in Germany of that time in order to break up with the obsolete production relationships of feudalism (Lukács, 1976). Unlike other systems of doing business (slavery or feudalism), capitalism indeed brought about the greatest era of enlightenment and development to the mankind (Fiamengo, 1973). However, free competition upon which it is being developed, even then started developing in two ways. In the beginning, it was defined by a large number of competitors and it was based on work, knowledge and innovations that improved production processes (Velić, Cerović and Maradin, in press). Simultaneously, it is followed by another dimension of competition which is predatory and is based on concentration of capital. Ruthless competition implies that any stagnation in development processes for a capitalistic enterprise means its definite destruction by greater and competitively more capable enterprises (Velić, Cerović and Maradin, in press). Process of accumulation of the capital represents successive capitalisation of produced values surplus (Lavčević, 1953), i.e. a certain piece of appropriated value surplus turns into an additional production form of capital belonging to capitalistic enterprise. Capital accumulation growth leads to the second instance, which is an increase of capital concentration, namely, collecting even greater amount of both production sources and hired labour of the few. Concentration of capital assets and production through accumulation, i.e. capitalising of the values surplus enlarges both individual and entire social capital (Lavčević, 1953). Within this process, implementation of the new technologies and knowledge is crucial. However, they require more and more sources in realisation of the new production processes. The process of capital enlargement is complemented by centralisation of capital, i.e. by leaving individuality of already existing individual capitals by merging or their absorption by larger enterprise (Lavčević, 1953). This process within modern economic reality is getting a form of direct investments of merging – *mergers* (Salvadore, 2003) and annexation – acquisition. Merging represents joint appearance of two or more competitors on the market, whereas acquisition represents destroying and merging of capital of the lesser competitors. In the latter, competition represents the most efficient tool of enlargement of capital, because in the competitive game, the one whose labour productivity is higher wins - lower expenses, which is reflected in lower prices. In view of that, large enterprises realise far higher labour productivity (production of larger quantities of products reduces production costs per production unit - economies of scale), whereas smaller enterprises do not survive market battle and get *swallowed* by larger enterprises (Lavčević, 1953). The final way of centralisation of capital is the process of merging of independent capitals into large capitalistic enterprises, which gets the form of joint-stock, or holding companies (Lavčević, 1953). This form of capital enlargement represents an important progressive dimension as well, without which capitalism would develop with difficulties, and that is the occurence of limited liability in business. The significance of the process of capital enlargement Marx underlined with the sentence: *"Accumulate, accumulate! This is Moses and the Prophets"* (Marx and Engels, 1977). In other words, Marx (1977) wants to say: *"Save, save, i.e. turn the larger part of surplus value or product surplus into capital again"* (Marx and Engels, 1977). Globalised world of today marginalises labour and nature to a greater extent than Marx could have anticipated, and that is the reason why Santini (2007) considers his work unavoidable in solving growing problems of Man and Earth. Capital letters M and E refer to devising of coexistence between work and capital, since at the moment our planet is working against itself hand in hand with human activities (Santini, 2007). The aforementioned processes imply diverting attention to regulations in view of domestic enterprises as well as the FDI mergers and acquisitions. This implies that the enterprises will most likely be encouraged by cost efficiency to use lower environmental standards or lenient regulations. In regard with former analysis, primary work hypothesis is stated:

H1: The nature of free competence forces enterprises to do business which is constantly directed on cost cutting, including the costs of protection of the environment.

In the necessary process of improving and broadening of production the additional sources are key factor in order for production to be realised. For that reason, credits have an important role in functioning of the economy and credit instruments are more easily acquired by larger enterprises (Velić, Cerović and Maradin, in press). At a certain time of broadening of capitalistic production, the phenomenon of economies of scales appears, which is the basis for production in large enterprises, not only on the example of natural monopolies, but also in all other large serial production that is also used by TNC today. Caused by the imperative of growth which secures the survival on the market, all three processes of capital enlargement affect the decrease of number of competitors and increase of production of the enterprise itself and market shares as well. These processes initially lead to governing over a certain branch of industry within national scope, i.e. to monopolies and oligopolies. It is important to mention that at this stage of development, competition may become especially risky, since the enterprises have grown and have too large organic

content of capital, so the battle between the giants might cause enormous damage of failing (Velić, Cerović and Maradin, in press). However, this process does not stop on national level, but based on the same principles, continues on the international market. That is the reason why it is considered that former national monopolies and oligopolies, by leaving the scope of national economy, evolved into TNC (Stojanov, 2012). This is why this analysis is a starting point, since the monopolistic position on the market represents an aspiration of all capitalistic enterprises, because it enables security, survival and the most efficient way of necessary realisation of even larger profits. The same thing is noticeable in concentration of capital on the international market between corporate giants of today.

2.1. Principles of production according to microeconomic analysis

Going on with the former analysis from microeconomic perspective, an efficient production implies enterprises of a large scale, standardised production lines and a large number of products. Growing incomes of scale (economies of scale) form when the increase of all inputs leads to more than proportional increase production level (Samuelson and Nordhaus, 2010). Such production requires enormous sources of large enterprises, which confirms validity of the former analysis concerning the growth of the enterprise. Having defined the economies of scale, it is now necessary to tackle the logic of costs, more precisely to tackle an average fixed cost of the enterprise, which is relevant for the topic. Fixed cost divided by input gives the average fixed cost:

$$\mathbf{AFC} = \mathbf{FC}/\mathbf{q} \tag{1}$$

This equation implies that increase of production quantity **q** at constant fixed cost **FC** gives constantly failing curve of fixed cost (Samuelson and Nordhaus, 2010). In other words, if an enterprise sells more products, it can disperse its fixed costs on multiple units. Since the enterprise strives to profit, i.e. making money is their priority, companies survive by cutting costs in any way possible (within the law) (Stiglitz, 2009). The major idea of this way of production is production increase on the account of range income and dispersion of fixed costs on as many production units as possible. Furthermore, the enterprises that are able to realise the processes described are limited liability corporations, with a suitable management structure, which can attract large offers of private capital, produce a lot of similar products and join investors` risk (joint-stock company) (Samuelson and Nordhaus, 2010). This definitely implies that TNC also apply these and former principles in their functioning. Basic logic behind this way of doing business is cutting costs, since that means larger profit, and larger profit enables larger accumulation of sources for growth and survival on the market. If the same logic is applied between production costs and the costs caused due to environmental protection, it can be deduced that the enterprises will be more sensitive to increased environmental protection cost. Therefore, it can certainly be claimed that if costs can be avoided, they will be. The process of capital enlargement is a necessity defined by accumulation of the profit which is subsequently transferred back into the production, in order to realise the production based on the economies of scale principle and further development of the enterprise. Since the profit is determined by cost efficiency, cutting environmental protection costs is a natural and expected reaction of the enterprise in all development stages. Described principles and the logic of enterprises` growth confirm primary work hypothesis, meaning that the protection costs will be cut anyway, the additional reason would be that, for example, cutting environmental protection cost does not have an immediate opposite reaction as reducing of the salaries does.

2.2. Bearers of FDI – TNC

Within former analysis, the idea of corporations and their limited liability have been mentioned, but what are corporations in fact? Today`s multinational company is an enterprise which broadens its business within many countries in order to get closer to its clients, cheaper sources of production factors or competition (Lovrinović, 2015). TNC expand their business to all continents through enlarging their network of affiliates, branches, offices, distribution, clients and all other things connected to their activities, including production (Lovrinović, 2015). Corporation is an enterprise owned by many individual shareholders, which has legal individuality, so it is really *a person* who can buy, sell, borrow money, produce goods, provide services and make contracts on their behalf (Samuelson and Nordhaus, 2010). Corporations enjoy the benefits of the right of limited liability, under which the investment of each owner and his financial exposure are strictly limited to a specific invested amount of money (Samuelson and Nordhaus, 2010). In principle, shareholders control the company, while managers run the company and make business decisions. Limited liability has a great advantage since it enables collecting of large amounts of capital, bearing in mind that each shareholder knows the most he can lose is his investment. On the other hand, limited liability may signify large expenses to society. A mining company can excavate gold and make an enormous profit for the shareholders, but it can also leave poisonous remnants from processed ore, which contains toxic substances like arsenic (Stiglitz, 2009). From both social and financial aspects, the costs of purifying such environmental problem may exceed the value of what is excavated. But, when the problem is notified and the government of the country where the corporation does business demands purification, the mining company declares

bankruptcy. The problem is left to the society and its citizens who suffer both from destruction of the environment and purification costs (Stiglitz, 2009). This is validated by numerous examples from the practice, e.g. the explosion of Union Carbid factory in Bhopal, in 1984, which caused over 30 000 dead and 100000 sick people for which nobody was prosecuted for; oil spilling from Exxon Valdez ship, in 1989, with the given fine of $51,000 and 1000 hours of trash collecting for the skipper; oil spilling on the British Petroleum platform in the Gulf of Mexico scooped 180,000 square metres of the sea, with the $20 billion compensation for environmental damaging (Lovrinović, 2015). Although it is very difficult to find the perpetrator in these cases and penalties are in discrepancy with the performed damage, they are still considered as accidents. However, practice shows deviant behaviour of TNC in regular business too, therefore there is another definition of corporation, according to Stojanov (2013), who describes TNC and transnational banks as fundamental economic subjects of our time and mirror image of globalisation process. Their microeconomic principle of behaviour is the principle of growing incomes and falling costs. Furthermore, Stojanov claims that transnationalisation of world economy forms a global market, whose main characteristic is an imperfect competition with dominant oligopolistic morphology. In oligopolistic conditions large corporations are not only a price makers but a rule makers as well, i.e. the enterprises not only dictate the prices, but also make the rules of the *game* (Stojanov, Jakovac, 2013).The size of TNC represents a special comparative advantage (WWF-UK,1999). That very size gives certain power, so apart from demanding and charging the rent from exploitation, they even demand entrance barriers for other competitors, lower environmental standards and concessions, ergo, TNC become the rule maker in practice as well.

3. MOVEMENT TRENDS OF FDI - POLLUTION HAVENHYPOTHESIS (PHH)

Influences of FDI on the environment of a country are usually observed from the perspective of *pollution haven hypothesis* (PHH). PHH assumes that polluting industries will look for the appropriate ground for relocation of their sections in the countries with lower environmental standards and turn them into pollution havens (PH) (Copeland and Taylor, 2004). PHH also assumes that the industries like mining and raw material processing will be motivated to relocate their production where they will be relatively free to do business the way they see fit and will not have to pay purification cost for their activities (Farlex Financial Dictionary, 2012). For that reason, PHH is usually observed three-dimensionally:

- *Dirty production* transfer into underdeveloped countries with lower environmental standards,
- Toxic waste disposal from developed into underdeveloped countries,
- Excessive exploitation of resources of underdeveloped countries, e.g. oil/ore or forest exploitation (WWF-UK, 1999).

Literature that studies PHH always leaves some open space for the debate on micro-influences of FDI since it is difficult to identify and aggregate their negative influences and verify the hypothesis (WWF-UK, 1999). Apart from that, PHH is additionally blurred by enormous amount of FDI which goes between the developed countries with strict environmental standards. At the beginning of 2000, PHH was considered an urban myth, with no adequate empirical confirmations. There are two major arguments for such suppositions:

- Environmental standards do not represent sufficiently large costs to affect the decision on production relocation (Levinson and Taylor, 2008),
- Polluting industries are capital intensive and represent comparative advantages of highly industrialised countries which are difficult to relocate (Candau and Dienesch, 2017).

Reasons for transfer of industries between developed countries are: more developed infrastructure, larger market and better educated labour. On the other hand, the countries with bad and/or no regulations regarding environmental protection do not have afore-mentioned characteristics and they are governed by incompetent governments, which may cause even larger costs to the enterprise. According to Candau and Dienesch (2017), the debate on PHH was mostly based on data collected in the USA, whereas it was neglected in Europe and the rest of the world at the same time. However, entering of post communist countries of Europe, Russia and China in free capital flow makes PHH the attractive field of research again. Candau and Dienesch (2017) claim, that PHH is almost always followed by corruption, which blurs real results of the research. According to the research of Kolstad and Wiig based on a sample of 81 countries that received FDI in exploitation of natural resources in the period between 1996 and 2009, econometric analysis confirmed positive correlation between the increase of corruption and foreign investments in this sector. Shaxson (2007) found similar evidence having exposed corruption of oil industries in Africa. Therefore, it can be concluded that the countries susceptible to corruption are considerably attractive to foreign capital in this area, since it enables making of huge profits, as well as that Stiglitz (2009) was also right with statements on inevitability of corruption, if it enables additional profits without any fines. In order to determine actual reasons why capital is moving and when it influences the environment in a negative way, it is necessary to classify movement trends of FDI, and these are: new markets, production platforms and search for resources (Aliyu, 2015). According to Esty and Gentry (1997), investments within first two categories are the least sensitive to growth of environmental standards. However, when FDI are in search for resources, it is considered that they can be sensitive to the change of law on protection of the environment

(Aliyu, 2015). Movement trends of FDI should also be complemented with the search for low costs of: labour, doing business and production factors, which may be sensitive to growing environmental standards. This sensitivity is caused by growth of competition on the world market and growth of corporate power in global economics (Aliyu, 2005). On the other hand, modern economics characterised FDI as generators of development, which countries can really benefit from, regarding increase of production capacities, technological transfers, training of domestic enterprises and improvement of their export sector. However, are benefits of FDI real, is the question that is very difficult to answer, because companies tend to extract bigger part of the profit and that development is considerably slow. To attract and keep foreign investments, a lot of countries are ready to make more and more concessions (WWF-UK, 1999). Therefore, taking into account the previous analysis and movement trends of FDI, as well as conclusions of the previous hypothesis, second hypothesis is set:

H2: If the motive for transfer of industries is a search for resources or lower environmental standards, FDI will move in accordance with suppositions of PHH, since it is the necessity which results from concentration of capital and market competition.

3.2. Influence of FDI on the environment

Official viewpoint of *mainstream* economics on environmental influences of FDI is defined by following argumentation:

- Countries have comparative environmental advantages, i.e. countries with low income should use the opportunity to tolerate pollution and excessive exploitation of resources and set low standards in order to attract FDI.
- FDI increase the tendency for improvement of environmental standards, i.e. together with the development that comes with them, the population`s awareness of protection of the environment will also rise and performed damage will be restored.
- FDI possess and brings more developed and cleaner technologies from those which are used by local manufacturers, which is why it is important to attract foreign investments, in order to accelerate environmental performances of doing business in these countries (WWF-UK,1999).

During reconsideration of the economic development which is based on the aforementioned principles, there is a quotation from Business Week (02.08.1993.) on the subject of bearers of FDI – TNC and the economic growth: *"Free market and free trade in new global economic system are things which will end slow economic growth and high rate of unemployment in industrial world. This is what new economic order really is."* (Stojanov, 2012). Almost 25 years have passed since this euphoric boom of liberalism and the slow economic growth has not been ended yet. Nevertheless, it seems that apart from Asian tigers and China, other countries do not mark significant growth and development, whereas the differences between developed and underdeveloped countries deepen even more and are followed by rapid destruction of the environment. While the competition between enterprises is decreasing, mobility of the capital brought the competition for FDI even between the developed countries is intensified every day to such an extent that the developed countries compete in, for example, by lowering the income tax in order to attract and keep TNC but in more sophisticated industries. There is also a similar competition between the underdeveloped countries regarding lowering the environmental standards and labour rights. There are also practical examples in favour of these claims, especially in the extraction sector, for example, countries of Asian-Pacific region were competing in the middle of the 1990s in order to attract investors to the mining sector (copper, iron, gold, coal and aluminium). More precisely, in 1985, when the Philippine government cut concession costs through financial and technical agreements, investments started coming, and within a year, there were 16 FDI in this sector (Mining Policy Institute, 1998). The other example is Papua New Guinea and Indonesia, whose governments drastically lowered control over protection of the environment in the mining sector. All mining operations in this area did business under privileged conditions of minimum or no control (Mining Policy Institute, 1998). In Indonesia, all mining corporations got the immunity on environmental laws according to Contracts of Work (Mining Policy Institute, 1998). Facilitating or no laws on environmental protection caused very serious environmental damage. An imposing question arise: why do countries tolerate this kind of behaviour and why do they compete? The answer to this question lies in the fact that extraction industries demand enormous investments and technologies, owned by large enterprises. Since very few countries have enough sources for investments to such extent. They are forced to indulge the demands of TNC, which is confirmed by previous claims that TNC have comparative advantages that enable them to become rule makers. However, it also partly confirms the second set hypothesis, because TNC were willing to invest in countries with lower environmental standards. For that reason, critics of globalisation, such as Hermann (1995), Gissinger and Gleditsch (1999), Kaplinsky (2000) and Shiva, (2004) describe TNC as the key active participants and winners of globalisation process that cause inequality and injustice, whereas Wettstein (2009) defines them as symbols of false promises of neo-liberal project (Giuliani and Macchi, 2013). According to Brecher and Costello, fall of wages, social and environmental conditions are the result of global production strategies of TNC, that lead the world towards the *"race to the bottom"* (Giuliani and Macchi, 2013; Stojanov, 2012). In favour of this debate also comes the announcement of the Philippine

government in Fortune magazine from 1975: *"In order to attract the company like yours, we levelled the mountains, cut down the jungles, drained the marshes, redirected the rivers and relocated the villages, so that you can do your business more easily."* (Stojanov, 2012). The phrase *race to the bottom* is very often mentioned in researches connected to PHH, and the words of the Philippine government bear a special weight today. Indeed the liberalisation played a great role in global economic development if the results are aggregated. Productivity *per capita* rose from 614 to 4908 billion dollars in the period from 1970 to 1999 (WWF-UK, 1999). However, economic trends disguise the accumulation of social and environmental problems. The position of World wildlife fund – WWF is stated in favour of the penultimate claim, estimating that the world`s potable water supplies decreased for 50% for the period stated, that ecosystem of the seas deteriorated for 30% and that forest areas are reduced for 10%. In the same period of time, global energy consumption rose over 70%, together with the rise of greenhouse gases emission (WWF-UK, 1999). Furthermore, in the period between 1960 and 1994, proportion of income between 20 richest and poorest countries rose from 30/1 to 78/1(WWF-UK, 1999). These devastating numbers question the validity of *pollute now* and *clean up later* thesis, as well as the neoclassical thesis on faster convergence of countries to FDI, thus throwing the light on PHH again.

3.3. PHH Ghana case

According to Appiah-Kondau (2013) in Ghana case study, trade was a great factor in damaging the environment, which is reflected in uncontrollable exploitation of natural resources (ores, forests). Adoption of Economic Recovery Program in 1983 poured a lot of FDI into the mining sector in Ghana. Due to production growth out of this platform, Ghana adopted the Investment Promotion Act in 1994 (Solarin, Mulali, Al-Musah and Ozturk, 2017). In the period between 1990 till the end of 1999, mining sector in Ghana attracted over 3 billion dollars of foreign investments, i.e. 60% of total influx of FDI into the country (Appiah-Kondau, 2013). Foreign investment trend in mining in Ghana continued in 2000s as well, so in the period from enactment of recovery platform in 1983 to 2011, mining sector attracted 11, 5 billion dollars in total or 65% of total FDI into the country (Appiah-Kondau, 2013). However, market liberalisation and influx of FDI brought with them brisk energy consumption, a large mercury pollution (Hg) and degradation of soil. According to Aragón and Rud research (2014), agricultural land situated in regions where mining activities are performed becomes infertile. Decline in fertility of the agricultural land is not insignificant, since in the period between 1997 and 2005 the fertility decreased for about 40%. Solarin, Mulali, Al-Musah and Ozturk (2017), got to the result that for every 1% rise of FDI influx there is 0,026 % rise of CO_2 emissions into the atmosphere. Out of total CO_2 emission, energy production is responsible for 41 %, mostly by thermal production of energy (Solarin, Mulali, Al-Musah and Ozturk, 2017). Appiah-Kondau (2013), while testing Ph hypothesis based on two regressive equations, come to conclusion that FDI attracted by lenient environmental laws in Ghana contribute to larger CO_2 emissions and exploitation of forest potentials in the country. Solarin, Mulali, Al-Musah and Ozturk (2017) came to similar conclusions and claim that in case of Ghana, PHH is valid and that FDI increases CO_2 emissions, as well as that Ghana developed comparative advantages in polluting industries and that Ghana became PH. By confirming PHH on the Ghana case, second set hypothesis in this paper has been confirmed as well. Apart from Ghana example, the research of Sapkot and Bastol (2017) also confirms the hypothesis. Testing the PHH validity on the example of South America, they got the results that for every 1% of FDI increase, there is a pollution of 0,036%. Looking into emissions of CO_2 in China in the period between 1980 and 2012, Sun, Zhang and Xu (2017) using ARLD method came to the results that by increase of FDI influx by 1 %, CO_2 emission rises by 0,058%, which ultimately cements second hypothesis.

4. CONCLUSION

Enlargement of the enterprise is based on three intertwined processes: accumulation, concentration and centralisation of capital. Initial process of accumulation of capital is based on transfer of the part of capital back to the production. During accumulation of adequate sources, a possibility for concentration and centralisation of capital is created. Since accumulation is defined by profit and profit is defined by costs, bearing in mind ruthless competition, enterprises are forced to reduce costs in all possible ways. Cutting the costs includes costs of environmental protection if it is legally possible. This process confirms first work hypothesis. Movement of capital in search for resources and lower environmental standards - PHH, is also based on the same principles of growing incomes and falling costs. If TNC are in search for resources and lower standards, their investments will be directed towards zones which are more lenient and where standards are lower. Besides, if TNC are large and strong enough, they will try to use their power in order to achieve their ultimate goal, regardless the consequences they leave behind. It is indeed confirmed on the example of extraction industries in Ghana and Asian-Pacific region, which empirically confirms second work hypothesis. It is important to mention that the process of moving of FDI towards PHH is not widespread yet, even if they are polluters, e.g. steel production is still kept in host countries of TNC, because it represents strategic interest (WWF-UK, 1999). Moreover, it is necessary to point out that aggregation of influx of FDI leads to yet inconclusive results, since the majority of FDI is motivated by conquering of new markets, hence

the condition of motive in second work hypothesis. By growing environmental standards and laws, capital will be even more motivated to seek PH. More frequent positive results in testing the PHH validity, e.g. in Latin America and China speak in favour of that. It appears that in its practice TNC have support in theory with the principle: pollute first, clean up later, which the author of the paper does not approve of. This principle can endanger the fragile balance of ecosystems and cause irreparable consequences. Therefore, as much as the development and growth of the country are important, it is highly recommended that countries reconsider all possible negative consequences of FDI before they are accepted.

REFERENCES

Aragón , F.M. & Rud, J.P. (2014) Polluting Industries and Agricultural Productivity: Evidence from Ghana, International Growth Centre, 2018. Retrieved from: https://economics.ucr.edu/seminars_colloquia/2013-14/applied_economics/Aragon%20paper%20for%204%2023%2014%20seminar.pdf

Appiah-Kondau, P. (2013). The Efect of Trade Liberalization on the Enviroment: A Case Study of Ghna, *Thesis towards the award of Master of Philosophy Degree in Economics at the University of Ghana*, Department of Economics, Legon.

Aliyu, M. A. (2005). Foreign Direct Investment and the Environment: Pollution Haven Hypothesis Revisited, *Paper prepared for the Eight Annual Conference on Global Economic Analysis*, Lübeck, Germany.

Copeland, B.R., & Taylor, M.S., (2004). Trade, growth, and the environment. *J. Econ.,* Literature 42 (1), 7e71

Candau, F. & Dienesch, E. (2017). Pollution Haven and Corruption Paradise, *Journal of Environmental Economics and Management*, Volume 85.

Elisa Giuliani & Chiara Macchi (2013), Multinational Corporations' Economic and Human Rights Impacts on Developing Countries: A Review and Research Agenda, *Discussion Papers del Dipartimento di Economia e Management* – Università di Pisa, n. 158.

Esty, D.C. & B. S. Gentry (1997), Foreign Investment, Globalisation and Environment, *Globalisation and Environment: Preliminary Perspectives*, OECD, Paris.

Farlex Financial Dictionary (2012). Farlex: 2018. Retrieved from https://financial-dictionary.thefreedictionary.com/Pollution+Haven+Hypothesis

Fiamengo, A. (1973). Osnove opće sociologije*,* Vol. 9, Narodne novine, Zagreb.

Lavčević, G. (1953). Monopoli i financijski kapital, Rad, Beograd.

Levinson, A. & Taylor, S. (2008). Unmasking the Pollution Haven Effect, *International Economic Review*, Vol. 49. DOI: 10.1111/j.1468-2354.2008.00478.x

Lovrinović, I. (2015). Globalne financije, Accent d.o.o., Zagreb.

Lukács, G. (1976). Mladi Marks. Njegov filozofski razvitak, Beogradski izdavačko grafički zavod, Beograd.

Marx, K. & Engels, F. (1977). Kapital 1, Institut za izučavanje radničkog pokreta Prosveta, Beograd.

Mining Policy Institute, (1998). Trade Liberalisation, Mining Investment and the Impacts on the Enviroment and Related Social Issaues, MPI, Sydney.

Solarin, S.A., Al-Mulali, U., Musah, I. & Ozturk, I. (2017). Investigating the pollution haven hypothesis in Ghana: An empirical investigation, *Energy 124*, Elsevier.

Santini, G. (2007). RifiN: 2018. Retrieved from http://www.rifin.com/rifins-news/472-prolo-je-140-godina-od-izdanja-prvog-toma-kapitala-karla-marxa

Kolstad, I. & Wiig, A. (2013). Digging in the dirt? Extractive industry FDI and corruption, *Econ. Gov.,* Vol. 14., Springer-Verlag Berlin Heidelberg, DOI 10.1007/s10101-013-0133-2

Shaxson N (2007) Poisoned wells: the dirty politics of African oil. Palgrave MacMillan, New York.

Candau, F. & Dienesch, E. (2017). Pollution Haven and Corruption Paradise, *Journal of Environmental Economics and Management*, Volume 85.

Sapkota, P. & i Bastola, U. (2017). Foreigndirect investment, income, and environmental pollution in developing countries: Paneldata analysis of Latin America, *Energy Economics*, No. 64.

Salvatore, D. (2003). Microeconmics Theory and Applications, 4th edition, Oxford University Press, New York.

Samuelson, P.A & Nordhaus, W.D. (2009). Ekonomija, Vol. 19, Mate d.o.o., Zagreb.

Stiglitz, J.E. (2009). Uspjeh globalizacije, Algoritam, Zagreb.

Stojanov, D. (2012). Ekonomska kriza i kriza ekonomske znanosti, Ekonomski fakultet Sveučilišta u Rijeci, Ekonomski fakultet Univerziteta u Sarajevu, Rifin, Zagreb.

Stojanov, D. & Jakovac, P. (2013). Ekonomska znanost u zamci globalizacije, *Ekonomski pregled*, No. 64.

Sun, C., Zhang F. & Xu, M. (2017). Investigation of pollution haven hypothesis for China: An ARDL approachwith breakpoint unit root tests, *Journal of Cleaner Production*, No. 161.

Velić. I., Cerović, Lj. &Maradin, D. (in press). Monopoly Exploitation and Rent-Seeking as an Inevitability of Capital Concentration, *Asian Economic and Financial Review*, AESS Publications*.*

WWF-UK (1999). Foring Direct Investment and the Environment: From Pollution Havens to Sustainable Development, by Mabey, N. and McNally, R. WWF-UK Report.

INVESTMENT IN RENEWABLE ENERGY SOURCES - ANALYSIS AND ASSESSMENT OF JUSTIFICATION

Nikola Vujanović[1]
Belgrade business school - higher education institution for applied studies
e-mail: vujanovic.nikola92@gmail.com

Abstract: *The question that is increasingly being posed in modern society is based on the strategic potential of electricity sources. We are witness to the fact that the last two decades have been marked by sudden climatic changes, and that in this period the average temperature on Earth has increased by 0.6 degrees, which is the highest temperature rise in the last thousand years. Of the total potential of renewable energy sources in the Republic of Serbia, 16.7% is the potential of solar energy, but far less is used. Although the potential of solar radiation is about 30% higher in the Republic of Serbia than in Central Europe, it is assumed that unused capacity has occurred due to insufficient investment activity in this area. For decades, solar energy is used to generate heat in terms of heating water, living space, and also for cooling, and its use is reflected in multiple advantages. It is a quiet, clean and reliable source of energy. Therefore, the subject of this paper will be the methodology for efficient management and evaluation of justification of investments in energy projects, shown on the concrete case of building a solar power plant on the territory of the city of Belgrade.*

Keywords: *project management, feasibility assessment, renewable energy sources, solar energy, energy*

1.INTRODUCTION

The management of projects in the field of energy has the main focus on renewable energy sources, more specifically solar energy and all benefits that the society expands to the realization of investment in electricity. This area of research is very important since energy is a strategic resource of developed and underdeveloped countries. A range of benefits that are often immeasurable for one community brings the growth of the energy sector that leads to the economic development and prosperity of a community. Natural resources are defined as renewable or non-renewable geological, hydrological and biological values that can be used directly or indirectly and have a real or potential economic value. (Lia, Ertesvag, & Zhao, 2013). Energy is characterized by the capacity to produce actions, to cause movement, to modify body temperature, or to transform matter, or to induce different changes (Jena & Misra, 2014). Today, several forms of energy are recognized, of which the most important are electric, chemical, thermal, radiation, mechanical and nuclear energy. In relation to the process of energy transformation, the basic forms of energy include sources and types of energy, and as forms appear: primary, secondary, final and useful energy.

All energy sources are divided into renewable and non-renewable energy sources (Sam Aflaki, 2016). The focus in this paper is the renewable sources that will take primacy over non-renewable sources in the coming years.

As the most important advantages of non-renewable energy sources, according to (Marković, 2010) are: constantly, better ability to adapt to needs, storage and transport in natural form, less investment for plant construction, converting and using and drive and maintenance.

It can definitely be noted that the listed benefits are most often benefits of the investor itself, if viewed from the perspective of the investor. The question arises as to which benefits of using such investments can bring to the wider community. Are there benefits for stakeholders who are not directly involved in the exploitation of projects? Can the realization contribute to the preservation of the environment, reducing air pollution, emissions of gases, reducing various diseases, etc.? Yes, The assumption is that projects using renewable energy can be exploited. One of the basic definitions of renewable energy sources is spending at the same speed as they are renewed. These energy sources are in nature and are renewed in whole or in part (Ilicak, 2014). According to the National Strategy for Sustainable Use of Natural Resources and Goods natural resources in the territory of the Republic of Serbia provide five basic functions: the function of the source, recipient function, circuit function, information function, recreational and other functions.

The functions just displayed show the role of electricity projects from the point of view of the community. The previous division can observe the strategies and goals that the projects could produce during their exploitation period. It is necessary to look at the different needs of people and to properly measure all the benefits that the project brings, taking into account the socially acceptable

and necessary benefits (Kordik, Travniček, & Pavelka, 2015). The energy of the Sun, Wind, Sea and the oceans, biofuels and biomass represent non-renewable energy potentials on planet Earth. On the other hand, the basic non-renewable energy sources are fossil fuels, oil, gas and coal whose exhaustion is already very certain. Energy projects are characterized as investment with respect to the characteristics of long-term observation, complexity, large money investments necessary for the realization, resource consumption and the participation of a large number of stakeholders. The lifespan of these projects is twenty years and more, with extremely high initial investments (Zorita, Fernandez-Temprano, Garcia-Escudero, & Duque-Perez, 2016). Management itself is based on concepts that use appropriate methods of organization, planning and control in order to rationalize all necessary resources and coordinate the performance of the necessary activities. Addressing the topic of renewable energy in the Republic of Serbia is one of the necessary conditions for further survival of the energy industry as a heavy industry. Namely, all projects involving the exploitation of renewable energy sources are divided into several categories, with the main focus on reducing consumption and additional due to the production and distribution of electricity, often uncondemning all the benefits that the projects bring to the community (Kasa, Ramanathan, Ramasamy, & Kothari, 2016). In relation to the above, the idea of this paper is to present ways and different projects with a focus on renewable energy sources with the ability to identify and measure the advantages/benefits that their implementation brings. Below the following is the theoretical background of renewables that are increasingly replacing non-renewable energy sources, along with an example of an investment project that presents a perspective and exploitation of solar energy in a very picturesque manner, but from a socially acceptable point of view. A number of social goals can be identified in the realization, and they have a much greater benefit than the one that private investors themselves acquire. Therefore, the following chapters show energy efficiency, the possibility of solar energy exploitation and case studies presented through the Cost-benefit analysis, i.e. the method of economic analysis that compares and evaluates all the advantages and disadvantages of a particular enterprise. this analysis can be used for investment projects that deliver not only direct commercial effects that are quantitatively expressed, but also for projects that bring significant indirect and immeasurable effects. It often contributes to deciding between choices between different forms of resource use, and based on determining overall contributions to reaching ecological goals. It is precisely the aim of this paper to look at all the indirect goals of building a solar power plant using Cost Benefit analysis and cost-effectiveness of investments from the aspect of social assessment of projects. In addition, it also aims to demonstrate that investment in renewable energy sources will make breach in the area of unimpeded access to the private energy sector, reduce the level of pollution in the country, the foreign trade deficit of electricity, create new jobs and create a set of benefits both for the company and for individual investors. Preliminary paper points to the importance of using renewable energy sources and it is not intended for a specific group of people, but for everyone interested in topics of general social importance. Addressing the topic of renewable energy in the Republic of Serbia is one of the necessary conditions for further survival of the energy industry as a heavy industry.

2. ENERGY EFFICIENCY AND ENERGY POTENTIAL OF THE REPUBLIC OF SERBIA

In order to understand the realization of electricity projects, it is necessary primarily to overcome the theoretical concept of energy efficiency and the potential of the Republic of Serbia, since the project that is part of the case study of this work is precisely the implementation of the project in the territory of our country.

The sustainable energy system is an energy efficient way of producing and using energy, which aims to have as little harmful impact on the environment as possible. Sustainable development implies a concept of economic activity that is based on meeting the needs of society without jeopardizing the ability of future generations to meet their needs. Improving energy efficiency for industry means reducing energy consumption for the same production volume. In this regard, the increase in energy efficiency in the economy refers to the reduction of energy consumption for: the production of a product, service performed or some activity performed. The concept of energy efficiency should not be confused with the notion of energy savings, because savings often lead to reduction, and reduction to reduction of comfort, which is certainly not the goal of energy efficiency, and energy management (Li, Guo, & Huang, 2016). The task of the investor who decides to implement the project in the field of energy is to select a project that will contribute to the reduction of negative impacts, all in the context of limited budgets and legal authorizations. The term non-renewable energy sources refers primarily to energy carriers created in the past and cannot be regenerated or produced again (Zikic, 2016). Most of the non-renewable energy sources refer to fossil fuels, fuels produced by anaerobic digestion of dead or dead organisms in the interior of the earth under the influence of high temperature and pressure, millions of years ago. The limitation of fossil fuel reserves and environmental problems

caused by their exploitation have led to increased interest in renewable energy sources, primarily for solar and wind energy. The name renewable or durable, comes from the fact that energy is spent in an amount that does not exceed the speed it creates in nature (Zarcone, Brocato, Bernardoni, & Vincenzi, 2016). Below is a focus on solar energy, as one of the most commonly used renewable energy sources.

Solar energy is the energy of solar radiation that we observe in the form of light and heat that we receive from the largest source of energy on Earth, the Sun. Solar radiation is also responsible for the constant renewal of wind, sea currents, waves, water currents and thermal gradients in the oceans (Zikic, 2016). For decades, solar energy is used to generate heat in terms of heating water, living space, and also for cooling (Rajani & Pandya, 2016). Republic Serbia has a 30% higher solar radiation potential than central Europe, and the intensity of solar radiation is among the largest in Europe. The average daily energy of global radiation for a flat surface during the winter period ranges from 1.1 kWh/m2 in the north and 1.7 kWh/m2 in the south, and during the summer period between 5.4 kWh/m2 in the north and 6.9 kWh/m2 south. The use of solar energy is carried out with the help of built solar plants or solar power plants. Solar power plants are facilities in which solar energy is transformed into electric or thermal energy. It can be seen in the form of solar radiation that appears in the form of light and heat that we receive from the largest source of energy on Earth, the Sun. Solar radiation is also responsible for the constant renewal of wind, sea currents, waves, water currents and thermal gradients in the oceans. For decades, solar energy is used to generate heat in terms of heating water, living space, and also for cooling. The use of solar energy has multiple advantages. It is a quiet, clean and reliable source of energy. Due to the rising price of fossil fuels and raising awareness of the need for environmental protection, there is an increasing interest in the use of renewable sources, including solar energy (Kayser, 2016). The possibility of exploiting the solar potential, the increase in the consumption of energy by the population and Public Suppliers and the speed of construction of the solar power plant, lead to an increase in the number of projects that occur in the field of energy. Also, the low level of investment risk is an advantage, since the state is committed to the purchase of energy in the next 12 years, paying off to the investor a predetermined purchase price of energy. Previous readers are familiar with the basic concepts that solar energy and its exploitation provide, but the potential of the Republic of Serbia that enables the implementation of electricity projects, which will lead to realization of indirect effects, which are the core of this work, is summarized below. It is very important that the Republic of Serbia has significant potential in renewable energy sources, which, unfortunately, is still underused. One of the reasons for such a situation is insufficient investment activity. It is expected that in the next few years there will be major developments in this regard, given the latest step by the Government of the Republic of Serbia in the sense of accepting the decision of the Council of Ministers of the Energy Community on the promotion of renewable energy through the transposition of Directive 2009/28 / EC on renewable energy sources. With this decision, Serbia set an ambitious goal to increase the share of renewable energy in total final energy consumption to 27% in 2020 compared to the current average consumption of 21%. The largest share in the production of energy products in the Republic of Serbia in 2017 was the production of coal (41.63%). Imports of 53.23% in 2017 had oil and oil derivatives, while most of them exported electricity (46.19%). Within the final consumption in 2017, the highest amount of coal was spent in the household sector (39.18%); in the transport sector, oil derivatives were mostly spent (61.30%); Electricity was mostly spent in the household sector (52.58%), and natural gas in the industrial sector (70.67%).

Regarding the balance of electricity, the primary production in 2017 for solar energy amounted to 14,780 GW / h, while for hydroelectric energy it amounted to 8,730 GW / h.

In the Republic of Serbia, as the energy producers, the following entities with the stated market share appear: public company "Elektroprivreda Srbije" with a market share of 92.37%, importers of electricity with a share of 7.55%, privileged and temporarily privileged producers with a market share of 0.003% and other producers from renewable energy sources with a share of 0.08%.

Observing different types of solar power plants, the differentiation in the territory of the Republic of Serbia has been carried out as follows: solar power plants “on the ground”, solar power plants on facilities up to 30kW, solar plants on facilities from 30kW to 500kW.

The data of the Ministry of Mining and Energy indicates that there are currently 17 solar plants in Serbia at the moment. The first solution for the opening of a solar power plant was approved on 09.05.2012, after which the interest in solar energy and the possibility of establishing own plants has increased. The total installed power of the subdued electricity producers amounts to 5.340,00 kW, while the total installed power of the temporary producers of electricity is 660.00 kW. The number of solar plants on the facility up to 30kW is 154, that is, the total installed power of the reputed producers

of electricity is 1.711,10 kW, while the total installed power of the temporary producers of electricity is 238.70 kW. In Serbia, solar power plants are installed on the facility from 30 kW to 500 kW and the current number is 21. The total installed power of privileged electricity producers is 1.504,10 kW, while the total installed power of the temporary producers of electricity is 495,90 kW. According to the latest available data, the total utilized solar energy potential for the production of electricity is 0.02056% of the miserable, while the production of heat is not used at all, although there is great potential. The next chapter is a case study with a description of the investment project for the construction of a solar power plant, with the main focus on the Cost benefit analysis and the overview of the indirect goals achieved through the implementation of the project.

3. THEORETICAL ASSUMPTIONS OF BENEFIT ANALYSIS

Cost-benefit analysis is one of the best approaches to evaluating projects of a broader social significance, that is, the focus of these analyzes is not only the effects that a particular project brings to the investor, but also the national community (Araujo, Almeida, Braganca, & Barbosa, 2016). In order to take into account all the effects, i.e. all social benefits and costs of the project, it is most often recommended to apply Cost-benefit analysis in the assessment of energy projects. Data analysis is a practical way to evaluate the eligibility of projects when it is important to look at the investment in the long term and broadly, in terms of causing effects to different people, industry and regions. Cost-benefit analysis is part of the European Union's cohesion policy since the 1990s, and is a compulsory part of the major project proposals since 2000. It is a useful instrument that should help European Union beneficiary countries to choose the best solutions and policies they will be applying for the necessary funds, and to distribute the funds to the European Commission in the best possible way. It also allows assessing the contribution of projects to the welfare of the country and the region, as well as the achievement of the objectives of the European Union defined in the framework of the Cohesion Policy. Such an analysis is usually defined as an activity that enables the inclusion and comparison of costs and benefits that some take into account the effects of a large number of financial, economic, social and other factors in order to assess the financial and economic viability of projects. The effects of all these factors need to be monetized (expressed in cash) in order to be mutually comparable. Economically profitable are only those projects that bring more benefits than costs, and it is recommended to select the one that brings the greatest benefits in terms of costs. The Cost and Benefit Analysis should help individuals and organizations that make decisions that are important to society, to use social resources more rationally (Li, Wei, & Zhou, 2014). Such decisions can be made by private entrepreneurs and socially responsible companies, as well as bodies of the state, regional and local administrations. That is, the analysis itself makes it possible to assess the feasibility and cost-effectiveness of the project proposal at an early stage in its development. A simple financial and economic analysis can point to the key weaknesses of the project proposal. These weaknesses would at some point, during the project's realization, become apparent without the Cost-benefit analysis, but the analysis should just help to avoid unnecessary waste of time and resources on projects that are not profitable.

4. INVESTMENT PROJECT FOR BUILDING A SOLAR POWER PLANT

There are differences in how to evaluate the justifiability of projects when they are designed to increase the general well-being of a community and private investor. Investors focused on realizing their own benefits are looking at the effects that the project brings in terms of profit and value addition. Previously, all advantages of using renewable energy sources have been made, but it is necessary, for the sake of clarity and full understanding, to present the process and possibilities of using Cost Benefit Analysis in identifying the indirect effects that one project can bring.

4.1 Basic information on project realization

For the purpose of rational use of electricity and reduction of greenhouse gas emissions (carbon dioxide, methane, nitrogen suboxide and fluorinated hydrocarbons), the project relies on the exploitation of renewable energy sources, which are primarily environmentally friendly and non-polluting (Yuksel, 2015). The investment relates to the construction of a solar power plant on a residential building in the Belgrade municipality of Vozdovac.

The total electricity produced is distributed to the network of the Public Supplier of the Republic of Serbia ("EPS Distribution"), but it is not significant to the investor who are the final consumers of the same. As the overall goal of the project is the generation of electricity over a period of 12 years and

the realization of subsidized purchase price for investors, exploiting solar potential through the exploitation of a solar power plant. The period of exploitation of the project is planned for the next 13 years, that is, the period in which the investor sells the whole produced electricity to the Public Supplier, the company EPS Distribution (Zikic, 2016). To install a solar power plant, 81 solar modules and two 300W inverters will be used to convert electricity. The power plant has a maximum capacity of 20.41 kW, and falls into the first category of subsidized purchase prices (solar power plants on facilities up to 30 kW), within which the investor would generate 20.66 € cents for produced kW/h. The average annual production in the period of exploitation of the project is 30,494.05 kW/h, with the production in August, September, October, November and December, and in the last (12 years) since January, ending in July. The reason for this is to start investing in the realization of the project, that is, the construction and installation of a solar power plant itself.

The scope of the project was observed in relation to the realization of the overall project, i.e., production of electricity and further distribution to the Public Supplier. As the most important activities in the realization of the given project, the following occur: Creating a study of opportunities, preparation of a preliminary feasibility study for the construction of a solar power plant, preparation of the feasibility of the study, on the basis of which the final conclusions on the validity and justification of the realization of the power plant construction project will be made, collecting the technological documentation, construction of the plant and installation of the necessary equipment, connection on the electrical network and further sale of electricity.

Socio-economic analysis identified the main problems that can be minimized or completely eliminated through project implementation. The problem tree, which will be explained in a few sentences, is a tool used to display the main problem with all the sub-problems, causes, and consequences, while the goal tree is used to "positively reflect" the tree of the problem.

The main problem is the low degree of exploitation of the potential of solar energy by the exploitation of solar power plants. The consequences arising from this problem are the inability to meet the needs for electricity, the economic underdevelopment, the non-use of EU funds and the increase in air pollution, while the causes of the problem are a small number of privileged electricity producers, incomplete implementation of the EU Emission Reduction Directive and insufficient awareness of people on the need for exploitation of renewable resources.

The following graphic represent a tree of goals, which refers to a positive response to the problem tree. Namely, for identified problems, negative reflections of the current situation, through the goal tree are given ways to minimize and eliminate them.

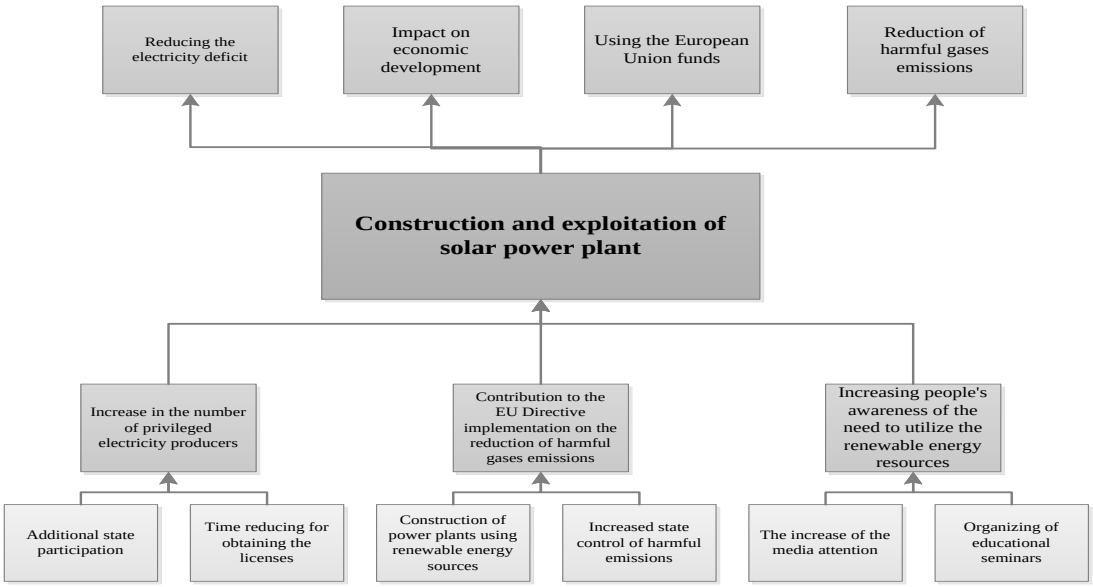

Figure 1: Goals tree

4.2 Identification of the indirect effects of the investment project in the construction of a solar power plant

The assumption is that the above mentioned activities can be realized, but in addition to the main goal of the project, the focus will be on the indirect effects that can occur during the project realization. As, the main in-line objectives of the project realization are identified as follows: reduction of greenhouse

gas emissions by 2%, exploiting solar potential as a renewable energy source, contribution to the implementation of Directive 2009/28 / EC on the promotion of renewable energy production (solar energy) and reduction of greenhouse gas emissions, to which the Republic of Serbia has committed itself to ratifying the Energy Community Treaty and reducing the number of people suffering from respiratory diseases (focus on adolescents) by 0.5% compared to the number of people with disabilities, due to the reduction of air pollution.

4.2.1 Reduction of emissions of greenhouse gases

During the realization of the project it is necessary to include additional socio-economic benefits arising from the implementation of the projects for the construction of a solar power plant. These are often common benefits, i.e. benefits at global level, caused by the reduction of greenhouse gas emissions affecting climate change on the ground (AlRafea, Fowler, Elkamel, & Hajimiragha, 2016). In order to evaluate this benefit, a standard priced price can be used, for example, to avoid the emission of harmful gases.
The following table shows the emission of non-radioactive gases in the production of electricity from different sources. This data is important for the economic analysis of the project because it can assess the benefits that would bring energy production through solar radiation.

Table 1: Emission of non-radioactive gases from conventional and renewable energy sources

Power plant type	CO_2 (mg/kWh)	NO_x (mg/kWh)	SO_2 (mg/kWh)	Solid particles (mg/kWh)
Coal/lignite	986.000	2.986	16.511	347
Oil	1.131.178	5.253	81.590	128
Natural Gas Turbine	560.000	1.477	152	34
Natural gas combined	450.000	756	152	6
Nuclear power plant	21.435	51	27	2
Hydro	22.696	23	33	5
Vetro	17.652	32	54	20
Solar (photovoltaic)	49.174	178	257	101
Biomass	58.000	1.325	76	269
Geothermal	18.913	280	20	0

The lack of project activity would cause further environmental pollution and the release of harmful gases into the atmosphere through the use of conventional sources would continue. Reducing the emissions of harmful gases is very important for the environmental aspects of the wider community because the effects of the emissions do not have an immediate but long-term and cumulative adverse effect. One of the objectives of the project is to reduce air pollution through reduced emissions of non-radioactive gases, indicated in the previous table. The amount of emitted gases to be saved equals the amount of gases that would be generated by the absence of project activity and the use of conventional sources for the production of electricity. The benefits that are obtained are calculated based on the differences in emissions using conventional sources. The emission of gases caused by the use of coal and oil, and on the other hand, solar energy is observed. The tables shown below show a comparative overview of the emission of four types of harmful gases (CO2, NOx, SO2, hard particles(soot)) in relation to the projected produced amount of electricity over the course of a century of exploitation.
The budget has determined that total savings would be 863.935,20 kg (by all categories of harmful gases), compared to the total amount of electricity produced. Based on "green certificates", each ton of emission reductions can be estimated at an average of 8 euros. The money-saving emission savings, using solar as opposed to conventional sources, amounts to a total of € 6,895.48.

Table 2: Emission of harmful gases in the production of electricity through solar energy during the project's exploitation period

Years of exploitation	0.year	1.year	2. yaer	3.yaer	4.yaer	5 yaer	6.yaer	7 yaer	8.yaer	9 yaer	10. yaer	11.yaer	12.yaer
Planned production (kWh)	13618,14	34573,16	34227,43	33885,15	33546,3	33210,84	32878,73	32549,94	32224,44	31902,2	31583,18	31267,35	20955,84
CO_2 (kg/kWh)	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174	0,049174
NO_x (kg/kWh)	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178	0,000178
SO_2 (kg/kWh)	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257	0,000257
Solid particles (soot) (kg/kWh)	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101	0,000101
Price (kg)	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008
Total broadcast (kg)	676,9577394	1718,632	1701,445	1684,431	1667,587	1650,911	1634,402	1618,058	1601,877	1585,858	1570	1554,3	1041,715
The total value	5,415661915	13,74905	13,61156	13,47545	13,34069	13,20729	13,07521	12,94446	12,81502	12,68687	12,56	12,4344	8,333718

Table 3: Emission of harmful gases in the production of electricity by using coal, during the project's exploitation project

Years of exploitation	0.year	1.year	2.year	3.year	4.year	5.year	6.year	7year	8.year	9.year	10.year	11.year	12.year
Planned production (kWh)	13618,14	34573,16	34227,43	33885,15	33546,3	33210,84	32878,73	32549,94	32224,44	31902,2	31583,18	31267,35	20955,84
CO_2 (kg/kWh)	0,986	0,986	0,986	0,986	0,986	0,986	0,986	0,986	0,986	0,986	0,986	0,986	0,986
NO_x (kg/kWh)	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986	0,002986
SO_2 (kg/kWh)	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511	0,016511
Solid particles (soot) (kg/kWh)	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347	0,000347
Price(kg)	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008
Total broadcast (kg)	13697,72441	34775,21	34427,45	34083,18	33742,35	33404,92	33070,87	32740,17	32412,76	32088,64	31767,75	31450,07	21078,31
The total value	109,5817953	278,2016	275,4196	272,6654	269,9388	267,2394	264,567	261,9213	259,3021	256,7091	254,142	251,6006	168,6264

Table 4:Emission of harmful gases in the production of electricity by using coal, during the project's exploitation project

Years of exploitation	0.year	1.year	2.year	3.year	4.year	5.year	6.year	7.year	8.year	9.year	10.year	11.year	12.year
Planned production (kWh)	13618,14	34573,16	34227,43	33885,15	33546,3	33210,84	32878,73	32549,94	32224,44	31902,2	31583,18	31267,35	20955,84
CO_2 (kg/kWh)	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178	1,131178
NO_x (kg/kWh)	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253	0,005253
SO_2 (kg/kWh)	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159	0,08159
Solid particles (soot) (kg/kWh)	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128	0,000128
Price (kg)	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008
Total broadcast (kg)	16588,92362	42115,26	41694,11	41277,17	40864,39	40455,75	40051,19	39650,68	39254,17	38861,63	38473,02	38088,29	25527,34
The total value	132,711389	336,9221	333,5529	330,2173	326,9152	323,646	320,4095	317,2055	314,0334	310,8931	307,7841	304,7063	204,2187

It is important to note that there is a close connection between the production of electricity and the emission of harmful gases that the sources cause. According to the Agency for Environmental Protection in the last three years, the energy sector participates in the largest volume of emissions of polluting substances into the atmosphere.

4.2.2 Reducing the number of respiratory diseases

Respiratory diseases relate to breathing diseases, and the most common cause of the disease is the polluted environment in which individuals live. In the Republic of Serbia, the highest share in respiratory diseases affects asthma, which is due to excessively strong immune response to the presence of asthma driver. Asthma is a chronic inflammatory disease of the respiratory tract. In people with asthma, this inflammation is the cause of repeated episodes of playing in the chest, choking and coughing, both during the day, at night, and after physical fatigue. All these symptoms are the result of the increased response of the airways to various stimuli. As a result, there is a diffuse airway obstruction, which is a variable degree, and it is lost either spontaneously or under the influence of the drugs on the spread of the bronchi and/or steroids. Triggers are the most commonly different allergens that cause a patient to suffer from asymmetric changes or an asymmetric attack itself.

The causes of asthma are: pollen, low air quality caused by air pollution, weather, cold air, high or low humidity and even sudden changes in temperature can often aggravate asthma, smoking and passive smoking, animals with fur or hair

Nitrogen oxides, sulphur oxides, so-called ground-level ozone, which is not the primary pollutant, but occurs as a reaction of these compounds, in addition, it is poisonous and what dominates and what is so important is the so-called ultrafine particles that stand out from combustion, primarily diesel. There is a link between conventional and renewable energy sources and how they function with the degree of air pollution. The subject of this study is the need to point out the importance of using renewable energy sources, since they have a much smaller impact on air pollution and environment (Brown & Ulgiati, 2016).

4.3 Basic indicators of social profitability of realization

In order to identify and calculate indicators of the project economic viability, the starting point represents stretching economic project flow after years of exploitation, with consideration of the total inflow, outflow, direct material and immaterial investment costs, using conversion factors and presentation of direct social benefits. The main advantage of exploitation is to reduce the emissions of harmful gases into the atmosphere. The following table also presents net effects that are the difference between inflow and outflow, and all subsequent budgets and conclusions are derived from it.

Table 5: The economic flow of the project after identifying and applying conversion factors

Р.Б	Ставке/Години	CF	0.год	1. год	2. год	3. год	4. год	5. год	6. год	7. год	8. год	9. год	10. год	11. год	12. год
1.	**Приливи**		**2.864,70**	**7.406,19**	**7.466,86**	**7.528,25**	**7.590,36**	**7.653,19**	**7.716,75**	**7.781,05**	**7.846,10**	**7.911,90**	**7.978,44**	**8.045,75**	**12.388,62**
1.1.	**Укупни приход**	**0,9340**	2.627,82	6.804,82	6.871,50	6.938,84	7.006,85	7.075,51	7.144,85	7.214,87	7.285,58	7.356,98	7.429,07	7.501,88	5.128,43
1.2.	**Корист од смањења емисије штетних гасова**	**1,0000**	**236,88**	**601,37**	**595,36**	**589,41**	**583,51**	**577,68**	**571,9**	**566,18**	**560,52**	**554,92**	**549,37**	**543,87**	**364,51**
1.5.	**Остатак вредности**	**0,9600**	-	-	-	-	-	-	-	-	-	-	-	-	6.895,68
2.	**Одливи**		**32.510,38**	**264,04**	**1.269,10**	**1.085,38**	**893,40**	**1.740,86**	**483,13**	**264,04**	**1.312,12**	**264,04**	**264,04**	**1.312,12**	**154,02**
2.1.	**Укупна улагања**	**0,9742**	32.400,36	-	-	-	-	-	-	-	-	-	-	-	-
2.2.	**Директни материјални трошкови**	**0,8734**	54,59	131,01	131,01	131,01	131,01	1.179,09	131,01	131,01	1.179,09	131,01	131,01	1.179,09	76,42
2.4.	**Нематеријални трошкови**	**1,0000**	55,43	133,03	133,03	133,03	133,03	133,03	133,03	133,03	133,03	133,03	133,03	133,03	77,60
2.5.	**Обавезе према изворима финансирања**	**1,0000**	-	-	1.005,06	821,34	629,36	428,74	219,09	-	-	-	-	-	-
2.6.	**Нето ефекти (1-2)**	-	-29.645,68	7.142,15	6.197,77	6.442,87	6.696,96	5.912,34	7.233,63	7.517,01	6.533,98	7.647,86	7.714,40	6.733,63	12.234,60

The social discount rate should reflect the social view that future benefits and costs will be valued at current values. Basically, it is recommended to use two rates, those for mature economies (3,5% rate) and rapidly rising (rate of 5.5%). Considering the current situation in the Republic of Serbia, the rate applied for the discounted value calculation is 3.5%. On the basis of the values shown in the following table, the budget of the social cost-effectiveness indicator of the project, the social net present value, the internal rate of profitability, and the cost-benefit ratio were executed.

Table 6: Display for calculating the criteria that indicate the justification of the project from the social aspect

Year	Total investments	Benefit	Cost	Discount factor	PVI	PVB	PVC	NI
0	32.400,36	2.864,70	110,02	1,0000	32.400,36	2.864,70	110,02	2.754,68
1		7.406,19	264,04	0,9662		7.155,74	255,11	6.900,62
2		7.466,86	1.269,10	0,9335		6.970,40	1.184,72	5.785,68
3		7.528,25	1.085,38	0,9019		6.790,05	978,95	5.811,10
4		7.590,36	893,40	0,8714		6.614,56	778,55	5.836,01
5		7.653,19	1.740,86	0,8420		6.443,78	1.465,75	4.978,03
6		7.716,75	483,13	0,8135		6.277,58	393,02	5.884,56
7		7.781,05	264,04	0,7860		6.115,84	207,53	5.908,30
8		7.846,10	1.312,12	0,7594		5.958,42	996,44	4.961,98
9		7.911,90	264,04	0,7337		5.805,20	193,73	5.611,47
10		7.978,44	264,04	0,7089		5.656,07	187,18	5.468,89
11		8.045,75	1.312,12	0,6849		5.510,90	898,73	4.612,17
12		12.388,62	154,02	0,6618		8.198,58	101,93	8.096,65
Total					**32.400,36**	**80.361,82**	**7.751,67**	**72.610,15**

The positive value of the criterion of economic net present value - ENPV (40,209.79 €) indicates that the project from the aspect of the company is profitable. The related project has more social benefits than costs and thus contributes to the increase in the welfare of the population, primarily the municipality of Vozdovac and beyond. The economic internal rate of return shows the rate at which the ENPV has the value of zero, and in terms of this project it is 19.41981%. A significantly higher economic rate of profitability than the social discount rate shows the project's economic viability. The cost-benefit ratio (CBR) is the ratio of the discounted benefits and costs of the project. The value obtained for the concrete project is 10.3670 and shows that the project is sustainable and that the present value of total benefits is greater than the present value of total costs and that the project is cost-effective from a socio-economic point of view. All indicators, both financial and social, indicate the justification for investing in the project of building a solar power plant under the patronage of "XXX" DOO from Belgrade.

5. CONCLUSION

In the end, it is already clear to everyone that there is no question of whether it is necessary to invest and use renewable energy sources, but the rather attention is on emphasis the economy viability and justification of investments in alternative energy sources. The issue that is very up-to-date in today's scenario is what is the timeframe for the return of funds in investments in the field of energy, as well as what benefits the realization of the project brings to both the investor and the wider community. The criteria have used to estimate are discounted cash flows are net present value, unit net present value, internal return rate, return period and social net present value. All these criteria have considered and indicated the justification of investments in the solar power plant construction and the invested capital return, related to the reference period, as well. The general conclusion being made is that a bunch of benefits for a wider social community is achieved through the use of renewable energy sources, whether it's about to the different type of energy applied. This study presents utilization of the solar energy, but the assumption is that both the use of wind energy, the exploitation of biomass or hydroelectric power makes a significant contribution to the community and human beings, while conserving nature and reducing harmful emissions into the atmosphere. The use of renewable energy sources will become a people's need in a very short period of time.

REFERENCES

AlRafea, K., Fowler, M., Elkamel, A., & Hajimiragha, A. (2016). "Integration of renewable energy sources into combined cycle power plants through electrolysis generated hydrogen in a new designed energy hub". *International journal hydrogen energy*, 16718-16728.

Amusat, O., Shearing, P., & Fraga, E. (2016). "Optimal integrated energy system design incorporating variable renewable energy sources". *Computer and chemical engineering*, 21-37.

Araujo, C., Almeida, M., Braganca, L., & Barbosa, J. A. (2016). "Cost-benefit analysis method for building solutions". *Applied energy*, 124-133.

Brown, M., & Ulgiati, S. (2016). "Energy assesment of global renewable sources". *Ecological Modelling*, 148-156.

Ilicak, m. (2014). "Energetics and mixing efficiency of lock-exchange flow". *Ocean modelling*, 1-10.

Jena, J., & Misra, R. D. (2014). "Effect of fuel oxygen on the energetic and exergetic efficiency of a compression ignition engine fuelled separately with and biodiesels". *Energy*, 411-419.

Kasa, S., Ramanathan, P., Ramasamy, S., & Kothari, D. (2016). "Effective grid interfaced renewable sources with powe quality improvement using dynamic active power filter". *Electrical power and energy systems*, 150-160.

Kayser, D. (2016). "Solar photovoltaic projects in China: High investment risks and the need for institutional response". *Applied energy*, 144-152.

Kordik, J., Travniček, Z., & Pavelka, M. (2015). "Energetic efficiencies of synthetic and hybrid synthetic jet actuators driven by electrodynamic transdrucers". *Experimental thermal and fluid science*, 119-126.

Li, J., Guo, H., & Huang, S. (2016). "Powe generation quality analysis and geometric optimization for solar chimney power plants". *Solar energy*, 228-237.

Li, W., Wei, P., & Zhou, X. (2014). "A cost-benefit analysis of power generation from commercial reinforced concrete aolar chimney power plant". *Energy conversion and management*, 104-113.

Lia, C., Ertesvag, I., & Zhao, J. (2013). "Energetic and exergetic efficiencies of coal-fired CHP plants used in district heating system of China". *Energy*, 671-681.

Marković, D. (2010). *Procesna i energetska efikasnost.* Beograd: Univerzitet Singidunum.

Rajani, S. V., & Pandya, V. (2016). "Experimental verification of the rate of charge improvement using photovoltaic MPPT hardware for the battery and ultra capacitor storage devices". *Solar Energy*, 142-148.

Sam Aflaki, S. N. (2016). Strategic Investment in Renewable Energy Sources: The Effect of Supply Intermittency. *SSRN*.

Yuksel, I. (2015). "South-easter Anatolia Project (GAP) factor and energy management". *Energy reports*, 151-155.

Zarcone, R., Brocato, M., Bernardoni, P., & Vincenzi, D. (2016). "Building integrated photovoltaic system for solar infrastrcture: Liv-lib project". *Energy procedia*, 887-896.

Zikic, S. (2016). Renewable energy sources as important factor of the long-term sustainable development concept in the Republic of Serbia . *Computational Engineering in Systems Applications (Volume II)*.

Zorita, A., Fernandez-Temprano, M., Garcia-Escudero, L.-A., & Duque-Perez, O. (2016). "A statistical modeling approach to detect anomalies in energetic efficiency of buildings". *Energy and buildings*, 377-386.

PAPER AND MUNICIPAL WASTE MANAGEMENT IN THE REPUBLIC OF SERBIA AND EU PRACTICES

Golub Markovic[1],
[1]Bunzl &Biach ltd.
**Corresponding author, e-mail: markovicgolub1@gmail.com

Abstract: *This work reviews the state of things in the Waste Paper Management in Serbia and Countries in the Region; unexploited potentials, limitations, challenges and the particulars have been addressed. The main intention of this work is to raise people's awareness about the importance this issue has on the entire society as well as to demonstrate specific ideas to responsible institutions which develop strategies in this area for businesses and citizens alike. Additionally, this work will demonstrate the position of Serbia in regard to Countries in the Region and there is no question that in respect to Waste Paper Collection and Packaging Waste Collection, it significantly lags behind the EU member countries. The work highlights the segment of the Primary Collection of Municipal Waste, that has not yet been established in Serbia and represents the basis for further developments in this area, and certainly a great potential from both the ecological and economic aspect.*

Keywords*: waste paper, municipal waste, primary collection, recycling, European objectives and norms.*

1. INTRODUCTION

Waste paper, as one of the key, and by nature the most common components of the packaging waste has for years been taking the lead in the placement of the packaging waste in the secondary materials market both ecologically and economically. The graphic- paper market is experiencing a growing global expansion. The factories producing packaging paper are registering a sustained increase in this branch, production capacity of the finished goods is reached in over two months, which is unusual. It is well known that waste paper is a deficient raw material in the Packaging Waste Paper Market in Serbia as well as in the Region. This is best demonstrated by the fact that in the course of the last ten years many factories opened only in Europe (container board producers)and with considerable capacities, especially in Austria (Posch, Brudermann, Braschel & Gabriel, 2015). Consequently, the increased demand for the Production of Packaging Paper was created by the Manufacturers of Transport and Commercial Packaging (corrugated board producers) which are using precisely packaging materials as the basic raw material. The manufacturers of storage boxes have a continuously rapid growth in demand for their products. This increased growth can mostly be attributed to the development of Electronic Commerce. In addition to empowering the giants of this industry (Amazon, E-bay), a large number of new online trade portals offering online services have opened up and so this market continues to grow. Retail giants have also developed online grocery shopping. All those aspects contributed to the growing need for packaging (boxes). From a book ordered through Amazon, to a consumer basket in the commercial market, a box has become necessary for everything. That trend was a turning point in the Paper Industry and also greatly contributed to its expansion. One of the influences of this trend was an increase in the generation of packaging waste, especially waste paper. The generation of waste paper has been on an increase in the last 15 years. (Andersen, Larsen, Skovgaard , Mol, & Isoard, 2007).

Waste paper has been receiving an increasing attention and gaining an ever-expanding role by the generators of this raw material (trade chains, print shops, cardboard factories, other industries' manufacturers, etc.). The demand for waste paper (practically all its classes) has been on the increase, in the European market it has been record- breaking, especially in the last five years. This is best witnessed by the various stock exchange indexes (f.e.FOEX PIX) where prices of waste paper per ton recorded very high levels causing a real headache to the European Packaging Paper Manufacturers since the waste paper procurement accounts for over 40% of the factory's total costs (Sauvageau, & Frayret,2015). In this respect, this trend has interested all participants in the waste paper market (generators, collectors, dealers, recyclers, green-dot companies) to direct the focus of their attention to this fragment of packaging waste. Interest has flourished, the possession of waste paper means power. There is no problem in the sales of this fragment of packaging waste, it is merely essential to find the most profitable way of acquiring the volumes waste paper to procure. The growth expansion of the paper recycling industry is endless, and managing this strategic raw material is an issue of great importance for the economy of a country.
Altogether, waste paper is the most important raw material in the world for the paper and cardboard industry (Ervasti, Miranda & Kauranen, 2016).

Further in this work, a concise comparison of Municipal Waste Management in Serbia and our environment will be presented, that will clearly illustrate how many countries, primarily the member countries of the European Union have exploited their own capacities and raised awareness about the importance of collection and recycling to an entirely new level, and that in themselves represent a possible future steps Serbia could follow in order to find herself on this path.

2. BASIC HYPOTHESES AND METHODS

In this chapter it will be summarized the importance of waste paper collection in Serbia. Managing this fragment of packaging waste is of key importance for several reasons:

- Ecological:

Improvements to the Packaging Waste Management System in order to increase the amount of collected waste and reduce the amount of waste that ends up in the landfill. With continuous and adequate investing in the Packaging Waste Management System, it is expected that the National Objectives in this domain will be on an increase from year to year. Significant amounts of waste paper end up on local landfills mixed with organic waste. As such, they are not usable for recycling in paper and cardboard factories. On the other hand, the environment is being polluted with unnecessary waste that is in itself recyclable. It is important to point out that one of the main reasons for increased recycling is precisely because it is the best alternative to burning when it comes to the impact on global warming and acidification of the environment (Schmidt, Holm, Merrild, & Christensen, 2007).

- Economic:

The issue of waste paper sales in the domestic and foreign market is practically non - existent. There are two large waste paper recyclers on the Serbian Market that are forced to import waste paper in order to satisfy the production needs. Therefore, every additional collected ton of waste paper has a guaranteed placement in the Serbian Market, and the secret lies within collecting, that is, within exploiting the potential that the Serbian Market has to offer.

- Social:

For a contemporary Society, awareness about the importance of Environmental Protection is a prerequisite for sustainable development. It is very important to educate new generations about importance of the renewable materials that are the basis for the sustainable development of the Society / Country as well as for the preservation of its natural resources, flora and fauna. The educational system is crucial, especially as far as the waste paper is concerned (Hanan, Burnley, & Cooke, 2013). The waste paper used to be traditionally collected in various ecological actions (schools, recycling islands, green days, etc.), but the consciousness in our region has not taken root not in the least as in has in the countries of the EU. The primary selection of packaging waste is very underdeveloped in the territory of Serbia, and one of the causes for this is exactly the underdeveloped awareness of the society as well as the lack of adequate techniques. This is an issue of great importance for the Society and appropriate steps must be taken in resolving this issue.

- Integration with European Union:

One of the key chapters in European Integration is precisely Environmental Protection and Renewable Energy Sources. There are many norms that must be met in order for Serbia (and other Countries alike) to become a full member of the European Union. Just in the waste paper collection per capita, Serbia considerably lags behind the EU Member States. According to the European Union's Community Waste Strategy, various treatment and disposal methods have been altered to superior levels/ higher waste management hierarchy that implies (Koufodimos & Zissis, 2002):

  - prevention/reducing landfill waste,
  - the Methodology of Utilization of Waste and Recycled Materials,
  - reducing the burning of waste materials as the means of prevention of global warming

This new philosophy has been adopted by most industrialized countries and promotes Environmentally Safe Waste Management, while at the same time maximizing renewable sources/ energy resources. Therefore, the good work in this area represents a necessary component for the key segments of our Society and the Country and the efforts that need to be undertaken shall be multiply profitable.

2.1. Primary collection as a key solution

Collection of Municipal Waste represents the beginning as well as the key activity within the Recycling. Raising awareness of the people and the use of appropriate techniques for the Primary Sorting of the Municipal Solid Waste's main fractions (paper, foil, plastic, glass, other waste) is the basis for the use of Renewable Resources (Pires, Martinho & Chang, 2011). This system has not been adequately implemented in Serbia and almost all municipal waste that is generated in households ends up in local landfills, mixing with organic waste and becomes unusable. There is place for the waste paper, as well as for foil, plastic and glass in the domestic and foreign markets alike. If we were to draw conclusions from waste paper only, that instead of ending up in landfills could be collected and sold to domestic recyclers, the multiple benefits would be achieved (Rigamonti, Ferreira, Grosso & Marques, 2015):

- The lifespan of a landfill would extend and the domestic potential would be exploited,
- The amounts of collected waste paper would increase,
- Domestic recyclers would realize cheaper procurement (waste paper from domestic markets is always cheaper in comparison with the import price), hence, the domestic economy is accelerating and by it the import is reduced as well as the dependency on foreign suppliers.

It is becoming obvious that it is necessary to move in the direction of the development of the strategic projects that would offer Serbian population the possibility to select the household waste, motivate them for such tasks, in time essentially generate awareness of how important this issue is for them, for future generations, that in this way we are giving a chance to Sustainable Development. Apart from the technicalities (selection baskets etc), it is necessary to apply other means of motivation that would contribute to the expansion of this segment in an adequate way. There exist already elaborated methods that ware widely applied in the EU Member States, such as stimulating financial measures for households, various eco- actions, student and school organizations etc. Since the Early 90' many EU Countries had a well-regulated legislation that defined the obligations of the Households Waste Management (Dahlén, Vukicevic, Meijer, & Lagerkvist, 2007).

2.2. EU members as a good practice examples

The issue of municipal waste has been recognized as one of the key topics of Environmental Protection in the EU, bearing in mind that this applies to very large quantities generated in the EU. In 2011 alone, over 252 million of municipal waste was generated in EU Member States (Da Cruz, Ferreira, Cabral, Simões, & Marques, 2014). What are the results and examples of good practice when it comes to primary collection in EU member states (Seyring, Dollhofer, Weißenbache, Herczeg, McKinnon, & Bakas, 2015):

- Countries that have introduced mandatory separate collection of a particular municipal solid waste fraction have reached a high recycling levels of municipal waste. Primary collection significantly contributes and ensures the achievement of the objectives for the preservation of landfills.

- It is crucial that the technical infrastructure is expanded, as well is informing and motivating users of the system for this kind of collection. Also, a complete System of Municipal Waste Management requires significant investments and the technique must be carefully selected for each site (Ferrão, Ribeiro, Rodrigues, Marques, Preto, Amaral & Lopes, 2014).

- The percentage of recyclable materials increases when municipalities and local governments introduce a door-to-door system. These collection methods lead to the highest recycling achievements and the best quality recyclable materials. The costs of collecting such models are higher than other alternatives, but the collection rates and revenues are also higher, and as a result, the costs of treating such materials are certainly lower (Pires, Sargedas, Miguel, Pina & Martinho2017).

- Implemented systems with sealed separated containers have shown that it is not easy to both encourage the motivate the population to separate their waste and it results in a higher percentage of impurities. However, such systems have proven to be a very reasonable solution for certain fractions (eg. glass).

- Combined collection of recyclable materials is the practice in several member states and results in a reduction in costs, but on the other hand the quality of the collected renewable materials is thus significantly worse. Collecting a dual collection (f.e. plastic and metal) is an adequate way to reduce costs and maintain good material quality. However, mixing several fractions can lead to greater cross-contamination, so the recycling rate of such material from the recycler is considerably higher.

- When a separate collection of biodegradable materials is included in the door-to-door system, the entire sorting of dry recyclables is increased (and other fractions).

- Municipal Solid Waste Collection Centers have the potential to improve the overall recycling rate provided they have adequate space for sorting a large number of different fractions of renewable materials. Each collection center must be specifically adapted depending on the territory of the area for which it is competent (Ramos, Gomes, & Barbosa-Póvoa, 2014).

- The trend in Recycling Markets (Recyclers) will continue to move towards increase in the demands of higher quality materials and larger volumes, which is why adequate collection is of primary importance.

3. RESULTS REVIEW

The importance of the Collection of Packaging Waste with the emphasis on the necessity of Primary Collection (municipal waste) is demonstrated in the previous chapters. In this chapter, the position of Serbia (a comparison) will be demonstrated, according to the two determining factors in the Municipal Waste Management:

- The amount of generated / collected municipal waste (kg per capita)
- The amount of municipal waste that manages to be recycled (kg per capita)

Table 1: Municipal waste generated by the Country (kg/per capita) in the1995 - 2016 period (EUROSTAT, 2015)

	1995	2000	2005	2011	2016	Change (%) 1995-2016
EU-28	473	521	515	498	480	:
Belgium	455	471	482	456	420	-7,7
Bulgaria	694	612	588	508	404	-41,8
Czech Republic	302	335	289	320	339	12,2
Denmark	521	664	736	781	777	49,2
Germany	623	642	565	626	626	0,5
Estonia	371	453	433	301	376	1,3
Ireland	512	599	731	617	:	:
Greece	303	412	442	503	497	64,0
Spain	505	653	588	485	443	-12,3
France	475	514	530	534	510	7,3
Croatia	:	262	336	384	403	:
Italy	454	509	546	529	495	9,1
Cyprus	595	628	688	672	640	7,6
Latvia	264	271	320	350	410	55,1
Lithuania	426	365	387	442	444	4,2
Luxembourg	587	654	672	666	614	4,5
Hungary	460	446	461	382	379	-17,6
Malta	387	533	623	589	647	67,0
Netherlands	539	598	599	568	520	-3,6
Austria	437	580	575	573	564	29,0
Poland	285	320	319	319	307	7,9
Portugal	352	457	452	490	:	:
Rumania	342	355	383	259	261	-23,7
Slovenia	596	513	494	415	466	-21,8
Slovakia	295	254	273	311	348	18,1

Finland	413	502	478	505	504	22,1
Sweden	386	428	477	449	443	14,8
Great Britain	498	577	581	491	:	:
Iceland	426	462	516	495	656	36,9
Norway	624	613	426	485	754	-32,5
Switzerland	600	656	661	689	720	20,9
Serbia	:	:	:	**375**	**268**	:

In 19 out of 31 Countries (Member States of EFTA), the amount of generated municipal waste per capita has an increasing trend between the years 1995 and 2016.
This parameter speaks volumes about the current state of things in the Municipal Waste Management System, as well as reflecting the economic situation of the said country because the greater the collected/ generated municipal waste the greater the consumption, that is the purchasing power of the population.

As can be concluded from the attached table, Serbia significantly lags behind in this segment in comparison with EU member states. In 2016, the average generation or collection of municipal waste amounted to only 268 kilograms per capita. Apart from Romania, which also has an unresolved issue of Municipal Solid Waste Collection, Serbia is well below the European Average with a negative trend when the years 2011 and 2016 are compared.

Following is graphic representation that will be presented below (figure 1) which percentage of collected / generated municipal waste is recycled or reused. This data represents the key parameter of rounding up the municipal waste management process, since the essence and main objective is to reuse the waste from households that the population is sorting (the methods were discussed in previous chapters).

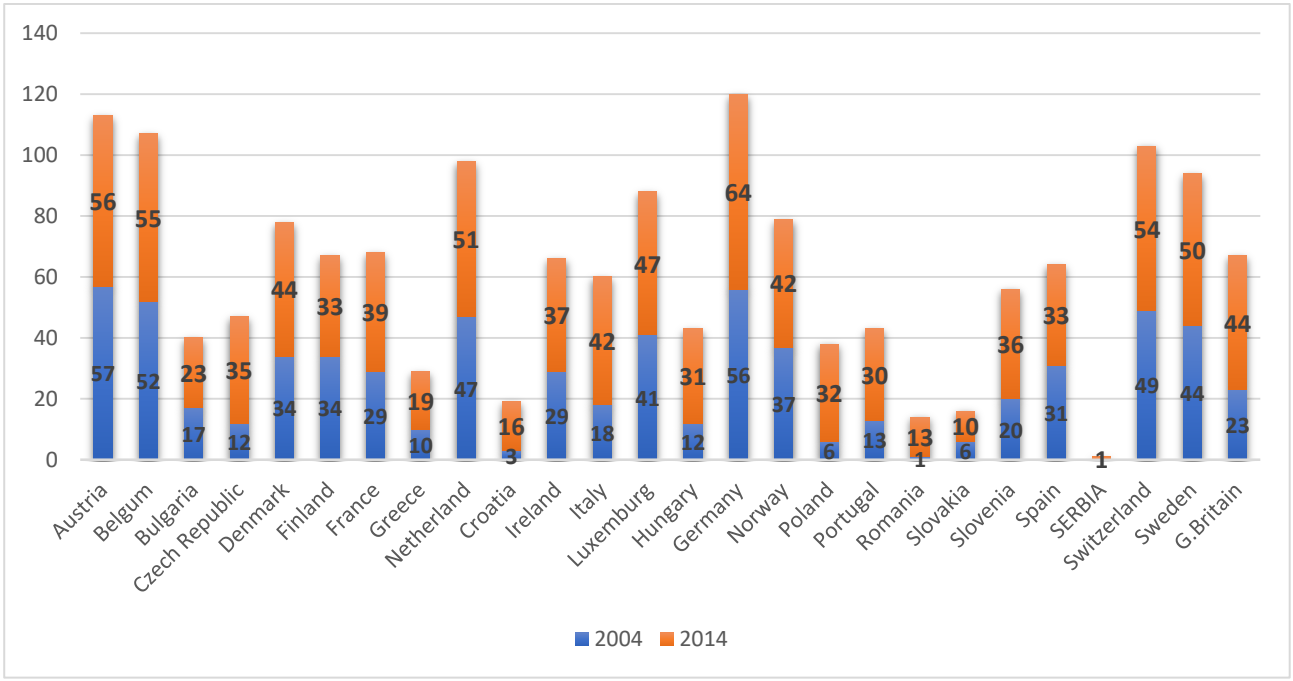

Figure 1: Municipal Waste recycled by the Country (kg/per capita) parable 2004/2014

From the attached Chart it can be concluded:

- Germany, Austria, Switzerland, Netherlands and Sweden are leading in the recycling of their municipal waste in 2014
- In general, 15 out of 32 EEA member countries, have increased the rate of Municipal Waste Recycling in the last 15 years.

In 2015, the European Commission has set out new Objectives for Municipal Solid Waste that account for 60% of recycling and preparations for reuse by 2025 and 65% by 2030 (Groot, Bing, Bos-Brouwers & Bloemhof-Ruwaard, 2014). In addition, new methods for reducing municipal waste that are deposited in landfills have been adopted.

Unfortunately, Serbia has virtually no Recycling of Municipal Waste, but essentially all municipal waste ends up at local landfills. This is a big problem for the State and Society.
Austria, Belgium, Denmark, Germany, the Netherlands, Norway, Sweden and Switzerland, minimize the amount of municipal waste to landfills. The benefits of this type of municipal waste management was addressed in Chapter 2.2.

When it comes to waste paper, this branch of packaging waste represents the largest amount collected on average in over 28 major European cities. Waste paper is the most important component of Municipal Waste (Rahman, Hussain & Basri, 2014). Waste paper has a long tradition in most cities, and a long history in the recycling process itself. In EU countries, paper is mostly collected by door-to-door collection systems, selection baskets that are later transported to collecting centers for municipal waste collected from citizens. As has been said in the introduction to this paper, waste paper has the highest rate of generation between all other fractions of packaging waste. Cities that have a successful waste paper collection system and recorded record highs are: Ljubljana, Tallinn, Helsinki, Riga and Berlin, which manage to collect more than 65% of generated paper / cardboard. (EUROSTAT, 2015), while in the territory of Serbia, the national target for 2016 is 42% and for 2017 it is 47%. For all fractions of packaging waste, the national goal of Serbia for 2016 is that the re-utilization rate reaches 44%, and for recycling 36% (Redžić & Misajlovski, 2016).

4.DISCUSSION

In general, the EU 2020 Strategy provides a guide to a sustainable society with the efficient use of resources. It sets goals and means for transforming the current economy, based on the intensive use of resources, to a new growth model for the efficient use of resources where municipal waste is again involved in the production process for the production of new products or raw materials (Expósito & Velasco, 2018)

The basic question that arises is how to approach the European Union Standards of Municipal Solid Waste and Paper Waste Management? Serbia has all the preconditions to be on an enviable level in this regard, especially when it comes to waste paper. There are two large recyclers in Serbia, with production capacities that exceed the generation of old paper on the domestic market, guaranteed placement and disposal / processing of waste paper has been solved. This is a huge advantage in comparison to the countries that do not have a domestic recycler (example: Montenegro) or countries whose processing / recycling capacity is less than the quantities generated in a given market (for example: Italy), and are forced to export their quantities to the markets where the need is greater than local generation.

This paper recommends to follow in the already familiar footsteps of EU Member States in relation to projects concerning the Primary Collection of Household Generated Municipal Solid Waste. This is the key to the solution of all the problems and it is precisely this question which the basis for further progress in the field of Municipal Solid Waste Management is. During this work, the benefits of investment to such a system were addressed. The return of investment from the economic side is certainly visible and observed from the Social and Environmental as well as sustainable development aspect, these projects are a necessity.

5. CONCLUSION

This paper presents a concise representation of trends in the EU regarding Waste Management, focusing on the Waste Paper, and addressing the current position of Serbia within this segment. Current results show that Serbia has a good predisposition to find itself in the company of successful countries on this issue, but the big disadvantage lies in the very foundation, which is the Primary Collection of Household Waste.

Many developed countries have recognized the importance of an organized Packaging Waste Collection System, focusing on the Primary Collection of Household Waste, the transport to collection and municipal centers, further treatment and recycling. The EU countries have exploited the potentials of the domestic market, set up the right methods that motivate the citizens, private and social sector, all stakeholders to follow the rules of the System and in doing so the entire chain benefits addressed in the Chapter 2 of this work. Already today, enviable results or records have already been recorded in the waste paper collection per capita, the coverage of the accumulation of waste paper in relation to its generation, to enviable levels of renewal of Package Waste Recycling that exceeds 60% in the EU countries. The Municipal Waste Management Systems have been practically brought to their impeccability. Achieved material and non-material benefits are priceless, for the economy and for the future generations. Process of change of some integrated way and awareness of the benefits of this issue are neither cheap not simple. Projects of this kind call for great financial investments as well as education of the citizens and all relevant participants. Primary Selection of Municipal Waste is a necessity and a predisposition if we are to make a move in the right direction.

Serbia is sooner or later waiting for a solution to solve the municipal waste management waste management as a precondition for European integration, only this time it is something we must recognize as a society on our own and make a choice from an economic point of view as well as ecologically a prerequisite for European integration, but this time something that we, as a society, should recognize and choose from, from the economic point of view, the point of view of environmental protection and sustainable development.

REFERENCES

Andersen, F. M., Larsen, H., Skovgaard , M., Mol, S., & Isoard, S. (2007). A European model for waste and material flows. Resources, Conservation and Recycling, 421–435.

Dahlén, L., Vukicevic, S., Meijer, J.-E., & Lagerkvist, A. (2007). Comparison of different collection systems for sorted household waste in Sweden. Waste Management, 1298–1305.

Da Cruz, N. F., Ferreira, S., Cabral, M., Simões, P., & Marques, R. C. (2014). Packaging waste recycling in Europe: Is the industry paying for it? Waste Management , 298–308.

Ervasti, I., Miranda, R., & Kauranen, I. (2016). A global, comprehensive review of literature related to paper recycling: A pressing need for a uniform system of terms and definitions. *Waste Management*, *48*, 64-71.

EUROSTAT. (2015). Packaging waste statistics. Retrieved f: Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging_waste_statistics&oldid=223528

Expósito, A., & Velasco, F. (2018). Municipal solid-waste recycling market and the European 2020 Horizon Strategy: A regional efficiency analysis in Spain. *Journal of Cleaner Production*, *172*, 938-948.

Ferrão, P., Ribeiro, P., Rodrigues, J., Marques, A., Preto, M., Amaral, M., ... & Lopes, A. (2014). Environmental, economic and social costs and benefits of a packaging waste management system: A Portuguese case study. Resources, Conservation and Recycling, 85, 67-78.

Groot, J., Bing, X., Bos-Brouwers, H., & Bloemhof-Ruwaard, J. (2014). A comprehensive waste collection cost model applied to post-consumer plastic packaging waste. Resources, Conservation and Recycling, 85, 79-87.

Hanan, D., Burnley, S., & Cooke, D. (2013). A multi-criteria decision analysis assessment of waste paper management options. Waste Management, 566–573.

Koufodimos, G., & Zissis , S. (2002). Waste management options in southern Europe using field and experimental data. Waste Management , 47-59.

Merrild, H., Damgaard, A., & Christensen, T. (2008). Life cycle assessment of waste paper management: The importance of technology data and system boundaries in assessing recycling and incineration. Resources, Conservation and Recycling, 1391–1398.

Pires, A., Sargedas, J., Miguel, M., Pina, J., & Martinho, G. (2017). A case study of packaging waste collection systems in Portugal–Part II: Environmental and economic analysis. *Waste Management*, *61*, 108-116.

Pires, A., Martinho, G., & Chang, N.-B. (2011). Solid waste management in European countries: A review of systems analysis techniques. Journal of Environmental Management, 1033-1050.

Posch, A., Brudermann, T., Braschel, N., & Gabriel, M. (2015). Strategic energy management in energy-intensive enterprises: a quantitative analysis of relevant factors in the Austrian paper and pulp industry. *Journal of Cleaner Production*, *90*, 291-299.

Rahman, M. O., Hussain, A., & Basri, H. (2014). A critical review on waste paper sorting techniques. International Journal of Environmental Science and Technology, 11(2), 551-564.Chicago

Ramos, T. R. P., Gomes, M. I., & Barbosa-Póvoa, A. P. (2014). Assessing and improving management practices when planning packaging waste collection systems. Resources, Conservation and Recycling, 85, 116-129.

Redžić, N., & Misajlovski , N. (2016). Izveštaj o upravljanju ambalažom i ambalažnim optadom u Republici Srbiji. Beograd: Ministarstvo Poljoprivrede i zaštite životne sredine.

Rigamonti, L., Ferreira, S., Grosso, M., & Marques, R. C. (2015). Economic-financial analysis of the Italian packaging waste management system from a local authority's perspective. Journal of Cleaner Production, 87, 533-541.

Sauvageau, G., & Frayret, J. M. (2015). Waste paper procurement optimisation: An agent-based simulation approach. European Journal of Operational Research, 242(3), 987-998.

Seyring, N., Dollhofer, M., Weißenbache, J., Herczeg, M., McKinnon, D., & Bakas, I. (2015). Assessment of separate collection schemes in the 28 capitals of the EU. Brussels: ENV, European Commission & DG Copenhagen resource institute.

Schmidt, J., Holm, P., Merrild, A., & Christensen, P. (2007). Life cycle assessment of the waste hierarchy – A Danish case study on waste paper. Waste Managemen, 1519–1530.