TECHNOLOGY AND INNOVATION MANAGEMENT

SUSTAINABLE TECHNOLOGY MANAGEMENT AND DEVELOPMENT - STATE, UNIVERSITY AND INDUSTRY PERFORMANCE MODEL

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Abstract: *In this paper a general model is created for measuring the performance of Technology and Innovation Management (TIM) related to the crucial dimensions/elements of the Triple Helix (TH) model. More precisely, the Triple Helix Model (high education – government - industry) is analysed in relation to its fulfilling the three main functions of TIM: planning, organizing and control (POC). The general model – TMD-TH (Technology Management and Development – Triple Helix) represents the framework for further more specific research into the relations of the observed dimensions. The general model is further divided into sub-models: TMD-G, TMD-U and TMD-I, where G stands for government, U stands for university and I denotes industry. The sub-models are to be investigated in more detail and the research results will be presented in separate papers. In the general model, the performance of each TH dimension is to be monitored by a set of indicators classified into categories according to the specific management function (POC) of TIM. The general model enables better systematisation of the indicators of TIM with links established with the main roles of the actors in the TH model. When applied in concrete situations in practice, at the level of national economy, the results obtained represent a base for developing policies and strategy that will be oriented at introducing change in the domains of highest priority in the aim of achieving more efficient and effective results in sustainable development.*

Keywords*: Triple-Helix (TH) concept, Sustainability, Technology and Innovation management (TIM), General model, Performance Indicators*

1. INTRODUCTION

In the dynamic global environment, with continuous and exponential technological growth and development, the relevance of the research conducted in managing technology, innovation and change is of high priority. The ultimate goal of achieving global competitiveness of firms and economies means that one of the crucial competitive factors today, technology and innovation, is to be managed by closely measuring, monitoring, controlling its performance. Why is managing technology so important? As stated in (White & Bruton, 2007), the necessity for technology management lies in: (a) the rapid pace of technological changes which require multidisciplinary approaches; (b) the rapid pace of technological development which shortened product life cycles; (c) the need to cut time for product development and create more flexible organizations; (d) the necessity to maximize competitiveness effectively by using new technologies; (e) the importance of changing management tools caused by rapid technology changes. Technology and innovation is placed at the centre of the policies and strategy developed for firms, industries, national economies, regions, sectors, etc. In this paper we develop the general model of sustainable technology and innovation management based on the assertion that it is the management of technology and innovation, not just the new technologies themselves, that represents the true competitive force leading to sustainable development.

Effective TIM is dependent on the capacities to measure and monitor performance which is not an easy task having in mind the interrelatedness of the activities, the time dimension and delays inherent to research and development inputs and effects, synergies, etc. Up to now, in both practice and theory, mostly used indicators of technology and innovation management (TIM) were related to research and development (R&D) activities, intensity of technology changes and degree of implementing innovations. The overview of literature in the field of TIM, as evidence of theoretical and empirical studies, shows that it is necessary to develop a complete, comprehensive approach. In this paper, an original attempt is made to classify and systematize TIM indicators according to basic management functions - planning, organizing and control (POC) linked to the performance of Triple Helix (TH) actors. The role of TIM as key factor in accomplishing sustainable development is clearly pointed out in theory and justified in practice, as sustainable new technologies and innovation lie at the core of economic, social and technological progress. The capacities and competencies in managing technologies are becoming at least as important, if not, even more significant than the capacities of the technologies, *per se*. TIM performance is measured and tracked by indicators at different levels: national economy, economy sectors, and companies. In this way, priorities are set for future actions in order to improve management areas that are not developed enough, and to achieve the overall goals of efficiency and effectiveness of technology management at all levels.

The perspective of sustainable development requires an overall approach, encompassing indicators classified by using the Triple Helix concept (Etzkowitz & Leydesdorff, 1995). The TH comprises the hybridization of three dimensions/elements university, industry and government in order to generate new institutional and social formats for the production, transfer and application of knowledge (The Triple Helix Concept, 2013).

The basic hypothesis and assumptions elaborated in this paper are the following:

General hypothesis:

1. Technology management and entrepreneurship is as important as development of technology, *per se,* for sustainable development, and

Special hypothesis and assumptions:

1. TH model is a basic model for sustainability and TIM indicators are established according to the dimensions/elements of TH,
2. TIM functions, elaborated by POC, classified according to TH dimensions/elements, enable the establishing of the comprehensive, general model,
3. The general model with feedback relations is applicable for effective strategic management in the state, university and industry domains,
4. Application of the model with systematized indicators in practice is a valuable tool for more effective strategic analysis, establishing policies and strategy and their implementation, with specific tasks for TH-state, university and industry related to different functions of TIM.

In this paper, the authors have created a new general cross-functional model for measuring sustainable technology management and development, TMD-TH, based on two concepts: (1) TH concept with three dimensions: university, industry and government; (2) management concept based on three management functions – planning, organizing and control.

2. THE PRODUCTIVITY PARADOX AND THE TRIPLE HELIX CONCEPT

Building knowledge-based economy and society in the traditional sense is not sufficient enough for substantial economic and social progress and development. Theoretically and in practice it has been discovered that, despite the undoubtedly central role of investments in new knowledge in economic growth, there is still a neglected, missing link to economic growth, employment opportunities and international competitiveness. (Levi Jakšić et al., 2011a)

The productivity paradox detected in the 1950s discovered a new phenomenon: the investments in physical capital were increasing, but the productivity indicators decreasing (Bailey, M. N., Chakrabarti, A. K., 1988, pp.5). The fact that intangible components have been neglected showed that a new perspective and paradigm was necessary. The Japanese management approaches that emphasize the «soft» elements had proved effective and were pouring into Europe (especially Sweden, Germany) in the 1960s and by the mid-1970s in the United States emerged the shift of focus towards intangible assets. Knowledge, creativity, ideas and knowledge based capabilities and skills were found to have been neglected whereas resulting in productivity slowdown while the physical capital investments were still growing. This result pointed out to intangible technology components and knowledge as inevitable in economic growth models (Levi Jakšic, 2011).

The scholars were quick to point to the common denominator for success: a shift away from the factor of physical capital towards knowledge capital, which generally consists of: science, technology, creativity, ideas. (Acs, Z.J., Audretsch, D. B., Strom, R. J, 2009., p. 7) Different forms of knowledge capital alone were obviously not sufficient in creating competitive strength and firm growth. Technology as the integrative concept emerged, consisting of physical/tangible and intangible elements. This opened a new perspective in understanding the forces of competitiveness in the detailed analysis of the factors relevant to technological progress and growth.

The productivity paradox of the sixties has evolved as the Swedish paradox in the last decades of the past century – «as measured by the most common benchmarks of knowledge investments, such as R&D, university research, patents, human capital, education, creativity and culture, Sweden has ranked consistently among world leaders. However, following more than a decade a stagnant growth and rising unemployment, concerned policymakers in Sweden started to worry about what they termed as «the Swedish paradox».(Acs, Z.J., Audretsch, D. B., Strom, R. J, 2009., p. 7) Detecting of the persistent stagnant economic growth despite high levels of knowledge investments...for the European context, had been termed the European Paradox. (Acs, Z.J., Audretsch, D. B., Strom, R. J, 2009., p. 7)

The new approaches show a clear turnaround focusing on soft elements not only in the form of intangible assets but involving also management principles and practices, entrepreneurship, leadership and emergence of technological rather than technical dimensions at the focus of competitiveness (Levi Jakšić, 2011).

Evidence from the case of Serbia clearly points to the very explicit roles of entrepreneurship that are missing in a country where resources are invested in scientific research but not effectuated in the economy and society. The indicators show that although intensive research in Serbia, when it comes to practical results and commercialization, the R&D phases of innovation lack entrepreneurship. In more detail it is shown that there is very low correspondence between fundamental and applied research. The links between the phases of Research, Development, Commercialization are in need of entrepreneurial cohesion. The entrepreneurship roles are viewed as necessary links to be introduced as follows: Research-Entrepreneurship-Development-Entrepreneurship-Commercialization (Levi Jakšić, 2011).

In the document presented in 2010 by the Ministry of science and technological development of the Republic of Serbia, «Strategy of Scientific and Technological Development of the Republic of Serbia», it is cited that one of the most serious problems of science in Serbia is the fact that a small amount of funds, from mainly one source invested in scientific research are distributed over more than 1 000 projects that were financed by the Ministry in 2009: 501 project of fundamental research for which 50.2% of the budget is allocated and 471 technology development and 129 innovation projects for which 39.2% of the Ministry funds are invested. According to their main definition and goal, the projects of technological development as result are expected to generate applied technological solutions, patents, pilot plants, new sort innovations, technological advancements and results with direct applicability. In the past period, 2003-2007, in the technological development field, over 3400 technical solutions have been realized. But, in spite of the high number of technical solutions, the number of patent applications from research and development institutions in the period of 2003-2009 has been extremely low, only 54. With these results Serbia has the lowest position in Europe.

Serbia is facing the same difficulties as detected for the situation in Europe. ,,The Europe 2020 strategy clearly signalled the importance of industrial competitiveness for growth and jobs as well as for Europe's ability to address grand societal challenges in the coming years. Mastering and deploying Key Enabling Technologies (KETs) in the European Union is central to strengthening Europe's capacity for industrial innovation and the development of new products and services needed to deliver smart, sustainable and inclusive European growth"(HLG on KET Final Report, 2011).

The High-level expert group (HLG) has identified the major difficulties Europe has in translating its ideas into marketable products – in crossing the internationally recognized "valley of death". This situation, namely the gap between basic knowledge generation and the subsequent commercialization of this knowledge in marketable products, has been commonly identified across the KETs and is known in broad terms as the "valley of death" issue. Its effects can include not only relocation of manufacturing and R&D, but also the disruption of entire value chains with their ultimate consequences on the sustainability of various strategic sectors in Europe. The "valley of death" is due to many factors including the absence of smart regulation, the unavailability of pre-commercial R&D support, insufficient access to large scale finance, and lack of political support and pro-active KET. To cross this valley, it recommends a strategy comprising three pillars: a pillar focused on technological research, a product demonstration pillar focused on product development, and a production pillar focused on world-class, advanced manufacturing.

Crossing the "valley of death" in the key enabling technologies in Europe requires the delivery of solutions to the three successive stages implicit in this crossing. The first stage, called "Technological research" consists of taking best advantage of European scientific excellence in transforming the ideas arising from fundamental research into technologies competitive at world level. The second stage, called "Product demonstration" allows the use and exploitation of these KETs to make innovative and performing European process and product prototypes competitive at world level. The third stage, called "Competitive manufacturing" should allow, starting from product prototypes duly validated during the demonstration phase to create and maintain in Europe attractive economic environments in EU regions based on strong eco-systems and globally competitive industries (HLG on KET Final Report, 2011).

Whilst European R&D is generally strong in new KET technologies, the HLG has observed that the transition from ideas arising from basic research to competitive KETs production is the weakest link in European KET enabled value chains. This is demonstrable evidence of the impact to-date of the absence of a major focus on enabling innovation in the EU and an over-emphasis on basic research both within EU research programs and in some Member States. By focusing on these key stages of the innovation chain, the HLG proposals can trigger a virtuous cycle, from knowledge generation to market flow with feedback from the market to knowledge generation support, thereby strengthening economic development in Europe.

Innovation and opportunity at the base of entrepreneurship is viewed in the perspective of the critical role of institutions in the promotion of innovation defined by national innovation systems, and universities that are cited as critical institutional actors in national innovation systems (Mitra, 2011). The Triple Helix concept is used as the general framework emphasizing the network of institutions in the innovation and entrepreneurship system to be viewed and taken into account in relation to the new roles and responsibilities universities take in the modern world. (Levi Jakšić et al., 2012b) The Triple Helix model does not consider manufacturing as the driving force of economic development in the post-industrial stage. It assumes that the creation and dissemination of socially organized knowledge are playing the key role in creating competitive advantage of an economy. In this sense, institutions that generate knowledge increasingly play a role in the networks of relations among the key actors: University, Industry, and Government. In distinction to the knowledge-based system, which can be considered as an outcome of interaction among different social coordination mechanisms (markets, knowledge production, governance at interfaces), the Triple Helix model gives a heuristic for studying these complex dynamics in relation to developments in the institutional networks among the carriers (Leydesdorff & Meyer, 2006) and those components should generate new institutional and social formats for the production, transfer and application of knowledge. Also, the distinction between these entities and their activities are increasingly overlapping. In areas of intersection, the actors can partially substitute for one another (Ivanova & Leydesdorff, 2012).

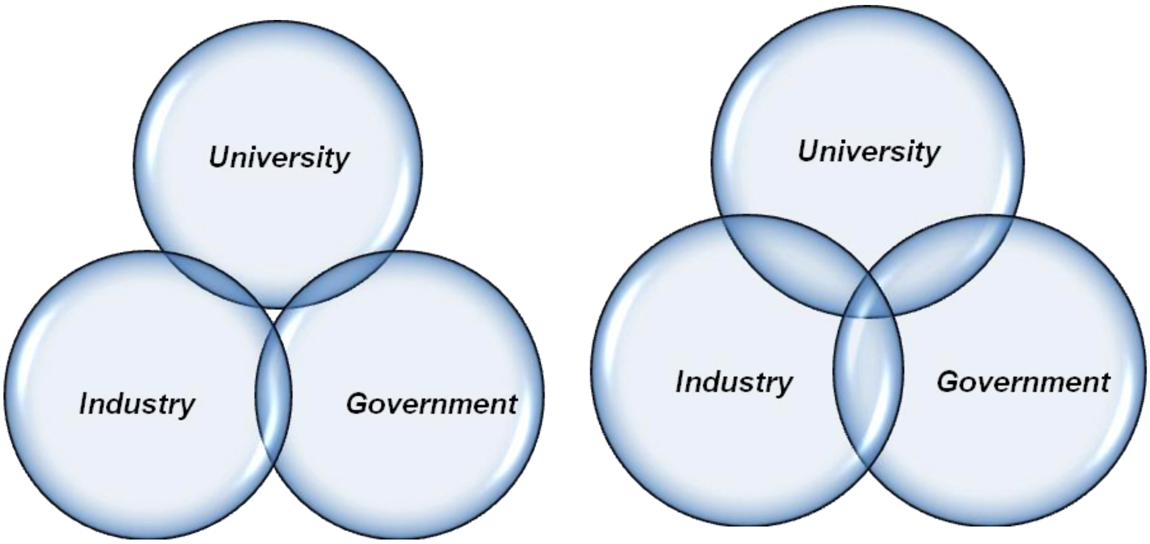

Figure 1: A Triple Helix configuration with negative and positive overlap among the three subsystems (Leydesdorff, 2012b)

The relationship between TH's elements is shown in Figure 1 as alternating between bilateral and trilateral coordination mechanisms or-in institutional terms-spheres. The systems remain in transition because each of the partner institutes also develops its own mission. Because of that, a trade-off can be generated between integration and differentiation, and new systems in terms of possible synergies can be explored and potentially shaped (Leydesdorff, 2012b). TH does not use only economic forces (*Industry*), regulations given by *Government* or research inventions performed by *Universities:* it can combine these categories and focus on examining the dynamics two or even all three components.

TH models can be elaborated in various directions. Networks of university-industry-government relations can be considered as arrangements which can be made the subject of social network analysis. This model can also be used for policy advice about network development, for example in the case of transfer of knowledge and the incubation of new industry. The new role of universities in knowledge-based configurations is the most explored topic among the three TH components, and it can be explored in terms of different sectors, regions, countries etc. (Godin & Gingras, 2000; Shinn, 2002). In some previous research studies (Levi Jakšić et al., 2012a), the thesis was confirmed that there is a constant need to research the universities' role in society, especially the one in practice and compatibility of the practical knowledge with current study programs at different educational levels.

In the TH system, universities have the leading role and this concept assumes that the knowledge universities produce is useful enough to be widely shared and applied, which should lead to national development. Industry operates in the Triple Helix as the place of production, government has the task to create contractual relations that will guarantee stable interactions and exchange, and in the end, the university is the source of new knowledge and technology, the generative principle of knowledge-based economies (The Triple Helix Concept - Theoretical Framework, 2011). The boundary between institutional spheres is blurred, because universities assume entrepreneurial roles by focusing on the production of useful knowledge and its exchange across a wider network of key players in socio-economic system. Also, industry should not only use practical appliance of knowledge, but also producing knowledge with a purpose of creating a wealth. And, finally, government has the task to facilitate interactions of industry and universities by creating policy frameworks for successful functioning of this cooperation. In developing countries, the challenge is to operationalise the TH system in order to provide sustainable basis for wealth creation and poverty reduction (Saad & Zawdie, 2011). Because of that, it is necessary to have some measures and indicators which will show the performance of a country within each TH area. In this paper, we develop a general model that examines all three components of the TH concept, and further research focuses on each component separately.

3. CROSS-FUNCTIONAL TIM MODEL

Technology and Innovation management implies: planning, organizing, leading, directing, organizing, coordinating and controlling all technology activities (operations) with the ultimate goal of providing continuous success (profitability, market share, environmental protection etc.). It includes all technological activities, strategic ones, related to management of technology development, through management of innovation, technology transfer, R&D activities and operational ones including managing a specific technology system, processes and operations as the form of implemented technology. (Levi Jakšić et al., 2011b) TIM, as specific set of competencies in the competency based competitiveness approach, is recognized as the critical success factor for firms, sectors, economies and regions. The integral TIM concept is focused at managing technology as external force and internal factor of the firm meaning that both the innovative and technological infrastructure and the technology and innovative capacities of the firm are taken into account. Managing technological diversification is a significant dimension of the new paradigm leading to operations competitiveness of the firm closely related to its innovative capabilities. (Levi Jakšić et al., 2012a)

In the previous section, it was postulated that the original TH model considers three entities represented in Figure 1. However, in some previous research (Levi Jakšić et al., 2012b), the authors concluded that for the relevant analysis of universities' impact in the economy, society and economic development it is necessary to introduce an extended Triple Helix model with an additional, fourth component - knowledge and science development (**Figure 2**). Its necessity derives from the interrelation between the dynamic category of science and knowledge development results and industry/economy/society sustainable needs with the government special roles in creating policies and funding research and development as well as educational and entrepreneurial activities in the economy and society. This new component influences the development of study programs which have the task to quickly respond to the latest environmental requirements by introducing the latest scientific results and findings in the study programs. In this paper, we examine measuring performance of TIM indicators based on the original TH model, but further research should include the science component, as well, because of its influence and a special role it plays in each of the traditional components of the TH model.

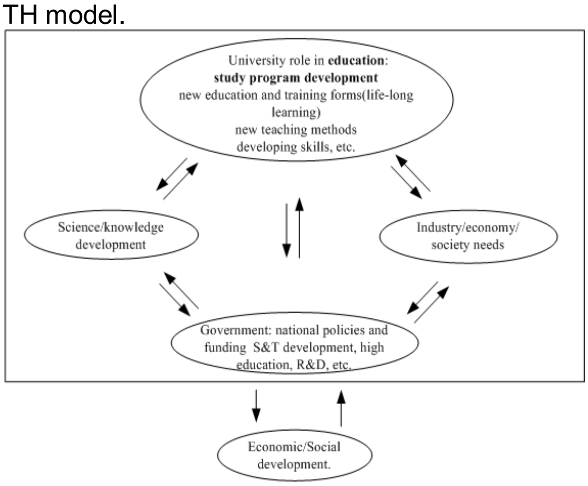

Figure 2: Study program development, Triple Helix and economic development. (Levi Jakšić et al., 2012)

Figure 3 shows the basic cross-functional TIM model, developed from the perspective of the Triple Helix (TH) concept and basic technology management functions. Firstly we have three separate TH entities: Government, Industry and University. Within each of the dimension we measure how successful the entity is in managing technology by evaluating its performance in each management function: planning, organizing and control. In this way, it is possible to view the current state, set the priorities within each category and to determine tasks that have to be performed in order to enhance sustainability based on prioritized actions in certain areas. All these dimensions determine sustainable development, and by using the established model the relevant feedback is possible for effective decision making.

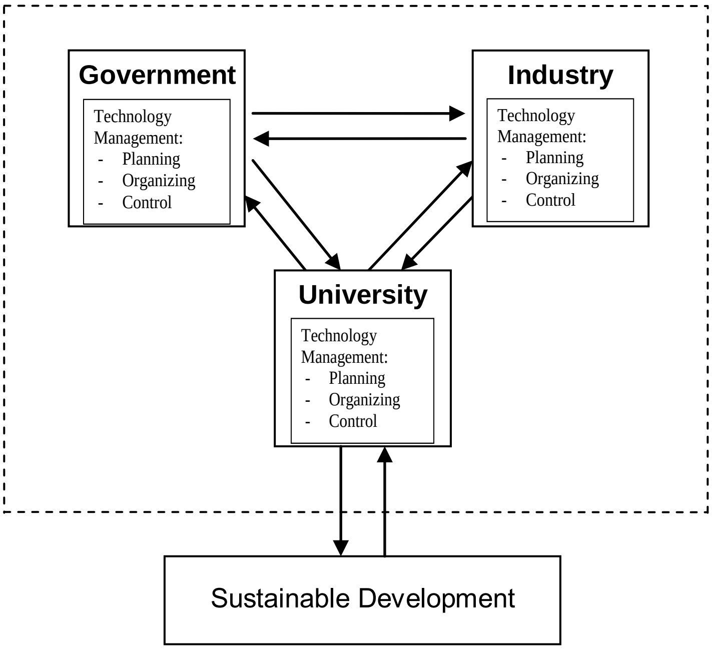

Figure 3: General cross-functional model

At a closer look at the model (**Figure 4**), we can examine in more detail the performance of technology management. Within each TH dimension, performance indicators are divided by basic management functions: planning, organizing and control. Planning activities and indicators are considered as inputs. These indicators measure infrastructure, investments and all other assets that are necessary to execute the main tasks and to achieve the results of the entity. Organizing performance is observed as a process that is transforming inputs (results of planning activities) into outputs..

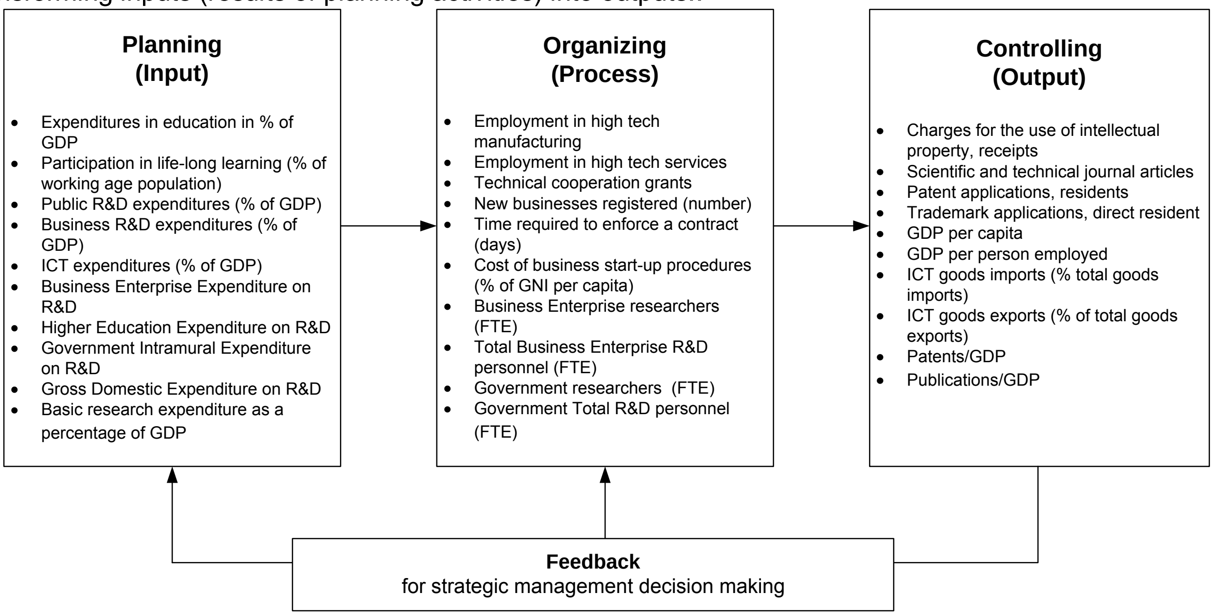

Figure 4: Technology Management Model[1]

[1] Indicators taken from (World Bank Indicators, 2014;EIS Indicators, 2009; Eurostat Indicators, 2014; OECD Indicators, 2014)

And, at the end, control is considered as the result of inputs (planning) and transformation in process of organizing. The control indicators are related to measuring the results of investing and managing (i.e. no. of patents, published papers etc.). These results are providing the feedback which is crucial for further decision making process related to achieving more in the level of sustainability. It should be noted that it is very difficult to separate indicators by these two dimensions (TH and TIM functions), and some overlapping and, the so-called "grey zones" are inevitable (as shown in **Figure 1**), especially in control activities, which are outcomes, the results that cannot be easily assigned to a category. In this case indicators would be repeated and classified in more than one category.

The model is decomposed for each TH component, and each component consists of its own indicators of TIM performance as shown in **Figure 5**.

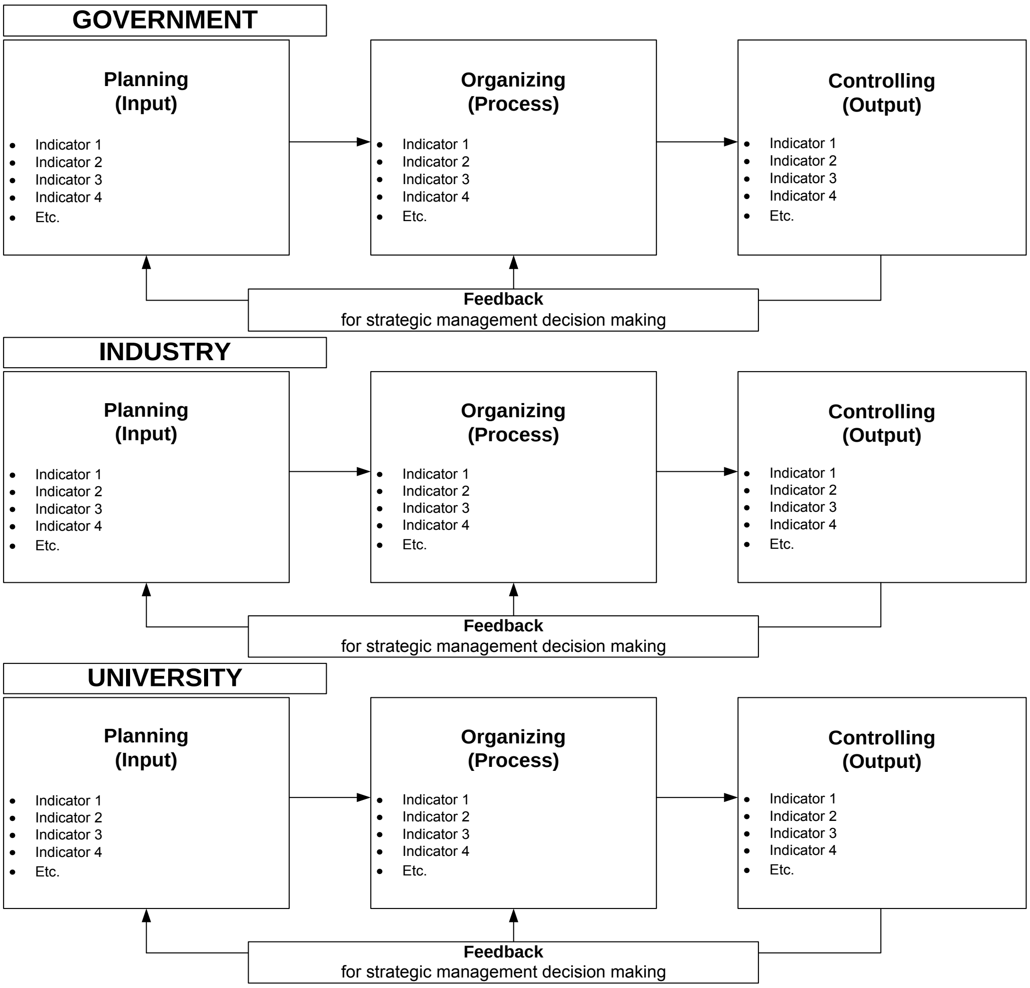

Figure 5: Developed sub-models of TIM model for each TH component

This model not only presents and classifies indicators, but it also highlights the connections that exist between these groups of indicators. At the end, the general model presents a framework for measuring performance of TH entities in TIM at the level of a national economy. It should be noted that the set of indicators may not be the same for each country, because of the specificity of each environment, but the majority will be applicable in most cases. In the general model presented in Fig. 5, the indicators are not specified and it should be noted that they need to be separated by TH components. Every component is to be examined separately and indicators for each management function should be defined. The indicators are developed according to the following criteria: easy measurable, accurate and the relevant data available. The model presented in Figure 4 consists of indicators measured by Eurostat, European Innovation Scoreboard (EIS) World Bank, OECD and similar organizations which provide relevant data and further research, considering identifying indicators for each TH component, and each management functions, would necessarily rely on these sources.

4. CONCLUSION

In the highly competitive global environment, with interminable and accelerating technological growth and development the necessity for technology management is not questionable (White & Bruton, 2007) Technology provides competitive advantage and is the crucial dimension in government, firm, industry, regional, and other, strategies. Levi Jakšić et al. 2011 state that, theoretically and in practice, it has been discovered that there is a missing component in acquiring economic growth with new employment opportunities and technological development. The missing link is the management of innovation and technology and technological entrepreneurship. It is crucial to enable scientific and technological developments oriented at creating new value in the economy and society. Efforts at achieving the efficient transition of science into new technologies and new technology into new value are the main task of effective TIM. In this effort, all the players within the TH model are significant as the TH notes the network of actors in the innovation and entrepreneurship system to be viewed and taken into account. The TH concept underlines the role of university in new, modern, knowledge-based economy. It also inspects the relations among the three components of a knowledge-based economy: (1) the knowledge-producing sector (University), (2) the market (Industry), and (3) Governments (Cooke & Leydesdorff, 2006).

In this paper we develop a general cross-functional model for measuring TIM performance of a national economy, from a TH perspective, creating separate sub-models for each TH component. This general model with the relevant indicators represents a base for measuring and monitoring how successful a national economy is in managing technology. All the basic management functions in TIM are evaluated (POC) enabling specific tracking of their performance coupled with the analysis of the contribution of each TH dimension in the specific performance of TIM. The complete analysis performed after the model is applied in concrete, real world situation, is the necessary tool for setting priorities and achieving better results in fulfilling the relevant goals of sustainable development: economic, social, environmental. In this paper, a list of the indicators is proposed based on the material provided by the World Bank and OECD, but the list is not closed and still needs to be extended and classified for each component of the TH model. It is planned that the general model as well as the sub-models be tested in a concrete situation, starting from the concrete results for Serbia and further to compare the situation with the countries in the region, as well as with the developed countries. This would enable a complete picture to be established with the cause and effect relationships more clear and leading to more precise and targeted policies and strategy with effective and sustainable TIM achieving sustainable development.

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GOVERNMENT PERFORMANCE IN TECHNOLOGY AND INNOVATION MANAGEMENT – THE CASE OF SERBIA

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Abstract: *This paper analyses the role of the state/government as one element of the Triple Helix model, and its role in Technology and Innovation Management (TIM). In order to observe the results of the measures and actions taken by the government, specifically related to the management of technology and innovation, a model was created based on selected quantitative indicators and indices. The model is developed for measuring and monitoring the performance in TIM, where we: first, classified the indicators according to the three basic management functions – planning organizing and control, observed as input, process and output, respectively; and second, show the relations that exist between these three categories of indicators. Planning indicators are observed as the investments in technological and innovative activities; Organizing indicators include the infrastructure, public administration efficiency and cooperation support, while control indicators refer to the national economy R&D and technology transfer effects and entrepreneurship outcomes. The model is tested based on the indicators for the Republic of Serbia. It is shown that the model is applicable in real world situations as, a useful tool to: 1) analyse the dynamics and changes that occur, 2) notice the interactions between functions of TIM, and 3) use the feedback as support in strategic TIM decision making of a national economy.*

Keywords*: Triple Helix, Technology and Innovation Management, State/Government, Performance, Serbia.*

1. INTRODUCTION

Contemporary management literature and practice recognize technology and innovation management (TIM) as critical success factor for firms, sectors, economies and regions. There is high evidence of steep rise in the development of the scientific field of technology management (Cunningham, 2011) corresponding to the practical needs of managing technology as the fundamental source of competitive advantage of firms and economies (Eskandari et al., 2007). Technological innovations in areas such as materials, electronics, aerospace, computers, telecommunications and biotechnology have influenced the rising dominant forces in the world economy. Yet, there are serious concerns about "our effectiveness in generating and exploiting technology" (Mallick & Chaudhury, 2000). The integral technology management concept is focused on managing technology as external force and internal factor of the firm, meaning that both the innovative and technological infrastructure and the technology and innovative capacities of the firm are taken into account (Levi Jaksic et al., 2012). The main institutions and actors in technology and innovation management process (at macro and micro level) can be identified as university, industry and government - the same elements that are recognized in the Triple Helix concept.

The concept of the Triple Helix (TH) was proposed by Etzkowitz and Leydesdorff in 1990s and today it is still developing through theoretical and empirical research. "The Triple Helix thesis is that the potential for innovation and economic development in a Knowledge Society lies in a more prominent role for the university and in the hybridization of elements from university, industry and government to generate new institutional and social formats for the production, transfer and application of knowledge" (Ranga & Etzkowitz, 2013). University-industry-government relations develop in terms of institutional arrangements that recombine three functions of the socio-economic system: (1) wealth generation and retention, (2) novelty production, and (3) control at the interfaces of these sub-dynamics (Leydesdorff, 2006). Overlap among governments, enterprises and universities, is the core of an innovation system. Interaction among these three players is important determinant of knowledge production and dissemination. During this process, active interaction among these three players promotes the rising spiral of innovation (Rao et al., 2012).

In recent decades, federal, state and local governments have created a variety of mechanisms to encourage knowledge-based economic development (Etzkowitz, 2002). The structure of national R&D system can be examined through the use of a Triple Helix framework that studies the relations among academia, business, and government (Etzkowitz, 2008). Development of a knowledge base is dependent on the condition that knowledge production be socially organized. The interfaces between institutions and functions can be expected to resonate into co-evolutions in some configurations more than in others (Leydesdorff, 2006). This confirms the relevance of studying country specific university-industry-government configurations (see for example Rao, 2012; Park & Leydesdorff, 2010). Also, each element of Triple Helix could be examined, putting in the context of technology and innovation management and country competitive position.

In this paper, we analyse one aspect of the Triple Helix model – the government sector, and develop a model for measuring and monitoring government performance in technology and innovation management (TIM). We classify TIM performance indicators (of the government sector) into three basic management functions: planning, organizing and control (POC). Since we observe these management functions as input, process and output (respectively), and present indicators for their measurement, we are able to: (1) analyse if there is a correlation between these three functions of TIM and (2) see which function is "ahead" of the others and which one "lags behind", which enables us to determine the weaknesses of government sector performance in TIM. The model is tested and applied in a real world situation, with indicators taken for Serbia.

This paper is organized as follows: Section 2 explains the government role in the Triple Helix model, and observes ways of measuring government performance; in Section 3, a model for measuring and monitoring government performance in TIM is presented; in Section 4 the model is applied in the real situation of Serbia, and Section 5 concludes the paper.

2. GOVERNMENT IN THE TRIPLE HELIX MODEL

The neo (institutional) perspective distinguishes three main configurations in the positioning of Triple Helix (TH) elements. (Ranga & Etzkowitz, 2013) In **statists' configuration**, government plays the leading role, driving academia and industry, but also limiting their capacity to initiate and develop innovative transformations. These examples could be found in Russia, China, Some Latin American and Eastern European countries. **Laissez-faire configuration** us characterized by a limited government intervention in the economy (US, some Western Europe countries), with industry as the driving force and university with limited role in innovation, acting mainly as a provider. Government in laissez-faire configuration is also limited, acting as a regulator of social and economic mechanisms. The Knowledge Society is characterized by **balanced configuration** where universities and other knowledge institutions act in partnership with industry and government and even take the lead in joint initiatives (Etzkowitz & Leydesdorff, 2000). There has been a shift from the model of the state encompassing industry and academia. Development strategies, whether based primarily on the industrial sector as in the US or the governmental sector as in Latin America, are being supplemented, if not replaced, by knowledge-based economic development strategies, drawing upon resources from the three spheres of Triple Helix (Etzkowitz, 2002).

2.1. Measuring government performance

Building knowledge based economy and society in the traditional sense and as defined by traditional indicators is not sufficient enough for substantial economic and social progress and development. Theoretically and in practice it has been discovered that, despite the undoubtedly central role of investments in new knowledge in economic growth, there is still a neglected, missing link to economic growth, employment opportunities and international competitiveness (Levi Jaksic et al., 2011).

Traditional performance measurement systems have concentrated on development of indicators largely relating to economy (inputs) and efficiency (costs) due to the limited ability to measure effectiveness or outcomes in government organizations (Kloot and Martin, 2000). Although government is not, neither the supply, nor in most cases, the demand side of new knowledge and new technologies, it can promote effective enterprise-university interaction in order to facilitate university technology transfer by institutional arrangements, policy making and so on (Rao et al, 2012).

According to Rao et al. (2012) there are two aspects of government R&D investments: one is government R&D funding which indirectly promotes university patent technology transfer activities by supporting teaching and research activities; the other is specialized government R&D programs (foundation) which directly support university patent technology transfer activities. Thus, based on triple helix theory, government R&D investments, including government R&D funding and government R&D programs, can influence university patent technology transfer activities (Rao et al., 2012). It was shown (Chang-Yang, 2011) that it is difficult to evaluate the aggregate effect of public R&D support. The author found out that there are different effects of public R&D support on firm R&D, depending on various firm- or industry-specific characteristics. Four potential channels are identified: the technological-competence-enhancing effect, the demand-creating effect, the R&D-cost-reducing effect and the (project) overlap (or duplication) effect.

The study (Caerteling et al. 2013) showed that government championship is an important positive factor for the performance of technology development projects. Government championing has more impact than government financial/technical assistance on both project performance and benefits to customers. Implications for practice were identified as: from a policy perspective, government should extend its technology policies by taking on the role as a champion, while companies should invest in building professional relations with champions in government. Despite the general growth of government R&D funding, R&D is potentially an area of government spending that is perhaps the most vulnerable to a budgetary cut in economic downturns. There are cross-national differences in government R&D funding in times of economic hardship (Kim, 2013). Strategic performance management demands an approach that is oriented at financial measures, but also at community concern and long-term development. The framework that presents strategic and balanced local government performance management is presented in Table 1 (Kloot and Martin, 2000).

Table 1: Choice in Local Government Performance Management (Kloot & Martin, 2000, p. 248)

Traditional Approach	vs.	Performance-oriented Approach
Top-down State Government and council-imposed, control-oriented performance management.	vs.	Strategic, collaborative, development of a performance management system involving all stakeholders.
Imposition of universal, industry-wide measures with less validity for specific council.	vs.	In-house development of valid, council specific measures to be used for organizational improvement and benchmarking with like councils.
Periodic reporting for the purpose of meeting control requirements of senior management, councillors and State Government.	vs.	Real-time up-to-date performance information for all stakeholders to monitor progress, demonstrate accountability and manage outcomes.
Piecemeal, myopic approach with a focus on the measurement process.	vs.	Integrated performance management system across the organization focused on value-for-money service delivery and organizational improvement.
Focus on financial measures only.	vs.	Focus on financial and non-financial measures: a results and determinants approach.

Investments in science and technology (S&T) are not the privilege of developed countries. According to Kim (2013) there is much to discover and learn from the experiences of non-OECD countries; in the recent years R&D funding in the developing world, especially countries such as Brazil, Russia, India and China, have been soaring, defying the predictions based on their economic and social levels of development. Political leaders in these countries promote S&T heavily as a springboard to move their nation forward in the increasingly knowledge-intensive economy of the 21st century.

3. A MODEL FOR MEASURING AND MONITORING GOVERNMENT PERFORMANCE IN TECHNOLOGY AND INNOVATION MANAGMENT

There are multiple indicators focused on measuring outputs at the level of industry, academia and government, independent of each other and much less systematic approaches in monitoring influences of outputs of industry, university and government to outcomes (effectiveness) (Singer & Peterka, 2012). In this paper we analyse one aspect of the Triple Helix, the government performance in TIM, and develop a model for its measurement and monitoring. The created model, in which government TIM performance indicators are classified into three crucial management functions – POC, is presented in Figure 1. We observe these three management functions also as three categories of indicators as: input, process and output, respectively.

As planning (input) indicators of government performance in TIM, we identified nine indicators, which refer to the *Investments* in technological and innovative activities of a country. These indicators are: R&D expenditures (% of GDP), Gross Domestic Expenditure on R&D - GERD (% of GDP), Government Intramural Expenditure on R&D - GOVERD (% of GDP), ICT expenditures (% of GDP), Basic research expenditure (% of GDP), Applied research expenditure (% of GDP), Experimental development expenditure (% of GDP), Government expenditure for new ventures/subsidies for new ventures (% of GDP) and Total investments in equipment (% of GDP).

Organizing (process) indicators of government performance in TIM refer to: *Infrastructure*, *Public administration efficiency* and *Cooperation support*. We identified eighteen organizing indicators: (1) nine infrastructure indicators (Government total R&D personnel (FTE), R&D organizations – government sector (number), Internet users (per 100 people), Fixed-telephone subscriptions (per 100 people), Mobile-cellular subscriptions (per 100 people), Personal computers (per 100 people), Electric power consumption (kWh per capita), Science and engineering graduates (% 20-29 population) and Population with 3rd level education); (2) eight public administration efficiency indicators (Time required to enforce a contract (days), Procedures to enforce a contract (number), Time required to register property (days), Procedures to register property (number), Cost of business start-up procedures (% of GNI per capita), Time required to start a business (days), Start-up procedures to register a business (number) and Time to prepare and pay taxes (hours); and (3) one Cooperation support indicator (Technical cooperation grants (BoP, current US$)).

We also identified twelve control (output) indicators of government performance in TIM and classified them into three main groups: *R&D results*, *Technology transfer results* and *Entrepreneurship results*. R&D results indicators refer to the patent activity of a country (Patent applications - resident, EPO patent applications (per million population) and USPTO patent grants (per million population)) and publishing activity (Number of scientific and technical journal articles). Technology transfer results include following indicators: Charges for the use of intellectual property, payments (BoP, current US$), Charges for the use of intellectual property, receipts (BoP, current US$), ICT goods imports (% total goods imports), ICT goods exports (% of total goods exports) and ICT service exports (% of total service exports). Entrepreneurship results are measured through the following three indicators: Number of new ventures (SMEs) with government support, New business density (new registrations per 1,000 people ages 15-64) and New businesses registered (number).

The model consists of thirty-nine indicators of government performance in TIM, classified into three main categories: planning (input), organizing (process) and control (output). The idea of the model is not only to present and classify indicators, but also to highlight the connections that exist between these categories of indicators. Planning indicators are seen as an input in technological and innovative activities of a county, measured through different indicators of investments in R&D and an indicator of government support for new ventures. The idea is to see if these investments are correlated with the Control (output) indicators, which refer to the patent and publishing activity of a country, results of technology transfer and entrepreneurship outcome. As the middle part of this model, which enables transformation of the observed inputs into outputs, we see the organizing (process) indicators which refer to technological and innovative infrastructure, public administration efficiency and cooperation support. The fourth element of the model is the feedback (from control to organizing and control to planning) which helps in making strategic management decisions in the area of TIM at the level of national economy.

Therefore, it is evident that this model presents a framework for measuring government performance in TIM that can be tested in any country. When applying this model, it is possible to include only the indicators that rest upon available data at a country level, so the next step was to make a choice of only those indicators from this list that were available and accessible (through large internet databases such as World bank, OECD, UNDP, UNdata and through the country's Statistical Office) for Serbia.

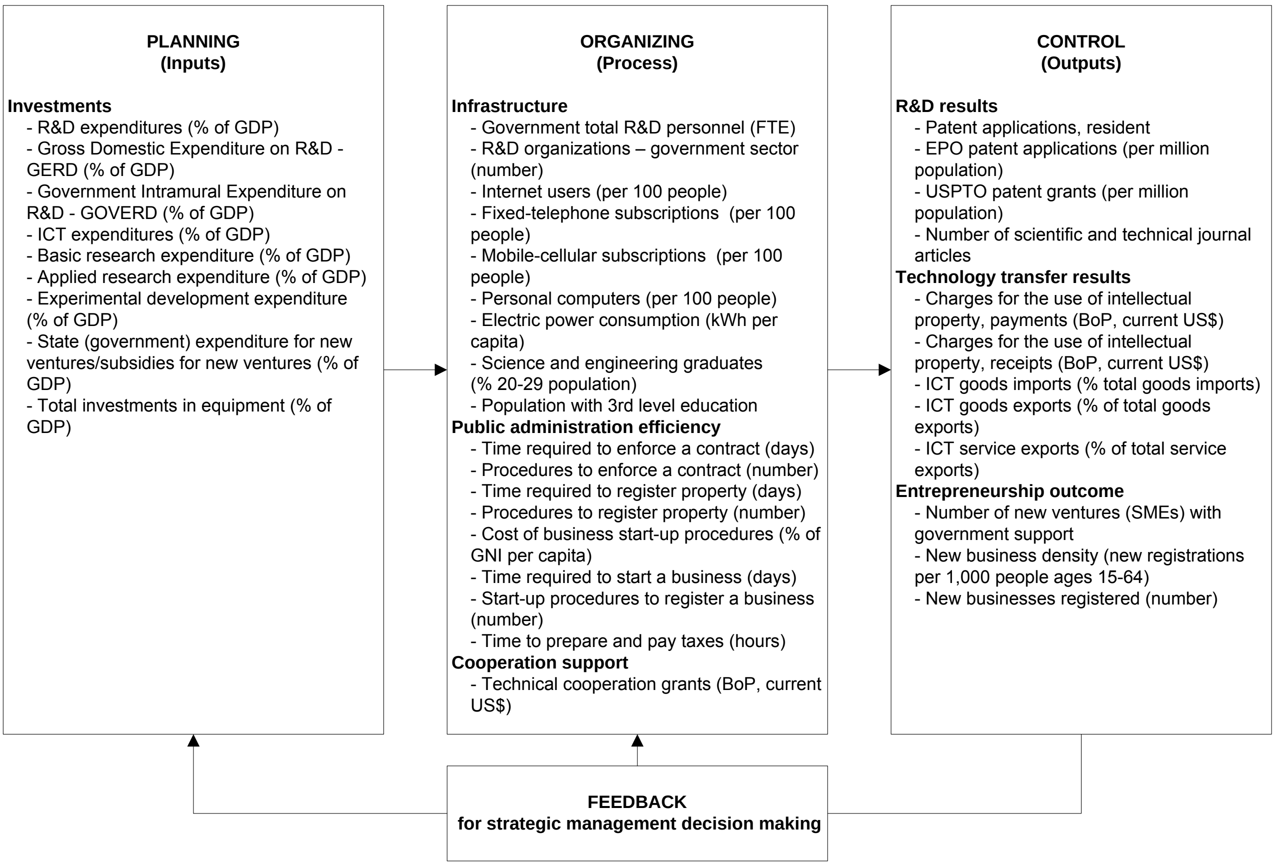

Figure 1: Model for measuring and monitoring government performance in TIM

4. APPLICATION OF THE MODEL WITH INDICATORS FOR SERBIA, RESULTS AND DISCUSSION

In this section we present an application of the created model in the case of Serbia. Thirty-one out of thirty-nine identified government performance indicators in TIM are measured at the country level. Data were collected from different sources: World Bank (2014), UNDP (2014), UNdata (2014), Statistical Office of the Republic of Serbia (2014) and European Commission – ERAWATCH country report – Serbia (2014). Lack of the available data for Serbia is the reason why eight indicators are excluded from this analysis.

In Table 2 we present the analysis of the government performance in TIM for the Republic of Serbia during the period 2008-2011. Column 2 presents the measured indicators of government performance in TIM. Column 3 presents the data source for indicators in Column 2. Columns 4-7 refer to the values of indicators for each year the observed period of time. Columns 8-10 present the indices of change (*IC*) over years, calculated as follows:

$$IC_{\frac{c}{p}} = \frac{Value_c - Value_p}{Value_p} \tag{1}$$

where *c* presents the current year and *p* the previous one. But, this equitation has to be applied with caution, because sometimes increase in value of an indicator over a two-year period has a negative influence on TIM (and vice versa – negative value has a positive influence), so we have to use the opposite value of IC in order to get valuable total result. For example, if we observe Table 2, $IC_{2011/10}$ for the indicator *Time required to register property (days)* is negative because value of this indicator decreased from 91 in 2010 to 11 in 2011 ((11-91/91) = - 0.87912), which is actually a positive phenomenon, so we have to use the opposite value for this IC. This is why this $IC_{2011/10}$ has a positive value of 0.87912. ICs with “opposite” values are marked with a sign * in the table.

Table 2: Indicators of government performance in TIM for the Republic of Serbia, period 2008-2011

Management function	Indicators of government performance in TIM	Data source	Year				Index of change over years (current/previous)		
			2008	2009	2010	2011	$IC_{2009/08}$	$IC_{2010/09}$	$IC_{2011/10}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Planning (input)	***Investments*** [a]						*0.7687*	*-0.0487*	*0.0259*
	R&D expenditures (% of GDP)	World Bank	0.385	0.919	0.764	0.735	1.3892	-0.1686	-0.0389
	Gross Domestic Expenditure on R&D - GERD (% of GDP)	Erawatch. European Commission	0.732	0.919	0.792	0.777	0.2555	-0.1382	-0.0189
	R&D performed by Government Sector (% of GERD)	Erawatch. European Commission	40.41	30.87	36.62	33.77	-0.2361	0.1863	-0.0778
	Basic research expenditure (thousand RSD)	Statistical yearbook of Serbia	4023613	10599663	10194423	10360031	1.6344	-0.0382	0.0162
	Applied research expenditure (thousand RSD)	Statistical yearbook of Serbia	3504120	9249510	6485507	8332825	1.6396	-0.2988	0.2848
	Experimental development expenditure (thousand RSD)	Statistical yearbook of Serbia	2713514	5095793	6147740	5991136	0.8779	0.2064	-0.0255
	Total investments in equipment (thousand RSD)	Statistical yearbook of Serbia	308863895	253368844	230547033	240129422	-0.1797	-0.0901	0.0416
						INPUT CHANGE	**0.7687**	**-0.0487**	**0.0259**
Organizing (process)	***Infrastructure***						*0.0203*	*0.0152*	*0.0092*
	R&D organizations - government sector (number)	Statistical yearbook of Serbia	67	68	59	58	0.014925	-0.13235	-0.01695
	Internet users (per 100 people)	World Bank	35.6	38.1	40.9	42.2	0.070225	0.073491	0.031785
	Fixed-telephone subscriptions (per 100 inhabitants)	UNdata	38.653	39.204	39.536	38.765	0.014267	0.008461	-0.0195
	Mobile-cellular subscriptions (per 100 people);	World Bank	120.521	125.126	126.036	130.248	0.038204	0.007272	0.033423
	Electric power consumption (kWh per capita)	World Bank	4291.844	4224.398	4358.812	4474.327	-0.01571	0.031819	0.026501

	Science and engineering graduates (% 20-29 population)	UNDP	21.5	21.5	23.7	23.7	0	0.102326	0
	Public administration efficiency						*0.10803*	*0.00844*	*0.11147*
	Time required to enforce a contract (days)	World Bank	635	635	635	635	0	0	0
	Procedures to enforce a contract (number)	World Bank	36	36	36	36	0	0	0
	Time required to register property (days)	World Bank	111	111	91	11	0	0.18018*	0.87912*
	Procedures to register property (number)	World Bank	6	6	6	6	0	0	0
	Cost of business start-up procedures (% of GNI per capita)	World Bank	7.6	7.1	7.9	7.8	0.06579*	-0.11268*	0.01266*
	Time required to start a business (days)	World Bank	23	13	13	13	0.43478*	0	0
	Start-up procedures to register a business (number)	World Bank	11	7	7	7	0.36364*	0	0
	Time to prepare and pay taxes (hours)	World Bank	279	279	279	279	0	0	0
	Cooperation support						*-0.65658*	*0.149693*	*-0.07822*
	Technical cooperation grants (BoP. current US$)	World Bank	322520000	110760000	127340000	117380000	-0.65658	0.149693	-0.07822
						PROCESS CHANGE	**-0.1761**	**0.0578**	**0.0142**
Control (output)	***R&D results***						*-0.02466*	*-0.04857*	*-0.14512*
	Patent applications. resident	World Bank	386	319	290	180	-0.17358	-0.09091	-0.37931
	Number of scientific and technical journal articles	World Bank	1043	1172.6	1165.3	1269.1	0.124257	-0.00623	0.089076
	Technology transfer results						*0.208775*	*-0.12006*	*0.095685*
	Charges for the use of intellectual property. payments (BoP. current US$)	World Bank	196380003.8	143291864.2	155910993.7	183330205.4	-0.27033	0.088066	0.175865
	Charges for the use of intellectual property. receipts (BoP. current US$)	World Bank	29039521.67	61611211.98	39040235.46	56902140.75	1.121633	-0.36635	0.457526
	ICT goods imports (% total goods imports)	World Bank	4.694	4.384	4.216	4.295	-0.06593	-0.03845	0.018821
	ICT goods exports (% of total goods exports)	World Bank	2.040	2.390	1.625	1.419	0.171428	-0.31984	-0.12702
	ICT service exports (% of total service exports)	World Bank	35.851	38.973	40.388	38.499	0.087079	0.036288	-0.04676
	Entrepreneurship outcome						*-0.09611*	*-0.04633*	*-0.10886*
	New business density (new registrations per 1.000 people ages 15-64)	World Bank	2.122	1.918	1.830	1.633	-0.09618	-0.04582	-0.10756
	New businesses registered (number)	World Bank	10746	9714	9259	8239	-0.09604	-0.04684	-0.11016
						OUTPUT CHANGE	**0.029335**	**-0.07165**	**-0.05276**
						TOTAL CHANGE	**0.2073**	**-0.0209**	**-0.0042**

Based on the calculated ICs for the observed indicators, we calculated ICs for input, process and output. These ICs represent the average values of ICs of the indicators included in each of these three groups. Then, the IC of total change over a two-year period is obtained as the average value of the ICs for input, process and output. In our research, we analyze the following changes: 2009/08, 2010/09 and 2011/10.

2009/08: Planning (input) indicators, which refer to the investments in technological and innovative activities, oscillate during the observed period of time. $IC_{2009/08}$ equals 0.7687 which indicates that great efforts are made at the country level, as far as investing is concerned. The reason why this happened is that, comparing with 2008, in 2009 R&D expenditures increased almost 3 times (reaching almost 1% of GDP – which is the highest value of the observed period). Basic research expenditure, applied research expenditure and experimental development expenditure also increased more than two times. This shows that a good basis for great results is formed, as far as we observe the input indicators. But, it is interesting to see what actually happens at the output side of the model represented by the Control indicators. Before that, if we observe the Organizing (process) indicators, $IC_{2009/08}$ equals -0.1761. Infrastructure is slightly improved ($IC_{2009/08} = 0.0203$) and Public administration efficiency also ($IC_{2009/08}$ = 0.10803), but Cooperation support decreased dramatically, resulting in $IC_{2009/08}$ = -0.65658, which caused Organizing change to be negative. But, it is encouraging to note that for Control (output) indicators, $IC_{2009/08}$ has a positive value of 0.0293. However, this is not a very good result if we observe the IC for the input indicators. Nevertheless, we know that, regarding technological and innovative activities, input cannot be immediately translated into output, so we expect this positive change to be seen in the following years. Total $IC_{2009/08}$ equals 0.2073, which is a good total result that indicates positive movements in government performance in TIM in Serbia.

2010/09: Input indicators' $IC_{2010/09}$ equals -0.0487 which is a bad result, compared to the previous one ($IC_{2009/08}$ = 0.7687). Investments stayed almost at the same level in 2010 as in 2009, excluding R&D expenditures, GERD, Applied research expenditure and Total investments in equipment, which decreased over these 2 years. Organizing (process) indicators improved - $IC_{2010/09}$ = 0.0578. This is a slight improvement that occurred because of the positive changes in all three groups that it includes (Infrastructure: $IC_{2010/09}$ = 0.0152; Public administration efficiency: $IC_{2010/09}$ = 0.00844; Cooperation support: $IC_{2010/09}$ = 0.1497). At the output side we have a worrying result: Control $IC_{2010/09}$ = -0.07165. This is a result of the decrease in all categories of output: R&D results $IC_{2010/09}$ = -0.04857; Technological transfer results $IC_{2010/09}$ = -0.12006; Entrepreneurship outcome $IC_{2010/09}$ = -0.04633, which indicated that technological and innovative activities were not fertile: inputs are not being transformed into outputs at a satisfying rate. Total change, as it is expected to be, is negative: Total $IC_{2010/09}$ equals -0.0209, which is much worse than the previous 2-year period when total $IC_{2009/08}$ was 0.2073.

2011/10: On first glance it is clear when looking at Table 2, that the results are better than in 2010/09. Planning indicators $IC_{2011/10}$ equals 0.0259. This is only a slight improvement, which has not yet reached the great results from 2009/08. Anyhow, a positive tendency is good to be captured. These results are a consequence of: 1. increased investments in applied research and equipment, and 2.keeping values of all other indicators at the same level in 2011 as in 2010. Organizing indicators also improved: $IC_{2011/10}$ = 0.0142 (Infrastructure: $IC_{2011/10}$ = 0.0092; Public administration efficiency: $IC_{2011/10}$ = 0.11147; Cooperation support: $IC_{2011/10}$ = -0.07822). But, on the output side, we notice the decline again – Control $IC_{2011/10}$ = -0.05276. R&D results and Entrepreneurship outcome declined ($IC_{2011/10}$ equals -0.14512 and -0.10886, respectively), while only Technology transfer results were better: $IC_{2011/10}$ = 0.095685, mainly because the increase in Charges for the use of intellectual property (both payments and receipts). Total $IC_{2011/10}$ = -0.0042, which indicates to the negative trend in government performance in TIM.

Trends of changes of ICs for the Input, Process, Output and the Total ICs changes for the observed period are shown on Figure 2.

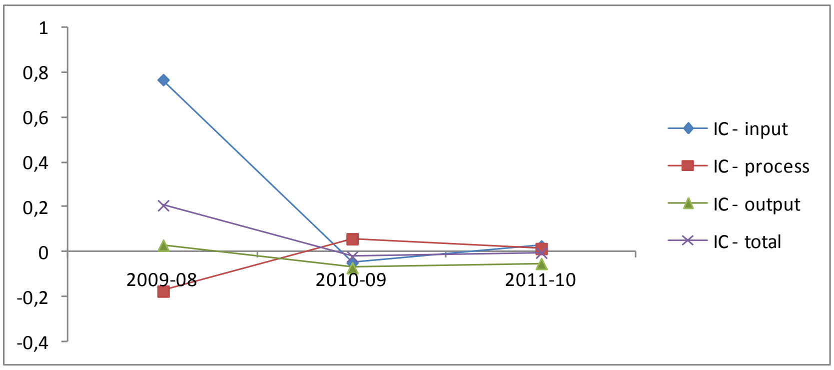

Figure 2: Trends of ICs of government performance in TIM (input, process, output, total) for the Republic of Serbia, period 2008-2011

5. CONCLUSION

Government as an important player and an element of the Triple Helix model, creates collaborative R&D projects and the necessary links among other elements, investing in development in different fields, regions and at different levels of a country. It is the key element in enhancing knowledge based economy that is largely based on efficient and effective technology and innovation management. Although government R&D investments could be vulnerable to a budgetary cut in times of economic difficulties, they are always present as incentives for the development of economy and society. Inputs, processes and outputs of government activity in Technology and innovation management are important to measure and analyse in order to determine correlations, achievements and weaknesses, as indicators relevant for the future activities and decisions. It is important to note that, by using the model developed in this paper, government impact in all three relevant spheres can be tracked, monitored and analysed for quick responding action with policies and strategy well adapted to the concrete TIM performance in practice.

In this paper, government performance in TIM is analysed and a model is created for its measurement and monitoring. One of the attributes of the model is its balanced structure enabling a systematic approach to the broad body of indicators already in use, oriented at better understanding the specific and most relevant role of the government in creating the innovative environment for supporting the basic technology and innovation management functions. In the model we classified the identified government TIM performance indicators into categories related to the three basic management functions - POC, also observed as the input, process and output, respectively, and show the relations that exist between these categories of indicators. Planning indicators refer to the investments in technological and innovative activities; organizing indicators refer to the technological and innovative Infrastructure, public administration efficiency and cooperation support, while control indicators refer to the country's R&D results, technology transfer results and entrepreneurship outcomes. Each of these categories and groups refer to the specific government TIM performance indicators, which are accessible in large internet databases such as the World Bank, OECD, UNdata, UNDP, and in the observed country's Statistical Office. In addition, we tested the created model in the case of the Republic of Serbia and have shown how the collected data can be analysed in order to measure changes, notice the interactions between the elements of the model and use the feedback as a support in making strategic management decisions in the area of TIM at the country level.

Nevertheless, this is not the final list of government performance indicators in TIM. This is the first attempt of the authors to create a systematic list of these indicators, which has to be re-examined, and potentially spread with more government performance indicators, which will be the subject of the authors' future research. The authors will also conduct further research of the other two components of the Triple Helix: University and Industry. This is necessary to complete the broader picture of the contribution and results of Triple Helix players in TIM at the national economy levels.

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MECHANISMS FOR STIMULATING INNOVATION CAPABILITIES IN WESTERN BALKAN COUNTRIES

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Abstract: *Over the past few decades knowledge-based development and innovation are recognized as an engine of the economy development. This created revolution in R&D activities and economy. In this paper the authors highlighted the importance of innovation for restructuring economies of Western Balkan countries. The results indicate that drivers of innovation in Western Balkan countries are generally less powerful than those in EU countries. Authors also presented policy measures that can be successfully implemented in order to improve communication between various stakeholders in the innovation process.*

Keywords*: innovation, innovation process, Western Balkan countries (WBC), mechanism for fostering innovation, small and medium sized enterprise (SME)*

1. INTRODUCTION

The core of the continuous innovation process is the commercialization of Research and Development (R&D) results. This means transforming an invention into product or service that will be sold on the market and provide return for the investor. Generally speaking, innovation potential of a country is determined by R&D activities, human resources engaged in them, institutions and regulations and use of information and communication technologies.

Innovation is important on different levels and for different reasons. On a country level, innovation is important as an engine of economic growth. It increases human wellbeing and employment. For companies, innovation improves productivity, enables development and shareholder return.

The data presented in this paper provide evidence of existing huge differences in innovation capacity of developing and developed countries. Developing countries still lag behind developed countries when it comes to number of researchers, R&D expenditures, number of scientific articles and patents, etc. This is the fact that restricts the scope of innovations available for commercialization.

Developing countries also have limited efficiency in the process of commercialization of R&D results. Lack of interaction between science and industry is major limitation of innovation process. Encouraging technology transfer from faculties to private companies is a strategy used by many countries in order to mitigate constraints of innovation process. Policy measures presented in this paper are being implemented with that purpose.

2. INNOVATION AS A KEY FACTOR OF ECONOMIC DEVELOPMENT IN MODERN SOCIETY

In the last few decades innovations have been identified as crucial driver of economic and social development. Theory of innovation was developed by Joseph Schumpeter during the 1940s and after that many authors began to explore this phenomenon. Many studies have showed that innovation has main role in acquiring comparative advantage in the individual company, as well as in the macro economy.

In a general case, "*there are only two ways of increasing the output of the economy: (1) you can increase the number of inputs that go into the productive process, or (2) if you are clever, you can think of new ways in which you can get more output from the same number of inputs"* (Rosenberg, 2004). Increasing productivity of the economy is a key for raising living standard. This productivity growth can enable rising wages of workers and increasing national per capita income. Innovation is essential for increasing productivity. In the long term, no economy can be competitive by just increasing inputs. The best way to raise living standard is to find new methods for combining natural, human and capital resources and increase productivity.

Innovation consists of the purposeful search for changes and the opportunities that such changes might offer (Drucker,1985). Innovation includes making change, creating new ideas and new opportunities. It is important to note that innovation and entrepreneurship are closely connected, so innovation is one of the instruments of entrepreneurship.

Joseph Schumpeter argued that economic development is driven by innovation through a dynamic process in which new technologies replace the old, a process he labeled “creative destruction”. In Schumpeter’s view, “radical” innovations create major disruptive changes, whereas “incremental” innovations continuously advance the process of change. Schumpeter proposed a list of five types of innovations: introduction of new products, introduction of new methods of production, opening of new markets, development of new sources of supply for raw materials or other inputs, creation of new market structures in an industry (OECD 2005).

An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD, 2005).This understanding is quite broad and includes not only the development of new technologies, but also improvements in business practices, relationships and organizations.

There are many studies explaining relationship between innovation and economic development and growth. Neoclassical economists treat innovation as key factor contributing to economic progress and long-term convergence (Fagerberg, 1994). Supporters of endogenous growth theory argue that differences in innovation potential create variations in economic performance and wealth of the nations. They also devote attention to the place of international trade in the growth process, including the transmission of innovations from the industrial economies to the less developed countries (Grossman & Helpman, 1991). However, it is important to take into account social and institutional perspective of an economy. In a study by Rodriguez-Pose and Crescenzi (2008) is shown how regional innovation capacity is shaped in interaction between R&D sector, economic, social and institutional sector.

Innovation has become extremely important factor in productivity growth. According to Boston Consulting Group, relative importance of innovation to labour and capital has been growing over time. This rate is especially high from the 1990s (The Economist, 2007).

Today, innovation is facing new challenges on global, national and organizational level. Innovative capacity is created in interaction between research, education and innovation. Perhaps the most important obstacle to innovation and commercialization of R&D results in insufficient collaboration between scientific and corporate sector. Industry and science relations have to be stronger to ensure that R&D activities anticipate market needs. Measures of encouraging university entrepreneurship can also help in fostering innovation activities in the economy.

3. POTENTIAL FOR INNOVATION IN DEVELOPING COUNTRIES

During the 2000s indicators that foster innovation in Western Balkan Countries (WBC) were generally less advanced than those in developed market economies. Although many developing countries have well-educated labour forces and good tradition of scientific research, many of them cannot compete with developed countries. In the following tables WBC are compared with selected EU countries using various indicators of science and innovation activities.

Number of researchers per million inhabitants from 2005-2011 in WBC varied widely across countries (Table 1). While in Croatia number of researchers was 1584, in Albania was only 148. These numbers are much lower than in selected EU member states in which average number of researchers was 2329,29. Countries members of EU-15 have much higher number of researchers per million people which indicates that WBC as well as new EU member states have to include more people in R&D activities in order to catch-up with developed countries.

Number of scientific and technical journal articles includes articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences. It is mainly in correlation with previous indicator in terms that countries with higher number of researchers have more scientific papers. Of course, this is not always a rule. For example, Slovenia and Bulgaria have more researchers than Serbia and Croatia, but have less scientific journal articles. However, these data should be considered with caution. The number of scientific and technical papers considers article counts from a set of journals covered by Science Citation Index (SCI) and Social Sciences Citation Index (SSCI). When interpreting these data for developing countries it is important to analyse if the improved number of scientific articles is result of including certain national journals in Science Citation Index or it is consequence of real increase in scientific productivity. Remarkable results in this area have Germany and United Kingdom whose researchers published over 46000 scientific papers in 2011 (which is partially due to their large population).

Table 1: Science and technology indicators in selected countries

Country group/ country		Researchers FTE per million people (2005-2011)	Scientific and technical journal articles (2011)	Patent applications filed (residents + nonresidents) (2012)	Trademark applications filed (2012)
Western Balkan countries	Albania	148	27	11	2700
	Bosnia and Herzegovina	193	54	16	4517
	Croatia	1584	1289	251	7564
	FYR Macedonia	461	77	40	3275
	Montenegro	763	28	78	3896
	Serbia	1221	1269	224	6815
	AVERAGE	**728,33**	**457,33**	**103,33**	**4794,50**
New EU member states (selected countries)	Bulgaria	1623	650	259	6329
	Czech Republic	2891	4127	1017	11198
	Hungary	2303	2289	758	4939
	Poland	1679	7564	4657	17023
	Romania	737	1626	1077	10519
	Slovakia	2817	1099	203	4744
	Slovenia	4255	1239	453	1824
	AVERAGE	**2329,29**	**2656,29**	**1203,43**	**8082,29**
Selected EU-15 countries	Austria	4397	5103	2552	9519
	Germany	3950	46259	48092	64497
	Netherlands	3218	15508	2713	n.a.
	Sweden	5191	9473	2436	11290
	United Kingdom	4202	46035	23235	42848
	AVERAGE	**4191,6**	**24475,6**	**15805,6**	**32038,5**

Source: World Bank

Data on patents and trademarks show success of research, development and innovation activity in certain areas. It is actually a measure of innovation activity of a country that shows knowledge utilisation and transformation of knowledge into potential economic benefits.

Table 2: R&D expenditure in selected countries (% of GDP) from 2010-2012.

Country/ country group		2010	2011	2012
Western Balkan countries	Albania	n.a.	n.a.	n.a.
	Bosnia and Herzegovina	n.a.	n.a.	0,27
	Croatia	0,75	0,76	0,75
	FYR Macedonia	0,43	n.a.	n.a.
	Montenegro	n.a.	0,41	n.a.
	Serbia	0,79	0,77	0,96
New EU member states (selected countries)	Bulgaria	0,6	0,57	0,64
	Czech Republic	1,4	1,64	1,88
	Hungary	1,17	1,22	1,3
	Poland	0,74	0,76	0,9
	Romania	0,46	0,5	0,42
	Slovakia	0,63	0,68	0,82
	Slovenia	2,1	2,47	2,8
Selected EU-15 countries	Austria	2,8	2,77	2,84
	Germany	2,8	2,89	2,92
	Netherlands	1,86	2,03	2,16
	Sweden	3,39	3,39	3,41
	United Kingdom	1,77	1,78	1,72

Source: Eurostat
National Statistical Offices

Number of patents and trademark applications filed in 2012 is also modest in WBC compared to selected EU countries. Croatia and Serbia have highest number of patents (251 and 224), while in other countries in Western Balkan Region this number is very low.

R&D expenditures as a percentage of GDP in the Western Balkan Region from 2010-2012 were much lower than in EU countries (Table 2). Certain countries even have no statistical data that would allow calculating this indicator. This is a serious issue because absence of statistical monitoring means the inability to compare and improve this indicator. In 2012 in WBC higher R&D expenditure as % of GDP had Serbia (0,96) and Croatia (0,75). Most new EU member states have higher R&D expenditures, but still not as in EU-15 countries. Lack of investments in R&D (especially private ones) is partly a consequence of poor business environment, which reduces incentives for investing, especially when risk is high (which is characteristic of innovation investments).

4. DIFFERENT TYPES OF SUPPORT TO INNOVATION IN WB COUNTRIES

There are numerous examples of good practice in fostering innovation in European Union. Many of them are collected and described under the project WBC-inco.net – Coordination of Research Policies with the Western Balkan Countries (WBC-inco.net, 2011). In this paper will be presented policy measures that are suitable to apply in Western Balkan Countries. They are the following: Strategic Innovation, Innovation Officer, Innovation Voucher scheme, Soft Landing Platforms, Competition for Best Technology Innovation.

Strategic Innovation

Strategic Innovation has the aim to allow large number of small and medium-sized enterprises (SMEs) to improve their innovation capacities. Increasing number of innovative firms is crucial for developing countries which can be achieved by coaching and stimulating existing firms to develop strategic approach to innovation.

This methodology was developed by UNU-MERIT (The United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology) in the Netherlands while participating in an EU funded program (EdiSon) in which pilots had been performed in 15 Dutch SMEs. Because of the success in the 15 SMEs on the one hand and the policy choices that had been made in the Euregion Meuse Rhine on the other, UNU-MERIT developed a project proposal together with 3 other project partners in Flanders, Wallonia and Germany (WBC-inco.net, 2011).

The initiative enables management teams to re-develop their business strategy by putting priorities, making choices and implementing them. In that way, many SMEs are facilitated at micro level. It is conducted as 4 step intervention and final implementing phase in companies. These steps of intervention include interviews with top management, innovation scan and two strategic sessions with management team in a group. Implementing phase in companies facilitate trained consultants.

Strategic innovation implies that if one region wants to make improvements in innovation area, it is necessary to include large number of firms that will make changes on micro level. Crucial factor of success of this program is selection and training of consultants and interest of companies for the program. This approach is very effective and it usually gets high scores in the satisfaction surveys.

Innovation Officer

Innovation Officer is the approach that stimulates innovation in SMEs by enabling qualified staff. Innovation officers enhance innovation results and help in overcoming bottlenecks in SMEs operating. Philosophy of this scheme is that entrepreneurs should use knowledge to innovate, so they need new employee – innovation officer that will act as driver of innovation. This officer should detect opportunities for innovation and find ways for their effective implementation. To do this, he needs to have adequate knowledge about innovation processes and development. All plans he proposes should be reviewed by independent commission.

This method for enhancing innovation was developed in the Netherlands. It was part of larger programme – “Innovatie Zuid” which was financed by EU, the Dutch government and private businesses. The overall program was managed by Brabant Development Agency (BOM) and the implementer of this measure was Syntens, not-for-profit innovation intermediary.

Applying this method requires having good implementing agency. This agency should be independent, capable of problem definition and act as an intermediary between the entrepreneur and the innovation officer. First step of this approach is the initial conversation with SME and defining problem/opportunity. After that, intermediary agency writes innovation project and look for innovation officer. Innovation problem and innovation officer are being presented to independent committee which makes decision about the request. Innovation officer starts working, submits reports and gets salary from the SME. SME gets money back from the intermediary agency based on the innovation officer's report.

Innovation Officer Scheme is important because it can be applied in broad base of SMEs and not only in highly innovative ones. It stimulates creating innovative culture by enabling SMEs high-educated young professional.

Innovation Voucher Scheme

SMEs have generally very limited human and capital resources which do not allow them to develop their own know-how. This creates serious delays and missing important market opportunities. On the other hand, there is lot of available, already developed expertise in academic institutions and large companies that can be offered to SMEs. Since SMEs are not well informed about these external sources, they do not know enough to use this opportunity. Reducing this gap between knowledge institutions and SMEs is main goal of innovative vouchers.

Innovation vouchers are usually defined as small lines of credit provided by governments to small and medium-sized enterprises to purchase services from public knowledge providers with a view to introducing innovations (new products, processes or services) in their business operations (OECD, 2010). Such approach directly stimulates knowledge transfer, but also creates long-term relationships between industry and research institutions.

Research vouchers pilot project was developed in province Limburg in the Netherlands in 1996. It was implemented in cooperation with multinational company DSM dealing with chemicals and advanced materials. The goal was to allow SMEs to make use of knowledge accumulated in DSM's research sector. At first, there was limited number of vouchers given to companies for three days advice from DSM Research. After that, certain companies got vouchers to make use of DSM Research's expertise in certain areas. After this pilot many more voucher schemes were developed both in the Netherlands and the rest of the world.

The European Commission rewarded innovation vouchers as one of the best schemes for fostering innovation in Europe. This measure is widely applied because it is really flexible in terms that each region/ country can decide what type of knowledge will be offered under the voucher regime. This enables adaptation of the method to specific situation in certain region.

Soft Landing Platforms

Globalization and using new technologies have created new form of competition for countries and enterprises. In modern economy companies have to face with international competition and get into new markets. International operating increases growth, creates comparative advantages and long term sustainability. When changing business environment, companies are coping with various problems, especially when it comes to legal and tax systems, finding employees and clients, etc.

Conquering global markets will be more successful if companies have external support. Moreover, if that support comes from technology transfer intermediaries, there will be synergetic effect. Such services that help innovation led business to enter on foreign markets are often referred as Soft landing. Support services that Soft landing agencies offer should be flexible and focused on specific company's needs. Skills and contacts this agency has will enable companies faster and easier managing in foreign country. There are various types of services that soft landing offers: business planning, market analysis, finding partners, experts and personnel, access to funding, logistic, etc.

Soft Landing Platforms are created with primary goal to offer professional consulting services to companies starting operating on international level. However, this has proved to be a mechanism for improving innovative results of the company. The created collaborations with partners from different regions and countries contribute not only to the extension of their own networks, but also support the provision of conditions for international collaboration for economic growth. For businesses to innovate in this way, this has proven to be an effective mechanism for improving the innovative application of research results and for business development support to start-ups and existing SMEs (Kniejski, 2013).

Competition for Best Technology Innovation

Competition for Best Technology Innovation promotes entrepreneurial spirit in the domain of high-tech and gives support to people willing to commercialize their ideas and innovations. The competition is based on the philosophy that interaction of innovation and entrepreneurship are crucial for competitiveness of companies, universities and the economy as a whole. It mobilizes researchers, students, companies and innovative individuals to present results of their work.

Competition for Best Technology Innovation is successfully implementing in Serbia. It was initiated in 2005 by the Ministry of Science and Environmental Protection. The idea came from the Faculty of Technical Sciences in Novi Sad because they organized similar competition for their students in 2003. In 2007 this competition began to organize in the Republic Srpska, as a result of cooperation between Ministry of Science and Technological Development of Serbia and the Ministry of Science and Technology of Republic Srpska.

The competition has several phases. First, competitors have to register via internet and if they pass evaluation they get professional training on how to create innovative strategy for their product/service. Second phase includes creating business and marketing plan. Participants that show greatest potential and progress present their ideas publicly – at an exhibition, semi-finals and finals. Main criteria for choosing winner are: economic impact, novelty, growth potential and social impact. This competition has facilitated creation of more than 80 enterprises in Serbia and Bosnia and Herzegovina. It also helped in connecting and presenting to each other research and business sector.

5. CONCLUSION

Commercialization of R&D results and their conversion in profitable goods and services is important determinant of economic development and country competitiveness. Besides other factors, the scope of R&D activities depends on the number of researchers and academic institutions, level of investments in this sector, government policy measures, etc.

In a modern interconnected world, innovations are becoming international, so openness to foreign technologies and cross-border cooperation plays important role in fostering innovation. Innovation process includes various stakeholders and their relationships shape the effectiveness of the process. In order to ensure these linkages, there should exist organisations that support entrepreneurs in introducing products, finding financial resources and establishing new spin-offs.

Available data show that drivers of innovation in Western Balkan countries were generally less advanced than those in new EU members and developed EU economies. WBC still lag behind these countries in terms of number of researchers and scientific papers, number of patent and trademark applications, expenditures for R&D, etc. As a consequence, innovation process in WBC is facing with significant challenges.

In order to increase the effectiveness of converting R&D investments in commercial products, there are many policy mechanisms that can be implemented in WBC. Most of them are oriented on enhancing innovative culture and creating stronger links between research and business sector. Strategic innovation, Innovation Officer and Innovation Vouchers enable individual firms to re-develop their business strategy and orient towards innovation. On the other hand, Soft landing Platforms offer help in getting into new markets, but still the support is given by technology transfer intermediaries. Competition for Best Technology Innovation educates professional and general public about the importance of entrepreneurship and R&D.

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POSSIBILITIES OF OPENING UP THE STAGE-GATE MODEL

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Abstract: *The paper presents basic elements of the Stage-Gate and Open innovation models, and possible connection of these two, resulting in what is frequently called an "Open Stage-Gate" model. This connection is based on opening up the new product development process and integration of the open innovation principles with the Stage-Gate concept, facilitating the import and export of information and technologies. Having in mind that the Stage Gate has originally been classified as the third generation model of innovation, the paper is dealing with the capabilities for applying the sixth generation Open innovation principles in today's improved and much more flexible phases and gates of the Stage Gate. Lots of innovative companies are actually using both models in their NPD practice, looking for the most appropriate means of opening up the well-known closed innovation, especially in the domain of ideation through co-creation.*

1. INTRODUCTION

The need for lean, rapid and profitable new product/service development has never been more evident. In today‟s business world, product life cycle is getting shorter, the competition is getting tougher, users are becoming more demanding, and therefore companies that do not innovate are losing pace with competition and slowly deteriorate.

A growing number of authors and leaders from different branches identified innovation as a key driver for achieving long-term success and profitability (http://www.prod-dev.com/stage-gate.php). Most of today's companies with great concern talk about improvement of their innovation performance in order to deliver sustainable growth and significant competitive differentiation (http://www.sopheon.com/industry-innovation/). However, it must be kept in mind that gaining competitive advantage by offering new product/service is not easy - in fact, it is estimated that about 46% of the funds, which company invests in the development and launch of new products/services is related to unsuccessful projects (http://www.prod-dev.com/stage-gate.php).

Having this in mind, the world's leading companies have revised their processes of product/service innovation, including critical success factors discovered through research of best practice, through introduction of the Stage-Gate new product/service development process. Based on various independent studies, which were conducted by leading consulting companies in the field of innovation management, it was concluded that 70-85% of the leading companies in the U.S. use model Stage-Gate for managing the entire process from idea generation to launching of new product/service to market (http://www.prod-dev.com/stage-gate.php).

Starting from this point, the paper is organized in tree main sections, first related to linear models of new product/service development, describing the development of innovation models through generations and the Stage-Gate model as a main representative of the third one; second related to open innovation model, its features and advantages; and third related to possible connection of previously mentioned models, discussing the ways of embedding the main principles of open innovation in the Stage-Gate model.

2. LINEAR MODELS AND STAGE-GATE

Innovation is identified as a key driver for strengthening of competitiveness, so that fostering innovation has become one of the key priorities in every company that strives to be the leader in the field. Globally, innovation appears to be the central element of today'sknowledge-driven economy, with domination of information-communactions technologies - ICT, as a key strategic dimension bringing completely new ways of communication and business. Even though the importance of innovation is recognized by most companies and they spend a lot of money on innovation, many of these initiatives do not generate reasonable profit or competitive advantage. Plenty of research in this topic reveals that the main problem does not lie in the invention part or the generation of innovative ideas, but more in the successful management of the innovation process from an idea to a successful product in the market (du Preez, Louw, 2008).Having that in mind, successful innovation demands a rigorous process for managing innovation, including a disciplined, stage-by-stage approval process combined with regular measurement of every critical factor, ranging from time and money spent to the success of new products in the market.

When it comes to innovation processes from idea to commercialized product/service, literature proposes a lot of different models and frameworks. Basically, six generations of models can be found, from simple linear to increasingly complex interactive and network ones (Rothwell, 1992), up to new concept of open innovation (Table 1).

Table 1: Development of innovation models (adopted from (du Preez, 1992))

Model	Generation	Characteristics
Technology push	First	Simple linear sequential process, emphasis on R&D; market is the recipient of the R&D results
Market pull	Second	Simple linear sequential process, emphasis on marketing, the market is the source of new ideas for R&D; R&D has a reactive role
Coupling model	Third	Recognizing interaction between different elements and feedback loops between them, emphasis on integrating R&D and marketing – Stage-Gate process, – The Collaborative Innovation Process
Interactive model	Fourth	Combinations of push and pull models, integration within firm, emphasis on external linkages – Minnesota Innovation Research – Program (MIRP) model
Network model	Fifth	Emphasis on knowledge accumulation and external linkages, systems integration and extensive networking – The Creative Factory Systems Innovation Model
Open Innovation	Sixth	Internal and external ideas as well as internal and external paths to market can be combined to advance the development of new technologies

One of the most important elements of this classification is chronological review of models development, where shifting of models from conventional, unilateral, facing the own R&D solutions, via one-sided market orientation, to interactive combination of push and pull models, and contemporary, network models based on knowledge can be clearly noticed (Stošić, 2013).

The first and second generation models are linear models pulled either by market needs or pushed by technology and science. Coupling model as the third generation model recognizes the influence of technological capabilities and market needs within the company‟s framework. Even though the coupling approach encompasses feedback loops it is essentially a sequential model. Cooper‟s Stage-Gate model, which is in the focus of this research, can be looked at as the main representative of this generation. This model divides the product innovation process into series of stages – set of parallel activities, and gates - decision points between the stages. The fourth generation innovation process model, known as interactive model, observes the innovation process as parallel activities across organizational functions. The fifth generation or network models are the influenced by external environment and effective communication with external environment. The sixth generation of innovation models is open innovation models, which can also be seen as network models, but instead of being only focused on internal idea generation and development, internal and external ideas and paths to market can be combined to advance the innovation process (du Preez, Louw, 2008).

Having in mind the aim of this study, the following text will be describing the Stage-Gate model, Open innovation model and possibilities of their connecting i.e. the opening up of Stage Gate model.

Stage-Gate® is a trademark of R.G. Cooper & Associates Consultants Inc., a member company of the Product Development Institute. It stands for industry standard for excellence in new product/service development. This advanced, widely applied and recognized process, skillfully integrates a number of practices in an easy to understand recipe for success. It is characterized by a structure that engages users at all levels and functions, and consequently allows making good and effective decisions regarding further project extension, and impacts on quality and speed of innovation project execution.

The current Stage-Gate is a third-generation process, which incorporates six Fs (Cooper, 1994):

- Flexibility,
- Fuzzy,
- Fluidity,

- Focus,
- Facilitation,
- Forever green.
-

The first three Fs makes the process less rigid, enabling it to be scaled to various size projects and enabling stages to be overlapped and approved conditionally. “Focus” means that the process is connected to a strategy. “Facilitation” refers to specific role gate keeper, who ensures that the process is properly guided. As a final point, “forever green” suggests the continuous improvement of the process. Generally, these six Fs enables a more sophisticated process, but they also encourage more abuse of the process (Cooper, 1994).
Using the Stage-Gate model improves efficiency and reduces the risk of failure, regardless whether it is launching of new product or technology that could change the competitive image in the market, or introduction of new products that could generate additional income for the company, or defense of company‟s market share by introduction of significantly improved product (http://www.stage-gate.com/resources_stage-gate_full.php).

Stage-Gate model is a business process for value creation that is designed for quick and profitable transformation of company‟s best ideas into new products/services. Model as such generates an organizational culture that includes existence of the new product development process leader, strategic responsibilities definition, high-performance teams, focus on customers and markets, excellent solutions, compliance, discipline, speed and quality.

It follows that the Stage-Gate model provides a conceptual and operational roadmap for driving new product development, from idea to launch, i.e., blueprint for managing the process of product/service innovation, aimed at increasing efficiency and effectiveness. Stage-Gate approach decomposes innovation process in a set of phases that comprise a set of planned, multi-functional and parallel activities. At the entrance to each stage is a gate, which role is quality control and decision-making Go/Kill/Hold/Recycle to the process (Cooper, 2011).

Phases are activities undertaken by members of the team owning to gathering the information they need for project progress toward the gate. The phases are cross-functional and activities are undertaken in parallel to speed up the time to market. In order to provide risk management, parallel activities within a particular phase must be designed in a way to gather important information - technical, market, financial, operational (Stošić, 2013).

The model is structured in that way that in front of each stage is a gate, or decision point. The decision about whether an innovation project is going to pass certain gates perform, combined, both internal managers and external experts, so-called gatekeepers. Gates have a dual role. First, to check whether the project met all the criteria identified in previous gate and second, to check whether the project meets the criteria for the current phase.

Every gate includes following (Stošić, 2013):

- Elements that represents deliverables – results of actions from the previous phase;
- Criteria on which the decision on project are made;
- Outputs, representing the results of the decision (Go/Kill/Hold/Recycle).

There are many different predefined qualitative and quantitative criteria based on which the assessment of innovation project is made in every gate. Such criteria have to give answer on the following questions:

- Are the milestones connected to technology met?
- Does the project perform in accordance with time and budget?
- Could innovation concept reach potential benefits for end-users?
- Does the innovation concept coincide with pre-set goals and strategy?

Specific criteria are different from gate to gate and become more rigorous as the project approaches the development stage.

One of the innovation project characteristics is high risk level which to a large extent affects the innovation process stability and depends on the process stage. Consequently, it is useful to execute risk identification in a more precise and efficient way in order to respond in the right time and manner. This is the reason why it is important to choose the right gatekeepers and criteria within the gates to implement the project in line with planned. Different findings on SG benefits and weaknesses are summarized in Table 2.

Table 2: Advantages and disadvantages of Stage-Gate model

Benefits (http://www.stage-gate.com/resources_stage-gate_full.php)	**Common Errors and Fail-Points**(Cooper, 2008)
Accelerated speed-to-market	Gates with no teeth
Increased new product success rates	Hollow decisions at gates
Decreased new product failures	Who are the gatekeepers?
Increased organizational discipline and focus on the right projects	Gatekeepers behaving badly
Fewer errors, waste and re-work within projects	Too much bureaucracy in the idea-to-launch process
Improved alignment across business leaders	Too much reliance on software as a solution
Efficient and effective allocation of scarce resources	Expecting the impossible from a process
Improved visibility of all projects in the pipeline	
Improved cross-functional engagement and collaboration	
Improved communication and coordination with external stakeholders	

P&G is one of the companies which can be seen as a good example of applying the Stage-Gate model. It introduced the SIMPL™ model which consists of four main stages, where stages represent a set of current best practices in the form of key activities, and also clearly defined deliverables for project team (Figure 1). There are also four gates or decisions points in the model, which are comprised of a team recommendation and a management decision (Cooper & Mills, 2005).

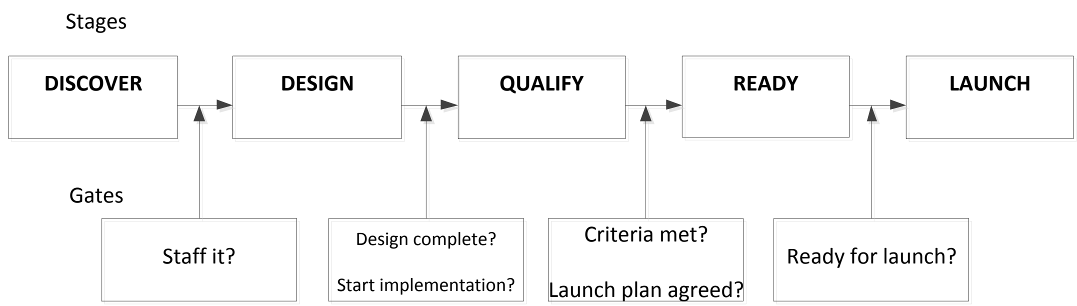

Figure 1: P&G"s SIMPL™ Process - An Idea-to-Launch Stage-Gate® Model (adopted from (Cooper & Mills, 2005))

3. OPEN INNOVATION AS A NEW PARADIGM

In today"s intensely competitive environment the main question is no longer why to innovate, but how to innovate. Bearing that in mind, innovation theory recognized that not all good ideas come from inside the firm, neither all good ideas emerged within the particular firm should be commercialized by that same firm (Gabel & Chesbrough, 2011).

Based on aforementioned, Henry Chesbrough coined the term “open innovation” to describe a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology (Chesbrough, Vanhaverbeke and West, 2006). While Chesbrough (2003, 2006) partly admits the rich source of antecedents to the „open innovation paradigm", there are some authors such as Trott and Hartmann (2009) who claim this paradigm to represent just an old wine in new bottles, meaning repackaging and representation of concepts and findings presented over the past forty years within the literature on innovation management.

The model of open innovation is based on the movement of ideas across organizational boundaries. Valuable ideas can be generated externally (outside the organization) and internally (within the organization), which also refers to the output of the innovation process, i.e. placement of innovations to the market.

On the other side, the conventional internal model of closed innovation is based on the principle of control for the success of innovation and innovation projects. The organization needs to generate and control their own ideas in the same way as the functions units - production, marketing, finance. The main features of both models are shown in the Table 3.

One of the factors that led to abandoning the concept of the closed innovation is the mobility and accessibility of knowledge due to ICT. Therefore, employees" fluctuation is encouraging knowledge transmission, resulting in a higher throughput of knowledge between the organizations. This has changed the logic of modern innovation processes and models, growing from closed to open ones, through well-known principles given in Table 3.

Table 3: Features of Open and Closed innovation model (Chesbrough, 2003)

Closed Innovation Principles	Open Innovation Principles
The smart people in the field work for us.	If we create the most and the best ideas in the industry, we will win.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value: internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to the market first.	We don"t have to originate the research to profit from it.
The company that gets an innovation to the market first will win.	Building a better business model is better than getting to the market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
If we create the most and the best ideas in the industry, we will win.	We should profit from others" use of our IP, and we should buy others" IP whenever it advances our business model.

For the successful implementation of this model, the organization should define the business in a way to use advantage of both internal and external ideas which can be improved through internal R&D, and to build an adequate business model which will provide greater value for the organization.

Key Factors to Implementing "Open Innovation" (Docherty, 2006):

- Broaden your view (where you look and your ability to see what"s there);
- Create alignment across the innovation ecosystem;
- Adapt an approach for your organization"s tolerance for risk;
- Put the focus on learning, not just results.

Many of the market leaders such as GE, Cisco, Adobe, Nokia, P&G, Spalding, Starbucks, successfully use the model of open innovation in order to improve their products/services, reduce the cost of R&D, solve technical problems and accelerate time to market (Stošić, 2013).

P&G has institutionalized its Connect and Develop program to ensure external ideas have access to the organization and that internal intellectual property is marketed to the outside. Aiming to speed and simplifying external innovation connections, P&G"s Connect and Develop program launched a new website, linking innovators directly to top company needs, and P&G business leaders directly to external innovation submissions. In the spirit of C+D, the web site was developed in collaboration with several external partners, which brought new innovative technology to the back-end of the site, enabling user submissions to directly feed into the business category leaders. This will allow P&G to review needs more quickly and more efficiently for strategic fit or scalability across the business.
(http://www.pgconnectdevelop.com/home/stories/cd-stories/20130207-pg-connectdevelop-launches-new-open-innovation-website.html)

4. POSSIBILITIES OF CONNECTING THE STAGE-GATE AND OPEN INNOVATION MODEL

Concerning the market needs and treat that internal R&D isn"t the engine of innovation anymore, left companies no options but to adapt their business if they want to stay competitive and not to miss opportunities any longer. Referring to that and the fact that a lot of external knowledge is now accessible, companies which have been using Stage-Gate model for their new product/service development make a great effort to improve their model, broadening it with open innovation features (Grolund, Ronneberg & Frishammar, 2010). It assumes accommodation of flowing the new ideas, intellectual property, technology or even fully developed products from external sources.

Companies which have moved to open innovation, also have to modify their Stage-Gate process, and consequently to modify their business model, making it more flexible in order to enable proper surrounding for networks of partners, alliances and outsourced-vendors. One of the best examples of Open innovation

Stage-Gate model usage is company P&G, which released SIMPL 3.0 version Stage-Gate system, designed to handle external ideas, technologies, and even fully developed products (Cooper & Edgett, 2008).

Using the open innovation in new product/service development implies its involvement in all three aspects of the innovation process, including ideation, development, and commercialization (Figure 2).

Ideation or Discovery stage: The first phase of the innovation process/project is always generating ideas - in the literature also known as ideation. The beginning of generating ideas process is always associated with the identification and understanding that somewhere there is a gap, i.e. new product characteristics, new elements of the business improvement process technology, a completely new business model (Cooper & Edgett, 2005; Cooper, 2011; Kahn, 2013; Stošić, 2013).This is the stage in which companies go across their borders looking for external information that could be helpful in satisfying customer"s needs, when it comes to ideas for new product/service development (http://www.stage-gate.com/resources_stage-gate_openinnovation.php). Many companies such as Starbucks, P&G, BMW, now use open ideation or co-creation, offering the possibility to customers to share their ideas by giving them problems the company is facing with or just giving them possibility to propose some new idea over the companies" sites.

Building the Business Case: Implies detailed market research, consumers" needs and desires, stakeholder analysis, concept testing, detailed financial and business analysis. As a result of the stage, a business case is obtained, i.e., defined the product/service, business justification and a detailed action plan for the next stage (Cooper & Edgett, 2005; Cooper, 2011; Kahn, 2013; Stošić, 2013). Concerning open Stage-Gate, this stage includes actions such as identification of missing internal capabilities, seeking for potential partners who will provide technological or marketing capabilities to develop and commercialize new product/service, developing an intellectual property strategy (http://www.stage-gate.com/resources_stage-gate_openinnovation.php).

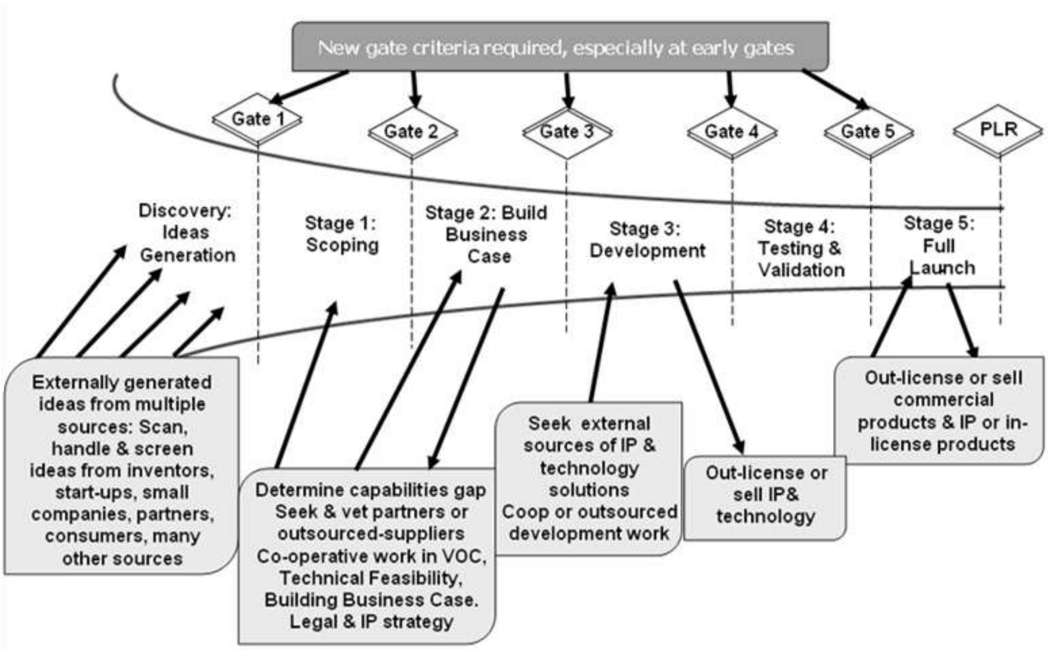

Figure 2: Open innovation Stage-Gate model
(http://www.stage-gate.com/resources_stage-gate_openinnovation.php)

Development stage: Within this stage comes to implementation of the action plan and development of new product or service. It is necessary to carry out various tests within the company"s laboratory in order to confirm that the product meets all the requirements (Cooper & Edgett, 2005; Cooper, 2011; Kahn, 2013; Stošić, 2013). Concerning the open Stage-Gate system, companies cooperate with suppliers or partners trying to solve technology and development problems and also try to get external innovations which have already been commercialized. Furthermore, companies can out-license or sell their internally developed technologies and intellectual property (http://www.stage-gate.com/resources_stage-gate_openinnovation.php).

Launch or commercialization stage: Start of full production and commercial launching of the product and its sales. Within this stage monitoring of the innovation project is carried out, as well as detecting and correcting mistakes (Cooper & Edgett, 2005; Cooper, 2011; Kahn, 2013; Stošić, 2013).On the other side, the open Stage-Gate system should enable the company to sell or out-license already commercialized products if there is a possibility to gain more value elsewhere; or to in-license – purchase an already commercialized products for achieving new growth for the company (http://www.stage-gate.com/resources_stage-gate_openinnovation.php).

Speaking about gates and criteria they include, they must also be modified in the open Stage-Gate system. In this case, not having all the capabilities to develop or execute a project doesn"t lead to a "Kill", but leads to seeking a partner to handle the missing elements. These modified criteria must be introduced, dealing with partner or supplier selection and their capabilities (http://www.stage-gate.com/resources_stage-gate_openinnovation.php).

Having been a leader in Open innovation model employment, P&G also made an effort to develop and introduce the *open Stage-Gate* model, frequently cited as SIMPL 3.0. This is the version of a Stage-Gate model and is a method used to drive products from idea to launch stages with clear go/kill criteria and timing requirements (Panduwawala, Venkatesh, Parraguez & Zhang, 2009). In addition, one of the examples that should be useful to mention is General Electric"s open Stage-Gate named "Toll-Gate" (Stage-Gate system) for handling an open innovation, both out-bound and in-bound (http://www.stage-gate.com/resources_stage-gate_openinnovation.php).

5. CONCLUSION

In this paper we discussed the opportunities to make connection between the Stage-Gate and Open innovation model, to integrate the open innovation principles into a closed new product/service development model. As it is previously stated, open innovation principles infiltrate almost every stage of the Stage-Gate process, while recently the most popular engagement of open innovation is in the ideation phase. The companies through co-creation or crowdsourcing try to solve current problems or even try to somehow attract end users to propose their ideas through online or offline games or over the companies" sites.

Various papers confirm that opening up the new product development process, in this case Stage-Gate process can generate significant value. On the other side, its implementation can be very challenging. We presented both Stage-Gate and Open innovation model and emphasized the possible points of their association. When it comes to this connection, it should be pointed out that not only changes in the Stage-Gate process has to be made but also company's current business model and capabilities have to be put under examination. For this model, very important is dynamic view, where companies should continuously revaluate their business models and be aware of own capabilities in order to successfully leverage problems when engaging in external collaborations (Chesbrough & Schwartz, 2007).

The "Open Stage-Gate" model has many benefits, starting from the fact that this model systematically integrates the principles of open innovation with existing Stage-Gate processes; it increase companies" proficiency in outbound open innovation activities (selling intellectual property - licensing); it provides systematic application of open innovation principles; it helps managers to continuously evaluate and adjust companies" capabilities and business model, i.e. business model innovation; it allows systematic review and assessment of importing intellectual property from outside the boundaries. Involvement of external know-how and technology can contribute the company in many ways, such as to complete a product, add value to the product offering, speed up the innovation process and reduce development costs (Gabel & Chesbrough, 2011).

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THE EVOLUTION OF MOBILE TECHNOLOGY IN RETAIL MARKETING CHANNELS IN THE REPUBLIC OF SERBIA

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Abstract: *The evolution of retail institutions in marketing channels goes towards the implementation of modern information technology. The use of mobile technology is influenced by changes in buying habits and improvement of the buying experience of consumers on a global scale. Mobile commerce application has an increasing tendency with significant involvement in the whole electronic commerce in the market of developed countries. Retailers implement mobile technology tin order to get closer to consumers, to present their offers and become competitive. Offer becomes available in the global market thanks to mobile technology, which allows comparison of different retailers' offers by consumers. Modern mobile technology in the Republic of Serbia is an opportunity for growth of the application of mobile retailing in the country.*

Keywords*: marketing channels, mobile technology, retailing, globalization, internationalization*

1. INTRODUCTION

The application of modern technologies in the retail marketing channel is changing the structure of the channel, as well as the relations between participants in marketing channels. Retailers adapt to changes in the global market in order to reach the individual consumer, which is much easier with the implementation of new mobile technology. Changes in the mobile technology have an increasing impact on end-users in the Republic of Serbia, which is a potential that needs to be utilized.

The development of mobile technology in marketing channels set the following goals: continual evolution and trends of mobile technology in marketing channels, development and implementation of mobile technology in the process of globalization and internationalization, the use of mobile technology in the Republic of Serbia.

The main goal of this paper is to show implementation of mobile technology in modern marketing channels, all influenced by rapid technological changes in the global market. It should be noted that the use of new mobile technologies in the retail channel marketing aims to increase the competitiveness and reaching the end consumer. The research goals will be achieved by applying analytical, descriptive and comparative methods in data processing.

2. EVOLUTIONARY DEVELOPMENT OF NEW MOBILE TECHNOLOGIES IN MARKETING CHANNELS

The use of technology in marketing channels led to a closer relationship between all participants in the marketing channels, including connection with the consumer. The technological revolution in telecommunications, as well as changes in lifestyle of potential customers has enabled the development of mobile technologies in marketing channels. New mobile technologies have found their implementation in marketing channels, especially in retailing, because it is an attractive way for purchasing for some groups of consumers.

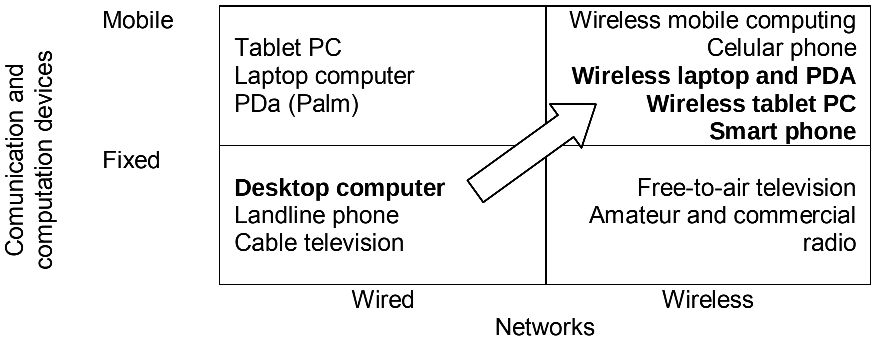

Figure 1: The development of the wireless mobile environments (Turban, King, et. al., 2010, p. 386)

Namely, the use of desktop computers and the necessity of connection of the computer to the Web, restricts those who want to obtain information about offers, or even do their shopping while on the way home, at work or in any other situation, when computer it is not available.

An additional factor which "pulls" the development of mobile application technologies are innovations in telecommunications and the emergence of new mobile devices with increasing performances, which exceeds the power of desktop computers. The evolution of new mobile technologies in marketing channels has led to the development of mobile environments. As it can be seen in Figure 1, the further development of the application of mobile technologies by consumers is influenced by the spread of use of mobile devices, especially smart phones with the characteristics of computers and tablet PCs, wireless laptops and PDAs that have a direct or wireless connection to the Web. Furthermore, mobile commerce includes any business activity conducted over the wireless network (Turban, King, et. al., 2012, p. 277).

In developed countries, the market share of mobile commerce in the overall e-commerce is rising from year to year, while in some countries show greater significance than the e-commerce. In the USA mobile commerce generated $41.68 billion of the total $262.3 billion of e-commerce sales in 2013, which was an increase of 68.2% from 2012 and account for 16% of total ecommerce sales (Forbes, http://www.forbes.com/, February 2013).

For the development of mobile commerce use by participants in marketing channels, it is necessary to access to adequate technical support for conducting transactions, the development of telecommunication network for rapid and secure exchange of information, adequate software support, applications that are customized and that are simply used by the user, and the willingness of all participants to accept the technology. Therefore, the infrastructure that supports mobile commerce requires the cooperation between multiple stakeholders such as mobile operators, service providers, manufacturers of mobile devices, Internet service providers, to the banking institutions and retailers and acceptance of technology by end-users, namely potential consumers.

In Figure 2 we can see the trend of exponential growth in sales via smart phones in the U.S. since 2012, with growth in the 2015th year, and an increase in the share of total e-commerce.

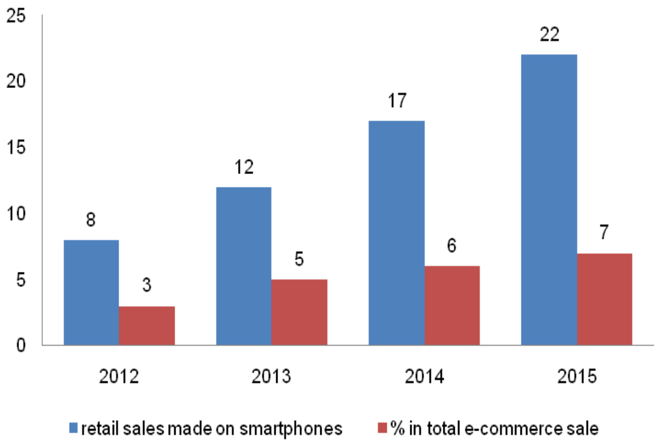

Figure 2: The U.S. Mobile commerce sale via smart phones in billions and share in total e-commerce sale with predictions in next years (Forrester Research, http://blogs.forrester.com/, January 2013)

In addition to high-performance smart phones, full use of smart phones means the existence of a developed telecommunication network. For the development of mobile commerce is crucial the evolution of mobile networks, and today we talk more about the implementation of 4G and 5G networks for mobile commerce. It is expected that transactions through mobile phones will rise to a thousand times until the 2020, influenced by the development of the new 5G network. The new technology should provide faster Internet at any time, video calls, instant access to on-line databases, creation of shopping lists, and buying via mobile devices will become more common (Končar, Leković, & Petrović-Katai, 2013, p. 122).

Smart phones with 5G technology have the possibility to choose the most secure data connections and ensure safe and fast transactions of mobile commerce. Data about the use of mobile devices, such as smart phones and tablet computers, shows their rise in share in turnover of retail marketing channel from year to year, and that tends to increase in the coming period, especially in developed market countries, such as the USA, Japan, Australia and so on. According to e-Marketer research in 2013 half the users of mobile technology in the United States will have a connection to the Internet (Lovreta, Končar & Petković, 2013, p. 435).

Table 1: The U. S. Mobile commerce sale via smart phone and tablet (eMarketer, https://www.emarketer.com/, April 2013)

year / share	2012	2013	2014	2015
retail m-commerce sales	24.81	38.84	53.41	71.16
% change	82	56.5	37.5	33.2
% retail e-commerce	11	15	18	21

The use of smart phones in recent years is growing due to the multifunctionality, and the additional benefits are provided by tablet computers. Therefore, in the further development of new mobile technologies in marketing channels is important the usage of high-performance mobile devices. In the developed countries a large part of the mobile commerce transactions are conducted via smart phones and tablet computers, which affects the growth of the total e-commerce transactions.

3. BUILDING THE MOBILE RETAIL CONCEPT IN CONDITIONS OF GLOBALIZATION AND INTERNATIONALIZATION OF THE MARKET

Although the revenue from mobile retailing is relatively small, this concept begins to occupy an important place in the shopping experience in traditional retailing. Mobile retailing improves shopping experience and allows interaction between consumers and retailers on global market. Thanks to the mobile retailing, retailers have the opportunity to develop interactive relationships with consumers, to learn about consumers' individual needs in the best way, and appropriately and quickly respond to consumers' demands.

Gaining a significant role in the modern process of buying, mobile retailing is used in different business forms of retail sector. With mobile phones, smart phones, tablet computers and other mobile devices that have access to the Internet, buying process is easier because it is allowed to search products, locate store and products in the store, compare prices on the Web, and so on. By that, consumer has the opportunity not only to communicate with the retailer, but also transfer its experiences to other consumers globally, as all information is available on the Web.

The use of mobile technology in retail affects on the value of the sales, which is directly associated with factors related to end-users, ie. potential consumers. Factors that are relevant for the adoption of mobile technology are income per capita, the number of mobile phone users, the availability of technology, consumer buying habits, education and information literacy of users, and so on. There are different ways of application and use of mobile technology by end-users, ie. potential consumers. The application of modern mobile devices has an impact on changing habits and behavior of consumers. Consumers are using mobile devices to access the Web and come up with the necessary information about the offer, especially (Deloitte, October 2013, p. 20):

- 56% getting store locations,
- 54% check/comparing prices,
- 47% getting product information,
- 45% shop/browsing online,
- 40% checking product availability in a store or website,
- 36% get/using discounts, coupons, sales information,
- 32% scanning product barcodes to find more product information,
- 31% making a purchase online,
- 24% getting text messages or exclusive deals from retailers.

Based on the above, it can be concluded that the use of new mobile technologies in retailing has an impact on the achievement of competitive differentiation against the competition, in such a way that the information is available to potential consumers irrespective of the consumers' location. Location-based mobile commerce (the user is physically located at any place) is the key for offering relevant personalized services, which is the combination of personalization and location (Končar, 2008, p. 242).

Mobile retailing offers new possibilities to end consumers regardless of time and space. In combination with locating retail store or products, mobile retailing creates new value for consumers. The following years are considered crucial for the penetration of mobile retailing in the global market. In Table 2 is a growing trend in the mobile retailing in the United States, as well as a growth of the share in the total e-retail.

Table 2: Predictions of the US retail m-commerce sales 2011-2015, with the % sale and share in retail e-commerce sales (Forbes, http://www.forbes.com/, February 2013)

year / share	2011	2012	2013	2014	2015
retail m-commerce sales	13.57	24.78	41.68	56.72	75
% change	171.7	82.6	68.2	56.72	32.2
% of retail e-commerce sales	7	11	16	19	22

As it is presented in Table 2, as in the preceding parts, the United States leads the world in the application of mobile technology and mobile commerce. Retailers in the U.S. implement mobile commerce in their business. A large number of medium and large retailers in the United States recognize the importance of mobile commerce in achieving competitive advantage and positioning over the competition. However, it can be concluded that mobile retailing is a still a small percentage of the global e-commerce, or mobile commerce, and therefore have a little share in total retail trade. The only exception is Japan with advanced mobile retailing. Region with a high-paced growth of mobile retailing is East Asia, where growth is much higher than in Europe. A significant portion of electronic retail transactions in Japan are conducted through mobile devices, which is why this country is considered to be advanced in the application of mobile technology in retail.

4. THE CONCEPT OF MOBILE RETAILING IN FUNCTION OF THE DEVELOPMENT OF THE MODERN MARKETING CHANNELS IN THE REPUBLIC OF SERBIA

For the development of mobile commerce in the Republic of Serbia, a necessary factor is the implementation of the infrastructure of mobile commerce. Retailers in Serbia should take into consideration the advantages of mobile commerce for business development. The strategy of mobile commerce should be a support to existing businesses.

Using the latest generation of mobile telephony should improve and precedes the development of mobile commerce in Serbia. Mobile operators in Serbia conducted testing 4G mobile network in real conditions in April 2011. Bimonthly testing was performed in collaboration with manufacturers of mobile devices, companies Ericsson, Huawei and Nokia Siemens Networks, that have installed their equipment in multiple locations. Successful tests have shown that the mobile network in Serbia is fully prepared for the introduction of LTE technology and the launch of next-generation mobile telephony. Bearing in mind that only part of the frequencies intended for the use of 4G technology is in use at present, only after the completion of the digitization process, which will happen in 2014, use of a wider frequency range and 4G phones will be in use in our country (Končar, Leković & Petrović-Katai, 2013, p. 122). Croatia has started to operate a 4G network based on LTE technology that brings users up to ten times higher data rates than previously.

Table 3: Devices used for accessing the Internet in the Republic of Serbia from 2006 to 2013 (Republički zavod za statistiku, 2013)

year / device	2006	2007	2008	2009	2010	2011	2012	2013
PC	94.0	90.0	95.2	93.2	91.1	88.7	84.8	80.9
Cellular phone	-	26.6	24.8	25.4	21.8	15.7	37.2	46.1
Laptop	4.6	8.6	8.5	15.4	19.3	27.8	35.4	46.6
Game consoles	-	-	-	1.5	1.3	1.1	1.3	2.8
PDa palmtop	-	0.5	0.5	0.7	0.1	0.2	1.1	5.0
TV	-	0.2	0.1	0.2	0.1	0.4	0.8	3.5

As the main factor in the further development of mobile retail in Serbia is the number of users of mobile devices, as well as information literacy of users. Number of mobile phone users has increased to 86.9% (up from 83.9% a year earlier) in 2013 in the Republic of Serbia (Republički zavod za statistiku, 2013, p. 2). In Table 3 it can be seen that for access to Internet users mostly use PCs (80.9%, with a fall in the previous year), and for this purpose the mobile phone is used by 46.1%, an increase over the previous year from 37.2%. However, using a PC to access to the internet from year to year declines, while growth in the use of mobile phones, laptop and tablet computers recorded growth in the period 2006-2013. Based on the above it can be concluded that the growth of mobile phone use will continue in the future, as well as use of the Internet by users, as a necessary condition for the implementation of mobile commerce.

Additional prerequisite for the implementation of mobile retailing is the development of mobile payment systems. What is recognized is that mobile payment systems are developing in recent years in Serbia. Thus, in cooperation with mobile operators and banks is developed a system for mobile payments “PlatiMo”, through mobile phones. Also, very popular in the Republic of Serbia is voucher system “Qvoucher”, which acts as an electronic "supplement" for payment goods and services on the Internet. After only two years since the introduction of this system it has over 20,000 users and over 25,000 transactions per month.

Revenue from mobile retailing in Serbia is relatively small, but its aspect begins to occupy an important place in the shopping experience. Mobile retail is yet to show its full potential in generating growth across all retail channels, along with improving the buying experience by allowing greater interaction between consumers and retailers. Exploitation of mobile technologies will enable retailers to be oriented towards the user, potential customers, develop closer relationships and increasingly meet the needs of individual consumers.

5. CONCLUSION

Continual evolution of new technologies and trends in marketing channels, under the influence of global environmental factors, leading to innovation and the emergence of new mobile devices with increasing performance. Thanks to the mobile retailing, retailers have the opportunity to develop interactive relationships with consumers in the global market. The implementation of new mobile technologies in retailing has an impact on the achievement of competitive differentiation against competitors in marketing channels. The implementation of new mobile technology needs to improve and develop mobile commerce in Serbia. As the main factor for this development of mobile retailing in Serbia is a growing use of the Internet by consumers.

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ADVANCED REAL ESTATE MANAGEMENT SYSTEM

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Abstract: *GIS and Internet services are one of the leading trends in the new developments of the information technology. Their impact could be seen in the different sectors of business and management. Very closely connected to the new paradigm of mobility, detecting the space/location is becoming one of the most important point for the different industries. Contrary to isolated use of technologies, Advance Real Estate Management System presents integration of GIS and Internet as one of new models in business management.*

Keywords*: GIS, Internet, Management, Real Estate, Model, Software*

1. INTRODUCTION

Information technology has shifted the paradigm of the global economy. In a macroeconomic sense, information technology affects the patterns of production, investment and employment. In a microeconomic sense, information technology changes business activities (Eui-hwan, 1999). The world is changing from the industrial age to the information age. The rise of information technology marks a more complex relations between space and time. The accent must be on the approach to treat the space and time as the key, integrated entities in the "new mobility".

Where people live? What they do? Where, when and how they go? And where, when, and how they spend their money are now key factors in the business success. From product development to distribution, marketing and sales, GIS technologies help companies identify, understand and serve their markets far more effectively than ever before (Winslow, 2002).

Space, place, location plays a key role in determining the type and nature of human activity. The space/location determinant is correlated with consumers' information needs, and product or service choices. Many previous papers from various fields have discussed the usage of space information in day-to-day business applications (Goodell & Syverson, 2007), (King, 2009), (Svantesson, 2007), (Briney, 2013).

However, as GIS technologies progress and spread across the globe, the more questions are arising. What can businesses do to stay ahead of the changes? Which technologies are the most efficient and flexible for different business models? What this type of the information could tell us about business processes and how do we use those insights to manage the same processes?

It is important to note, space/location as furthered by this renewed Internet industry has seemingly extended the influence of the 'social' as a driver of contemporary Internet innovations (Sap executive insight paper, 2011). Internet and surrounding communication technologies are becoming the key drivers in the innovations and new business models.

2. INTEGRATING GIS AND INTERNET TECHNOLOGIES FOR NEW BUSINESS MODELS

GIS's development has been more evolutionary, than revolutionary. It responds to contemporary needs as much as it responds to technical breakthroughs. Planning and management have always required information as the cornerstone. Early information systems relied on physical storage of data and manual processing. With the advent of the computer, most of these data and procedures have been automated. As a result, the focus of GIS has expanded from descriptive inventories to entirely new applications involving prescriptive analysis.

In the past, analytical models have focused on management options that are technically optimal. Yet in reality, there is another set of perspectives that must be considered, the business solution. It is this final sieve of management alternatives that most often confounds geographic-based decisions. These are not the usual quantitative measures amenable to computer algorithms and traditional decision-making models (Berry, 2000).

The step from technically feasible to business acceptable options is not so much increased scientific and econometric modelling, as it is communication. Basic to effective communication is involvement of interested parties throughout the decision process. This new participatory environment has two main elements—consensus building and conflict resolution. Consensus building involves technically-driven communication and occurs during the alternative formulation phase. It involves a specialist's translation of various considerations raised by a decision team into a spatial model. From this perspective, an individual map is not the objective. It is how maps change as the different scenarios are tried that becomes information. Often, seemingly divergent philosophical views result in only slightly different map views. This realization, coupled with active involvement in the decision process, can lead to group consensus (Berry, 2013).

However, if consensus is not obtained, mechanisms for resolving conflict come into play. The business-driven communication occurs during the decision formulation phase. It involves the creation of a "conflicts map" which compares the outcomes from two or more competing uses. Each map location is assigned a numeric code describing the actual conflict of various perspectives. For example, a parcel might be identified as ideal for a wildlife preserve, a campground and a timber harvest. As these alternatives are mutually exclusive, a single use must be assigned. The assignment, however, involves a holistic perspective which simultaneously considers the assignments of all other locations in a project area.

Traditional business approaches rarely are effective in addressing the holistic problem of conflict resolution. Even if a scientific solution is reached, it often is viewed with suspicion by less technically-versed decision-makers. Modern resource information systems provide an alternative approach involving human rationalization and tradeoffs. The dialogue is far from a mathematical optimization, but often comes closer to an acceptable decision. It uses the information system to focus discussion away from broad philosophical positions, to a specific project area and its unique distribution of conditions and potential uses (Berry, 2000). In this direction, GIS might have the unique ability to be the right solution.

GIS uses spatio-temporal (space-time) location as the key index variable for all other information. Just as a relational database containing text or numbers can relate many different tables using common key index variables, GIS can relate unrelated information by using location as the key index variable. The key is the location and/or extent in space-time.

Any variable that can be located spatially, and increasingly also temporally, can be referenced using a GIS. Locations or extents in Earth space–time may be recorded as dates/times of occurrence, and x, y, and z coordinates representing, longitude, latitude, and elevation, respectively. These GIS coordinates may represent other quantified systems of temporo-spatial reference (for example, film frame number, stream gage station, highway mile-marker, surveyor benchmark, building address, street intersection, entrance gate, water depth sounding, POS or CAD drawing origin/units). Units applied to recorded temporal-spatial data can vary widely (even when using exactly the same data, see map projections), but all Earth-based spatial–temporal location and extent references should, ideally, be relatable to one another and ultimately to a "real" physical location or extent in space–time.

Related by accurate spatial information, an incredible variety of real-world and projected past or future data can be analyzed, interpreted and represented to facilitate education and decision making (Rafi, 2011).

GIS technologies are not merely about space location, in this sense, and can be read as technologies of mobility. As Cresswell (2010) writes, mobility is “the entanglement of movement, representation, and practice”. Physical movement, Cresswell continues, is the “raw material” of mobility. Beyond this notion, however, representations of mobility abound. Mobility is thus about the meanings of movement (or the absence of movement) (Cresswell, 2011). In this sense, mobilities demand the recognition of the spatiality of our worlded interactions, despite the ways in which space and time are “tamed”, to use Massey (2005), by some methods for measuring movement.

The rise of Internet technologies marks a further enabling of the turning of space into time, while also producing more complex relationships of mobility between the here and there. These geographies of information technology emphasize the ways in which technology imbricates in everyday life.

It therefore becomes apparent that new models cannot succeed in a business sense without integrated framework based on detailed knowledge of GIS and Internet technologies.

3. RESEARCH AND OBJECTIVES

This research aims to develop an effective response to the challenges currently faced by emerging GIS and Internet technologies and their influences in different new business models.

It is intended that the research findings will contribute to the development of a framework/model designed to support the creation of the software which could be effectively used to manage new business models.

These above aims raise the following core project objectives:

• To identify different location/positioning and communication technologies

• To propose ways in which these specific technologies may be combined

• To create software to manage new business model related with Real Estate and property market

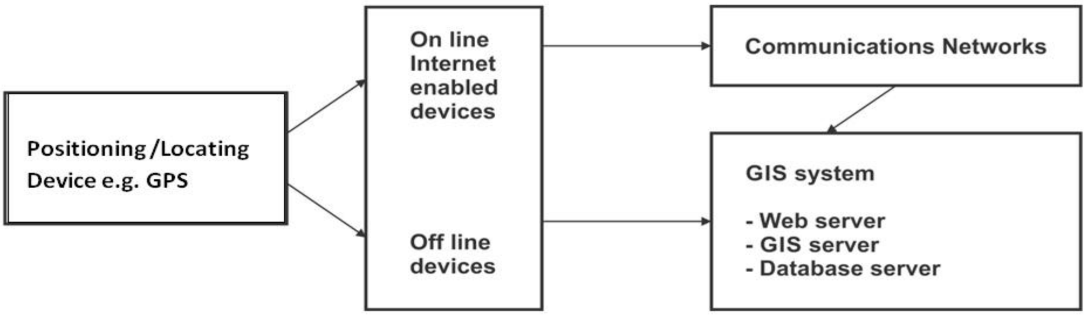

Figure 1. GIS and Internet technologies integrated with the communications networks

4. METHOD

HTML5 with Geolocation API was used and tested on the following the browsers and Geolocation service (including corresponding maps):

- Chrome - Google Location Services
- Firefox on Windows - Google Location Services.
- Firefox on Linux - GPSD
- Internet Explorer 9+ - Microsoft Location Service.
- Safari on iOS - Apple Location Services for iPhone OS 3.2+.
- Opera - Google Location Services.

The following code (JavaScript) was applied in the part of GIS in order to get the current location of the user:

```
// Current position
navigator.geolocation.getCurrentPosition(prcsGeolocation,geolocError,
{
timeout: 0,
enableHighAccuracy: true,
maximumAge: Infinity
}
);
//Tracking position
Id = navigator.geolocation.watchPosition(prcsGeolocation,geolocError,
{
timeout: 0,
enableHighAccuracy: true,
maximumAge: Infinity
}
);
```

Figure 2 Snippet of the code

The method of comparison was used with the following criteria:

- Accuracy of location
- Work in the different environments (in-door, bad weather conditions etc)
- The range of the different platforms and devices
- The level of adaption with open source software (like PHP, MySQL)

5. APPLIED GIS - ADVANCED REAL ESTATE MANAGEMENT SYSTEM

Malta is a southern European country in the Mediterranean Sea. With the area of 316 km2 and the population of 400000 people, Malta is one of the world's smallest and most densely populated countries. Malta's population density of 1,282 per square km is by far the highest in the EU, and one of the highest in the world [17- [Online]. Available: http://mt.wikipedia.org/wiki/Malt, 2014.]. Very limited space with population density and advance economy has a serious impact in many different sectors. One of this area is real estate or property market.

Malta with very good standard, historically always important geographic position, moderate climate, membership in Europe Union, is very attractive location for many people to buy or rent the property. The prices in last decade clearly indicates this trend. However, the micro location is increasingly becoming the key factor in the most of the business decisions related with the real estate system in Malta. It was clear the new information system needs to be in place, which represents not only the properties, but more the complete environment around the properties. The price is important factor, but the location is even more important.

The new system is based on GIS architecture with the following components:
- HTML5 with Geolocation API
- XML
- PHP
- MySQL

The main features of the system:
- Clear separation of the client and server side
- HTML5 and JavaScript enables all the platforms (Windows, PC, MAC) and devices (PC, SmartPhone, Tablet) to use the system
- Using XML as de-facto standard in exchange format
- PHP and MySQL as open source technologies

There are two parts of the application:
- Administrator part which is responsible for all input and updates of the data
- The part for Public user which could search for the property

Using HTML5 Geolocation API, which separates the implementation of Geolocation from the underlying devices, there are several benefits:

- There is a solution for the limitation of GPS (Chivers, 2013) which cannot work in bad weather conditions or in-door environment.

- Combining several methods of the positioning like GPS, A-GPS, Cell-ID, Wi-Fi (Reardon, 2005) etc, the accuracy of the coordinates is improved and it is available in all different environments.

- Web interface brings main advantage to avoid any limitation of using different devices with the different operating systems

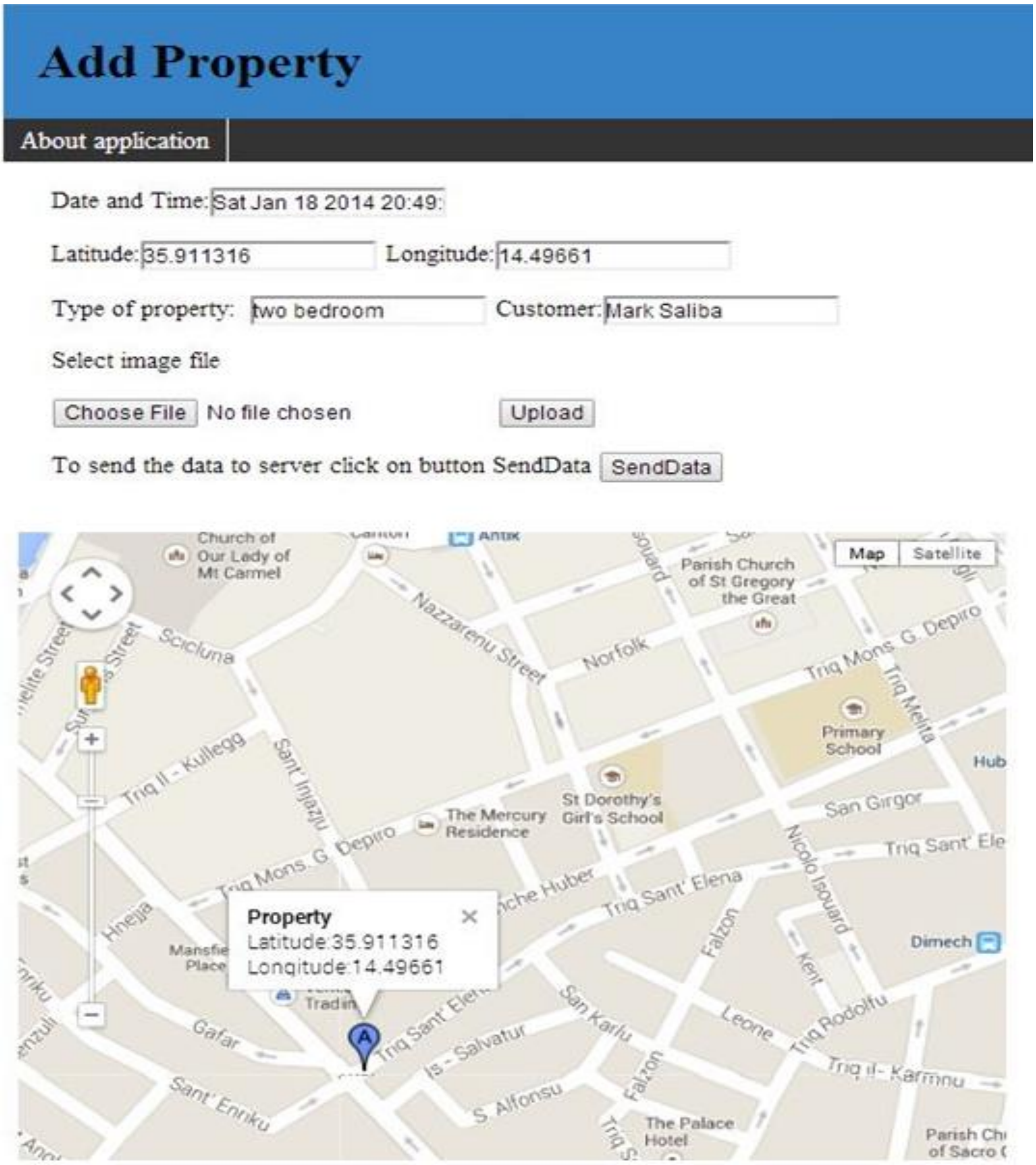

Figure 3. Add Property

Very important feature of the new system is the ability to add the objects which are located near the property. As it was mentioned, micro-location is becoming very important factor in any business decisions related with property.

How far is the post office? How far is the bank? But even more important the information about some small objects which usually is not available, like small supermarkets, green grocery shops, pharmacy etc.

Similar to the previous screen, adding the object located near the property is very simple process, getting the coordinates of the object, inputting the details of the object and send data to server.

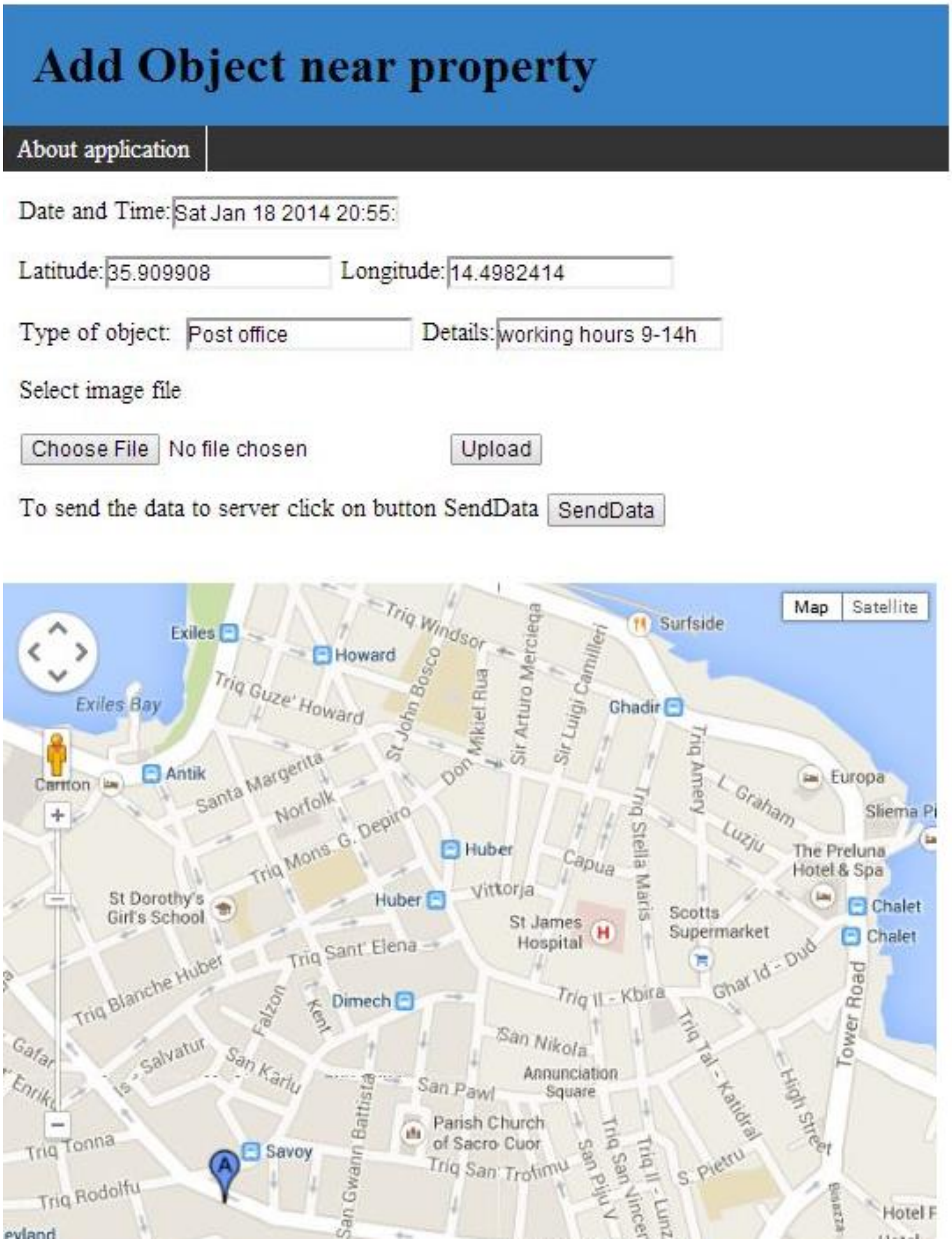

Figure 4. Add Object near the property

Public user of the application could use the search in two modes:

- Selecting the position of the map and inputting the search criteria like; find and show all the properties which are located in the distance of 500 m from this position and the value of these properties not to exceed 100 000 euro.

- Automatically getting the current position (show on the map) and inputting the search criteria like; find and show all the properties which are located in the distance of 500 m from this position and the value of these properties not to exceed 100 000 euro.

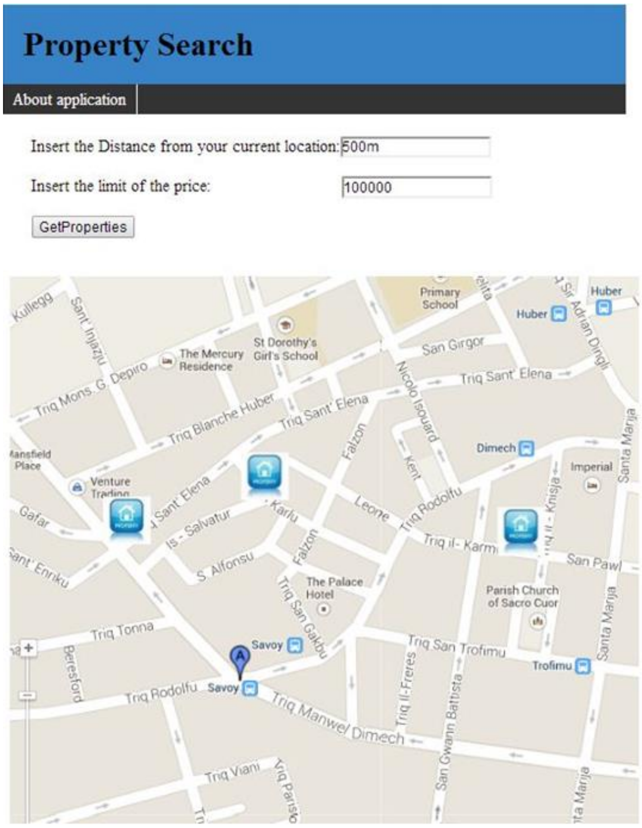

Figure 5. Property search

Figure 5. Shows three properties with above-mentioned conditions.

Figure 6. Property View

Clicking on one of these properties (exactly clicking on the icon which represents the property) from the Figure 5. the next screen (Figure 6.) will show the property.

The details of the property will be shown, like one or two images and the objects close to this property. The location of the objects and ability to see their position in a relation with the location of the property will give the new details about the property itself.

6. CONCLUSION

The new trends and developments of the information technology have very important or even the critical impact to all spheres of today's economy. Technological mobility, the characteristic of modern world, is changing the traditional meaning of the space/location. The new business models where the space/location is critical will require integrated approach in combining different Internet technologies with the communications networks where GIS will be synergy integrator on the separate levels.

Advance real estate management system is one of the examples where this integrated approach is applied. Considering very specific conditions, the system is developed to be the tool to manage appropriate business model with over 3000 properties and over 7000 objects. The new research and recommendations will be to create the other prototypes of the software solutions based on the above-mentioned integrated approach, always considering business model as a critical factor.

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CLOUD COMPUTING INFRASTRUCTURE APPLICATIONS IN COMPUTER SIMULATION

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Abstract: *This paper presents possibilities for improving computer simulations using cloud computing infrastructure. Authors examine the types and good examples of cloud-based computer simulations, offering suggestions for the architecture, frameworks and runtime infrastructures which support running simulations in cloud environment. There are cases when Monte Carlo simulation can have more accurate outputs than analytical methods. In order to reach such accuracy and results precision, Monte Carlo simulation sometimes requires orders of magnitude more computing time. Such computationally intensive scientific problems can be solved by using the possibilities offered by cloud computing platforms as cloud computing has become the standard for providing hardware and software infrastructure. Authors present results of solution that uses public cloud infrastructure for executing simulation experiments and increased efficiency of simulation execution more than 300 times and still keeping costs at acceptable level.*

Keywords: *cloud computing, infrastructure, computer simulation, Monte Carlo simulation*

1. INTRODUCTION

In last couple of years, Cloud Computing has become a standard for delivering hardware and software infrastructure. It is based on a pay-per-use business model where resources are acquired only when really needed and customer pays only for resources actually used. Cloud computing represents the mechanism for dealing with the use of external services as part of the computational foundation (Tor-Morten, 2012). It provides scalable, distributed computer services as needed. The aim of cloud computing is to present a service layer for its users where all detailed logic is made transparent and drawn upon as needed. In general, cloud computing is recognized as an infrastructure where all underlying resources (storage, RAM, processors, load balancers etc.) are completely abstracted from the end user. This leads to the cloud provider/vendor to be in charge of performance, reliability and scalability. Gartner (2013) defines cloud computing as a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies. The National Institute of Standards and Technology (NIST) defines cloud computing as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Peter, M., & Grance, T, 2011). The same authors list three service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Some authors extend this list with additional service models: Communication as a Service (CaaS), Database as a Service (DBaaS), Security as a service (SECaaS), Identity Management as a Service (IMaaS), Desktop as a Service (DaaS) (Schaffer, 2009) and Carroll et al. (2011) extend it further with: Monitoring as a Service (MaaS), Storage as a Service (STaaS), Compute Capacity as a Service (CCaaS), Hardware as a Service (HaaS), IT as a Service (ITaaS), Business Process as a Service (BPaaS).

Infrastructure as a Service (IaaS) service model brings possibility for outsourcing common elements of infrastructure like virtualization, storage, networking, load balancers etc. to a vendor of choice. The IaaS provider bills for the infrastructure services usage as per its service level agreement (SLA). One of the biggest benefits of IaaS is that it provides granular control, in which you can choose the core components for your infrastructure.

The starting hypothesis of this paper is that by using cloud computing technologies, researchers can increase efficiency of simulation experiment execution, decrease costs and improve computer simulation process in general. As in traditional computing environment, it is possible to execute all kinds of simulation experiments using cloud computing environment. This approach can make models accessible to a wider range of researchers, and data analysis of simulation experiments outputs can be performed in more improved ways.

2. LEASE OF HARDWARE INFRASTRUCTURE FOR SIMULATION LAUNCHING

Simulation is a process of creating abstract models of real systems and performing experiments based on these models. A computer simulation is a simulation performed by computer to reproduce behaviour of a system (Radenković et al. 2010).

IT infrastructure is the foundation for computer simulation, and has important impact on simulation execution efficiency, on process of simulation model development as well (Marinković et al. 2014). Recent development of virtual platforms and virtual platforms hardware infrastructure modified the way in which the applications, services and hardware are used on Internet. Cloud computing represents a new way for using infrastructure, hardware and software resources. We may differentiate between private, public and hybrid clouds (Figure 3). The well-known public ones are: Amazon, Google, Microsoft Azure and Salesforce. The private clouds are often developed within big companies, by using the virtual platforms (commercial: VMware, Citrix, or open source: Eucalyptus).

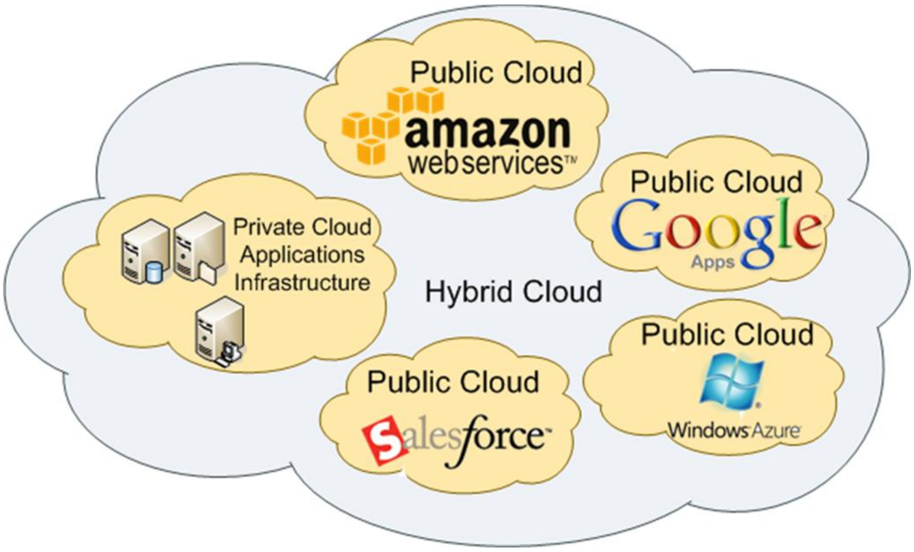

Figure 1: Types of clouds according to the development model (adopted from Slook, B, 2009)

In our paper we will present possibilities of using computing infrastructure offered by public cloud provider.

The use of cloud computing services has become inevitable in the majority of research institutions with the aim of fulfilling the need for increased IT resource and data storage capacities. The main three factors which influence the expansion of cloud computing use are the following:

1. Constant increase of IT resources and storage needs which lead to increased hardware and support costs;
2. Exponential growth of data used in research;
3. Greater use of Service computing which use Web 2.0 applications.

Along with IT infrastructure rented from cloud computing service providers, research institutions are starting to use applications accessible on the Internet, instead of traditional software installed on on local computers. This approach reduces IT system complexity, prices and maintenance costs.

Cloud Computing is most frequently related to lease of IT resources in public clouds (IaaS and PaaS service models). IaaS model includes leasing of virtual machines and data storage space, while PaaS model includes leasing of system software (operating systems, DBMS, application servers i and development tools).

The main components of any Cloud infrastructure are:

1. Hardware layer - including storage, IT and network infrastructure (EMC, IBM, CISCO, NetApp, HP, ...)
2. Virtualization layer - application of virtualization technologies: VMware, Citrix, Microsoft
3. Application layer – applications which are offered to users as a service.

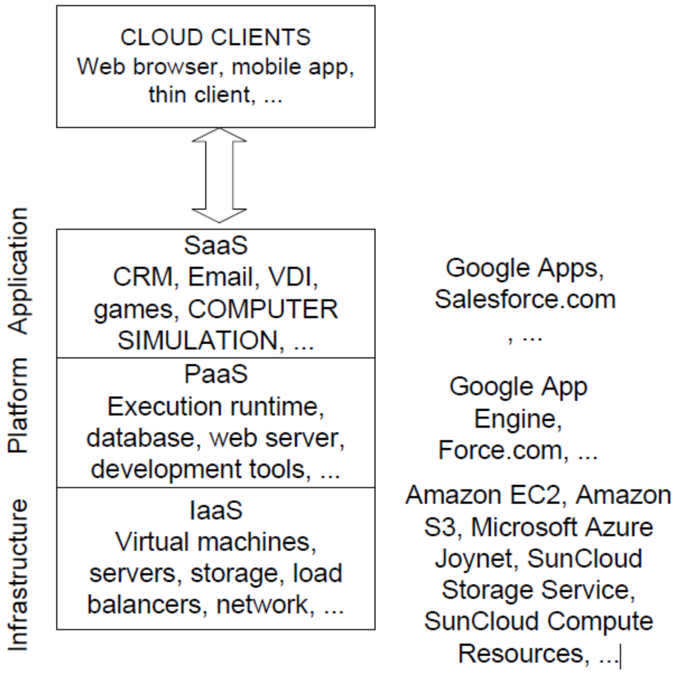

Figure 2: Service models of cloud computing (adopted from Peter Mell, Tim Grance, 2009)

Focusing on the lease of hardware and virtual hardware infrastructure, we can list three main aspects introduced as a novelty by Cloud Computing (Andrzejak et al. 2010):

1. User's impression that the resources are unlimited, which implies that there is no need for additional resources planning;
2. The ability to extend resources at any time and according to current needs;
3. The ability to lease IT resources for a short period of time (for example processors for an hour, data storage for one day) and their abandonment after the activity is finished.

Executing of simulation experiments of complex models has always been hardware demanding and time consuming. Also, necessary memory and storage space for storing results of such simulation experiments is extensive. By the rule, such experiments are demanding large databases which store numerous results of different experiments and their variations. Although they are usually structured, there is a great number of unstructured data output such as pictures, videos, etc. Additional challenge is put in front of researchers by using and processing the data resulting from simulation experiments.

We may conclude that computing infrastructure necessary for performing simulation experiments used to be one of most expensive components of simulation projects. Leasing of IT infrastructure from Cloud Computing service providers brings possibilities for performing multiple experiments which may be executed at the same time, in parallel, without the need of having own expensive IT infrastructure. Also in some cases, during the project implementation, researchers may need to change existing hardware performance by adding additional CPUs, memory and storage, and it is possible to be done during the very experiment. The virtual infrastructure provides business continuity plan, which means that the break-up of physical hardware does not influence the execution of the simulation experiment.

CLOUD INFRASTRUCTURE FOR EXECUTION OF MONTE CARLO SIMULATION

Poole, Cornelius, Trapp and Langton (2012) provide good examples for the implementation of the simulation experiment, by using the Monte Carlo simulation. This type of simulation is common in financial simulations field, and it can be implemented even in spreadsheet (Barjaktarović-Rakočević, et al., 2006, Marković, et al. 2005, Marković & Čavoški 2005). The users of Cloud infrastructure have the possibility to multiply calculations in a short time period within the Monte Carlo simulation experiments, which is the basis of the Monte Carlo simulation (Metropolis, N., & Ulam, S, 1949, Mahdevan, S, 1997). The classic infrastructure would require an expensive and specialized hardware. If it is not available it will be time consuming to perform calculations. The new infrastructure model ensures the repetition of a great number (millions and even billions) of experiments within a very short period of time.

Poole et al. analysed the application of GEANT4 C++ tool for simulation of penetration of particles through geometrical shapes by using the Monte Carlo simulation. Flexible definition of geometry and adjustment of physical processes offer the user a high level of control and the ability to simulate a wide spectrum of radio therapy techniques with the aim of rapid and quality determination of therapy with cancer patients. In carrying out this study researchers used Amazon EC2 as the computing platform and Amazon S3 as storage. By using the Amazon public cloud the Monte Carlo simulation was significantly speeded up by increasing the number of instances of simulation experiment.

In our study, we have used Microsoft Azure cloud platform as infrastructure for performing simulation experiment. For the experiment task, we have chosen simple case of approximating the value of π using Monte Carlo simulation. Although, there are more complex and useful applications of Monte Carlo simulation, including financial, behavioural, mechanical ad nuclear physics problems, we wanted to focus on benefits provided by using Cloud Computing infrastructure, leaving model as simple as possible.

For approximating value of π using Monte Carlo simulation, we used the approach of approximating the circle with radius r=1 inscribed within a square, as presented in Figure 3. The area of the circle is $r^2\pi=1^2\pi=\pi$, and the area of the square is $(2r)^2=4$. A simple Monte Carlo simulation to approximate the value of π involves randomly selecting n points and finding the number of points that satisfy (red points, Figure 3). In the end, the value of π is approximated as π —
As the generation of points are independent events, we can split them on different nodes and represent them as generating pairs of random numbers in the range between 0 and 1 inclusively and perform validation if they fit inside the circle area by verifying

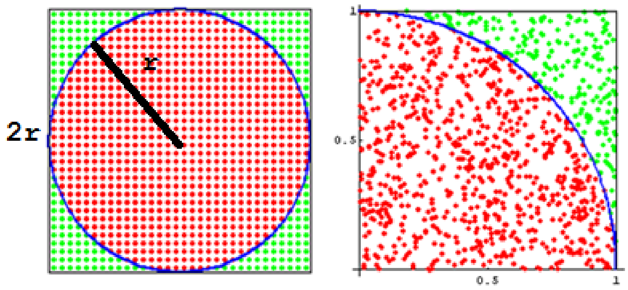

Figure 3: Circle inscribed inside of rectangle and points that fit inside, marked red

Implementation of the simulation software is done by using Java and JBoss application server including JBoss Messaging. The architecture consists of three different types of nodes: one manager node, JBoss cluster and multiple worker nodes and is presented at the Figure 4. Manager node starts and controls simulation experiment, splits simulation process into granular tasks, sends them in tasks queue and collects results from results queue, puts results together and produces final results of simulation experiment. JBoss cluster is in charge of delivery of tasks and results messages to and from worker nodes. Each worker node has the same piece of software installed and listens to tasks queue, performs incoming simulation task and posts back the result of task. The manager node split in tasks according to the necessary number of iterations per each task. Each task, before being sent to the tasks queue is assigned a unique identifier and is saved at the manager node. This way, if some worker node fails, that task is being resent to the task queue and gets delivered to other worker node for processing. In an asynchrony way, idle worker nodes take tasks from the tasks queue in order, one by one, executes necessary random numbers generation in iterations and posts results to results queue. After this, worker node is available for receiving new task from the queue and continues executing it. When all tasks are done, and manager node received all results, it can aggregate final result and calculate requested approximation.

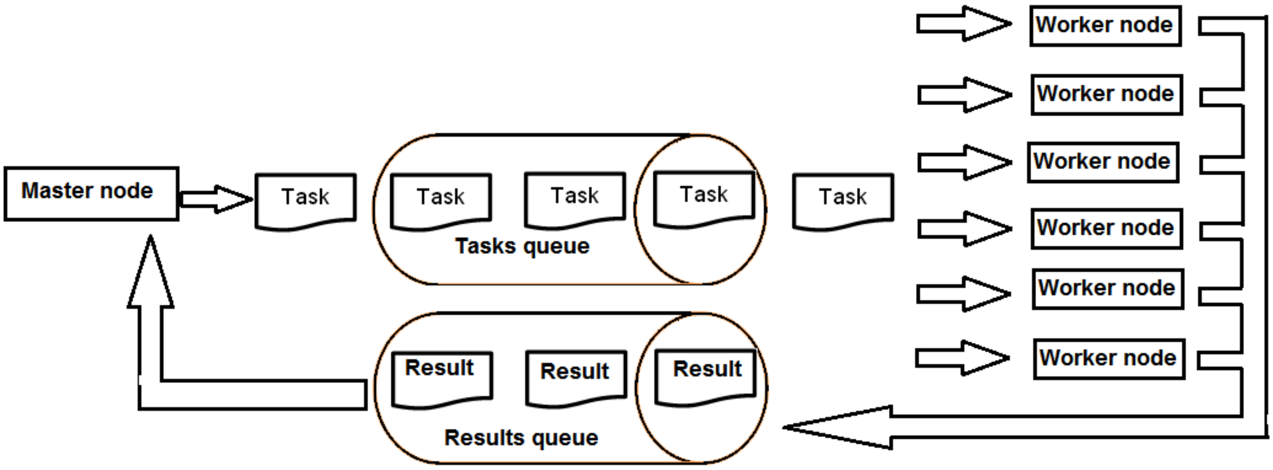

Figure 4: The architecture of simulation system

For comparison purposes, the experiment was conducted on single computer, HP ProBook 6440b, with i5 processor, having 2 cores at 2.4 GHz and 3GB RAM with sequential execution of random numbers generation and also in Microsoft Azure public cloud, on nodes with 2 virtual cores, and 3.5 GB memory. In order to get more accurate results, each simulation task is performed for 10 times and average results are presented in the Table 1:

Table 1: Performance and price comparison

Single computer			Cloud environment		
Number of points generated	Decimal Precision	Avg. Duration	Worker Nodes	Duration	Price (USD $)
100	1	**0,015 s**	2	2,24 s	0,27
1.000	1	**0,121 s**	2	3,45 s	0,27
10.000	2	**0,349 s**	2	4,82 s	0,27
100.000	3	**0,599 s**	2	5,01 s	0,27
1.000.000	3	**1,642 s**	2	7,96 s	0,27
10.000.000	3	**10,983 s**	5	21,72 s	2,74
100.000.000	3	105,354 s	5	**22,44 s**	2,74
1.000.000.000	4	19,944 m	10	**33,66 s**	5,48
10.000.000.000	5	2,648 h	10	**2,34 m**	5,48
100.000.000.000	5	1,042 d	20	**10,85 m**	10,95
1.000.000.000.000	5	11,003 d	100	**47,71 m**	54,75

These results are showing that working with small number of points generation makes more sense to be performed on a single computer rather than using multiple nodes cloud environment. This is most probably because of messaging overhead and time needed for synchronization between nodes. When number of random numbers generated for simulation goes over 100.000.000, 5 worker nodes perform this simulation task near 5 times faster than single computer. This speedup is more obvious when dealing with very large amount of random numbers generated (1.000.000.000.000) where 100 nodes finish this simulation task near 332 times faster, with quite acceptable costs (Figure 5).

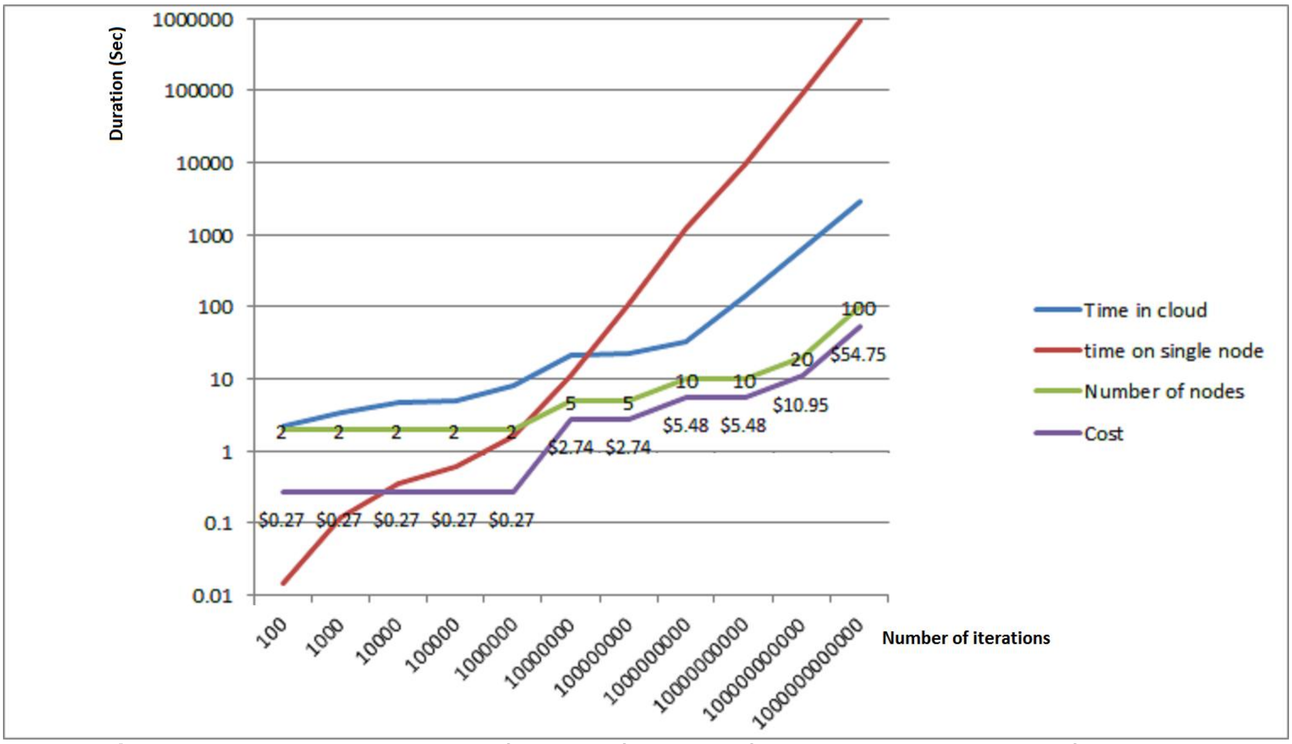

Figure 5: Experiment duration as function of number of nodes, cost and number of iterations

4. CONCLUSION

Earlier, most of the simulation software's paradigm was that each software user has his software copy installed on his computer. There was a strong relation between user, software and computing resources and this approach lacked scalability. By introducing virtualization and cloud environment, the way software is being developed and used has changed significantly. There is no more need for having own computing infrastructure. Distributed computing is now performed using multiple virtual machines rented from one or more cloud providers. As Fox et al. (2009), Harms & Yamartino (2010), De Assunção et al. (2009), Etro (2009), Kondo et al. (2009), Grossman (2009) and many other authors confirmed in their works, the use of cloud computing brings a significant reduction of IT cost. This is more obvious in cases where the system is used from time to time, executing tasks which require intensive computing resources usage, and then powered off. From results gathered during research, we can point out that, by using the public cloud infrastructure, the Monte Carlo simulation was significantly speeded up by increasing the number of instances of simulation experiment. As costs are linearly increasing as number of instances grows, in cases where time is a critical factor, by increasing the number of instances it is possible to speed up the simulation experiment execution with linear cost increase.

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