University Business Academy in Novi Sad
Faculty of Applied Management, Economy and Finance Belgrade

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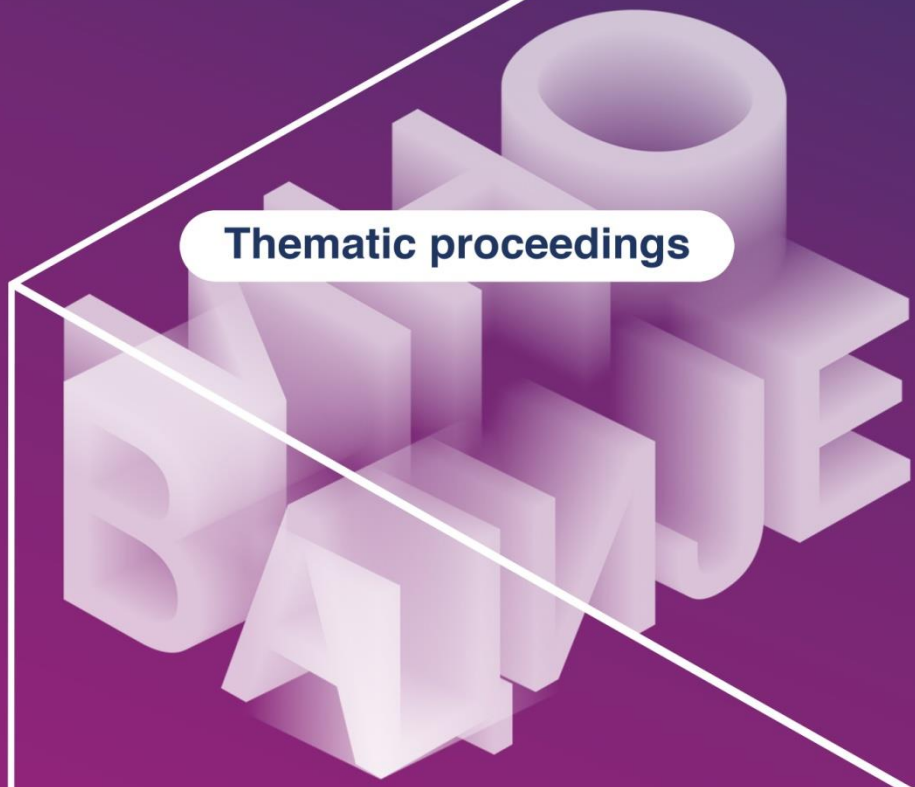

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FOREWORD

In contemporary society, the notions of "innovation" and "innovating" have become very significant, that being so to an extent that, in the majority of the missions and visions of contemporary companies, the use of this word has become mandatory. From a broader perspective, too, however, the essence of all developmental changes mainly reflects in innovativeness. Innovations are all around us. The fact that innovations are, to such an extent, present in the overall field of the human activity imposes the need for innovativeness to become the introductory point in carrying out the analysis of the complexity of the newly-emerging economy, society and culture, also including an individual. This process is further implicative of the unavoidable consideration of the innovation-development feedback. Thence exactly arises the driving motive for the Faculty of Applied Management, Economics and Finance in Belgrade to deal with the foregoing, together with the co-organizers, at the Fourth International Scientific-Professional Conference, entitled "Innovation as an initiator of the development".

This international scientific conference is organized with the aim of demonstrating that innovation is not only a part of an enterprise's business strategy, but also drives economic wellbeing and influences the progress of one whole country.

Suitably to the theme and the goal of the scientific conference, the two sessions are established: Session 1 – Innovations – basis for development (Thematic Proceedings), and Session 2 – Innovative activities – progress and future (International Conference Proceedings). The choice of the conference theme and the omnipresence of innovations, as well as the offered larger number of the thematic fields, have influenced the inclusion of the papers by many distinguished university professors, eminent researchers, experts and scientific workers both from Serbia and from abroad in this publication.

As a result of the Conference, the *Thematic Proceedings*are published in one volume and the same will be available to a wider scientific audience. The papers in this publication significantly contribute to the establishment of an inextricable liaison between innovations and development. Simultaneously, we have demonstrated that the field of innovations is definitely no longer only related to technical-technological progress. In

accordance with that, the papers may also be beneficial to both the scientific and the professional public and to all those interested in the impact of innovations on development.

Belgrade,
December, 2018

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THE STRATEGIC ROLE OF UNIVERSITY IN THE KNOWLEDGE-BASED ECONOMY: FROM THE ENTREPRENEURIAL UNIVERSITY TO UNIVERSITY ENTREPRENEURIAL ECOSYSTEM

Suzana Stefanović[1]

Abstract

The strong development of information and communication technologies has led to changes in lifestyle and business causing increasing importance of qualified human resources in the knowledge-based economy. In this regard, the role of university is changing too, leading to the expansion of mission of university from education, through research, to the role of active economic agent. Such an university is able to commercialize knowledge and inventions that have come in the process of research and development not only by patenting and licensing, but also by starting the companies (start-ups or spin-offs) established by the members of the university community (students, graduates, academics, alumni etc.). The aim of the paper is to point out the evolution of the mission of university as well as its importance in the economic development of the region/national economy, and also to show the changing role of university in agglomerations based on the geographical location such as industrial districts, clusters, and recently entrepreneurial ecosystem. Expected results of the paper are to demonstrate that modern, entrepreneurial university is not only the bearer of economic development in modern knowledge-based economy, but thanks to its role in innovative start-ups' incubation this university increasingly taking a central role in the entrepreneurial ecosystem.

Keywords:*entrepreneurial university, geographical agglomeration, networking, entrepreneurial ecosystem, innovation*
JEL classification: *I23, I25, L14, L26*

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Introduction

The strong development of information and communication technologies and the Internet has led to digitization in all spheres of life and work in modern society. The special impact digitalisation has on the business operations of small and medium enterprises and entrepreneurs (SMEEs), particularly in the manner of their establishment, operation and networking with other stakeholders. These changes require new knowledge and skills, which is why the inevitable changes in education, especially higher education are needed. The new role of university is reflected not only in changing the curricula and methods of transmission of knowledge to students, but also in networking with companies for the transfer of knowledge and competence, as well as in promotion of entrepreneurship, since the university educates future entrepreneurs. Transformation refers to the fact that an entrepreneurial way of thinking and working is require from the university too. This leads to a change in the mission of university which, besides educational and research institution is increasingly becoming the driver of economic development of countries and regions (Etzkowitz, 2002; Coduras et al., 2008; Etzkowitz & Ranga, 2011; Karpov, 2017). Entrepreneurial university should be able to commercialize knowledge and innovations in the market, and also to establish new start-ups by academics and students, and these are increasingly important activities at the university.

Involving and networking of university with businesses and other entities in the economic geographic agglomerations, such as industrial districts and clusters have long been recognized as the way in which the university can contribute to economic development and competitiveness of countries and regions. Modern trends in the development of entrepreneurship recognize the importance of the location or the specific context for the competitiveness of business entities as well as regions or national economies (Porter, 1998), which contributed to the affirmation of the concept of entrepreneurial ecosystem. The entrepreneurial ecosystem, as a set of independent actors and factors, becomes the bearer of the development of innovative entrepreneurship as an enabler of economic development in the knowledge-based economy (Stam & Spigel, 2016). The entrepreneurial university has an important role within the entrepreneurial ecosystem. Moreover, recent trends in the development of this concept suggest that an entrepreneurial university is becoming the epicenter of the entrepreneurial ecosystem (Guerrero et al., 2017;

Malecki, 2018). Therefore, the aim of the paper is to point out the evolution of the mission of university as well as its importance in the economic development of the region/national economy, and also to show the changing role of university in agglomerations based on the geographical location such as industrial districts, clusters, and recently entrepreneurial ecosystem. Expected results of the paper are to demonstrate that modern, entrepreneurial university is not only the bearer of economic development in contemporary knowledge-based economy, but thanks to its role in innovative start-ups' incubation this university increasingly taking a central role in the entrepreneurial ecosystem, becoming, in this way, university-centered entrepreneurial ecosystem.

The role of knowledge and innovations in competitive advantage creation in different types of economic geographic agglomeration is the subject of review in the first part of the paper. The changing role of so-called 'entrepreneurial university' in the modern knowledge-based economy will be discussed in the second part of the paper. The third part deals with the new concept of university centered entrepreneurial ecosystem. The fourth part of the paper should point to the potential of Serbian universities for the development of entrepreneurial ecosystem. In the end, concluding remarks and recommendations for the management of universities and policy makers will be given.

The evolution of geographic economic aglomerations' concept and innovation driven competitiveness

The changes brought by globalization of the world economy and the strong development of information and communication technology have led to increasing importance of relationship based on cooperation and networking of market participants. In consideration of the way in which cooperation contributing to the competitive advantage of a company, the conceptual framework of the theory of network is based on (see more in: Stefanović, 2010). The starting point of the paradigm based on relational theory, which is the basis of network theory also, is that the cooperation between the companies - strategic partners leads to the creation of superior value that provides a competitive advantage. In addition, the value in cooperative relationship between firms is created through the knowledge generation and organizational learning, which lead to innovation (Stefanović, 2015).

Networking for obtaining collective strength and support is particularly important for SMEEs that operate in a specific location, which brings us to a model of networking of companies and other participants based on geographic agglomerations (Stefanović, 2015). Referring to the work of Zahra, authors Stam & Spigel (2016) point out that whereas previously the individual entrepreneur was the 'sole locus of value creation', a shift in economic theory emphasizes the importance of placing entrepreneurs in the bigger picture, which includes various dimensions of context such as time, space, social, organizational and market dimensions. Although in the past context was 'taken for granted', the same authors indicate that during the last decade more attention has been devoted to some aspects of the context, such as location. Therefore, geographic location, as a specific aspect of context, should not be simply viewed as a control variable or a proxy, but should be in the focus of research, especially with regard to how social, cultural, political and economic processes and structures within a specific location affect the entrepreneurial activity (Ibid.).

Research on the issue of economic geographic agglomerations and their impact on the competitiveness of the company or region, however, is not so new. The evolution of the phenomenon of geographical agglomerations goes from industrial districts, first mentioned by Alfred Marhall, through clusters, National Innovation Systems (NIS), up to the latest research on the entrepreneurial ecosystems. However, the way in which the participants in these agglomerations connects, objectives, results and the role of knowledge differ, and we will stress the key similarities and differences between these concepts.

Industrial district, from the standpoint of Alfred Marshall (1920), is a model of economic agglomeration which leads small businesses, characterized by small size and a high level of production specialization, to turn to the inter-organizational networking in order to take advantage of the local base of knowledge and resources, and in this way achieve positive externalities that come from a common location (Staber, 2001). The same author states that companies in the same industry can benefit from spatial proximity (so-called economies of localization) through a common access to qualified labor (talents), specialized suppliers, sharing of information and communications infrastructure. Stam and Spigel (2016) cite the benefits of the so-called knowledge spillovers. Also, Iandoli et al. (2012) underline that thanks to the geographical proximity and accessibility of social capital, industrial districts are favorable locus

for diffusion of tangible knowledge. It is indicated that a key output of industrial district is regional economic growth, primarily in productivity (Stam & Spigel, 2016).

Michael Porter especially contributed to popularization of clusters as a form of business networking based on location, and he reviewed the concept of cluster in the context of a comparative analysis of the international competitiveness of national economies (Porter, 1998). Namely, clusters are seen as "geographic concentrations of interconnected companies and institutions in a particular field" (Ibid, p. 78). Clusters, besides SMEEs from a particular industry, may also include related and supporting industries, such as suppliers of components and parts, providers of ICT services and other infrastructure, marketing agencies, financial institutions, government and state agencies, universities, standardization agencies, institutions for education and training, which all provide the necessary inputs and should contribute to a common creation and launch of recognizable product brands (Ibid). Innovations and new brands will lead to the final key otuput of a cluster ie. national/regional competitiveness (Stam & Spigel, 2016). Clusters allow rapid creation of innovation and gathering a critical mass of resources to implement the innovation through development of new products/services.

The efforts of economists to identify the determinants of countries' innovative performances in the early 1990s resulted in the emergence of the concept and theory of National Systems of Innovation (NSI). Economists say that this concept is based on the fact that "innovation and accumulation of knowledge are the fundamental drivers of economic growth" (Acs et al., 2015, p. 15). This concept assumes that the process of knowledge creation can not be understood out of a country's institutional context (Ibid.). Innovation performances of a country/region are determined by the structure of the national/regional innovation system. Stam & Spigel (2016), who using the term Regional Innovation System (RIS), point out that it is related to networks that connect the hubs in which knowledge is created (such as universities and public research laboratories) and innovative firms within a given region. Thanks to the knowledge spillover between these organizations, increased number of innovations at the regional/national level occurs as a final output. In addition to the emphasis on context (regional or national), the great advantage of this concept is a systemic approach. However et al. (2017) point out that this is not the only systemic approach which is related to

innovation and entrepreneurship. There are, according to these authors, at least three approaches: Nelson's National System of Innovation (NSI), Porter's approach to the competitive advantage of nations, and Systems of Entrepreneurship, which provide Acs et al. (2015).

Stam & Spigel (2016) state that it is significantly different role of the knowledge in the ecosystems and similar concepts such as clusters and innovation systems. When it comes to the clusters and NIS knowledge is related to the technical know-how needed to develop new products or technologies as well as market knowledge necessary to successfully launch products on the market. Although knowledge is also a key determinant of the ecosystem, a new type of knowledge is emphasized: the entrepreneurial process knowledge, ie. "knowledge about the challenges facing entrepreneurs as they scale" (Ibid, p. 5). Therefore, the networking between entrepreneurs is needed in order to entrepreneurial knowledge within an ecosystem be distributed.

As noted above, the entrepreneur is the central figure in the entrepreneurial ecosystem, but not just any entrepreneur. Although, based on Schumpeter's tradition, the entrepreneurship is associated with the innovations, which then lead to the economic growth and development, Sussan & Acs (2017) state that can be distinguished two types of entrepreneurial activity: on the one hand there is routine entrepreneurship, which is in fact a type of management, and on the other hand, there is Schumpeter's view or high-growth entrepreneurship. Routine entrepreneurship encompasses what most authors in the literature on entrepreneurship means – self-employed, small businesses and new and small firms. Under high-impact entrepreneurship Sussan & Acs (2017) effectively mean activities necessary to create an innovative high-growth ventures where markets have not been fully established or known, as well as manufacturing process itself. These entrepreneurs through innovation contribute to the growth of productivity and economic growth. Similarly, study conducted by Ivanović-Djukić et al. (2018) showed that both in developed European countries and in the upper-middle-income South-East European transition countries high-growth-expectation entrepreneurship (as defined by Global Entrepreneurship Monitor - GEM) has by far the strongest impact on economic growth.

The concept of the entrepreneurial ecosystem in recent years gained in popularity, indicating the significant impact that context ie. locational

factors have on the entrepreneurial process. There are two important determinations in this concept. The first one is entrepreneurial – which means that the concept is about entrepreneurial process, in the Schumpeterian sense of entrepreneurship as a process relating to the creation of innovation, ie. new products that can be successfully exploited at the market. Here again, entrepreneurship is seen in the narrow sense, and relates to a high-growth start-ups or scale-ups, such as pointed out above by the cited Sussan & Acs (2017). Also et al. (2016) stress that "this type of entrepreneurship is an important source of innovation, productivity growth, and employment" (p. 2). Therefore, these authors also emphasize that the entrepreneurial ecosystem does not include the traditional indicators of entrepreneurship, such as self-employment or small businesses. The criteria of entrepreneurship, which are better suited to this new concept are innovative and growth-oriented entrepreneurship. Other essential determination of this concept is that it is an ecosystem. Although the concept of ecosystem is taken from the biological sciences, here it is seen as "purposeful collaborating network of dynamic interacting systems that have ever-changing set of dependencies within a given context" (Sussan & Acs, 2017, p. 57). This is the type of geographic economic agglomerations, as well as the above-described industrial districts, clusters and national innovation systems because it also emphasizes a geographic perspective. In other words, it is focused on the culture, the institutions, and the networks, which are built over time in the particular region in order to develop a productive ie. innovative entrepreneurship (Stam & Spigel, 2016).

There is no uniform and precise definition of the term, and numerous definitions of authors such as Isenberg, Stam and Spigel, Feld, Acs and others contributed to a better understanding of the entrepreneurial ecosystem. One of the first attempts to explain the entrepreneurial ecosystem is one of Isenberg (2010), who stated that: "The entrepreneurship ecosystem consists of a set of individual elements – such as leadership, culture, capital markets, and open-minded customers – that combine in complex ways" (p. 43). After that, Isenberg (2011), for practical reasons, tried to systemize these elements into six domains: policy, finance, culture, supports, human capital, markets (p. 6). Stam & Spigel (2016) state that concept of entreprenurial ecosystem represents: "Set of interdependent actors and factors coordinated in such a way that they enable productive entrepeneurship within a particular territory" (p. 1). In order to explain the concept of a productive entrepreneurship same

authors refer to Baumol that under this term means any entrepreneurial activity which directly or indirectly contribute to the net output of economy, or which leads to an increase of the aggregated welfare. Therefore, although a significant output of the entrepreneurial ecosystem, entrepreneurial activity is not the final outcome of the entrepreneurial ecosystem. Stam & Spigel (2016) observed entrepreneurial activity more as intermediary output of the system. Entrepreneurial activity leads to the innovation that can possibly lead to the creation of a new value in the company, which is the final outcome of entrepreneurial ecosystem. Such entrepreneurial activity has many manifestations, such as the innovative start-ups, high-growth start-ups, and enterpreneurial employees (Ibid).

By studying numerous papers and studies, Spigel (2017) came to the one of perhaps the most accurate definition of the entrepreneurial ecosystem, stating that it is "combination of social, political, economic, and cultural elements within a region that support the development and growth of innovative start-ups and ecourage nascent entreperenurs and other actors to take the risks of starting, funding, and otherwise assisting high-risk ventures" (p. 50).

Although the role of innovative entrepreneurs is the core of every successful entrepreneurial ecosystem, it has a number of other elements and attributes that must be complied with in order to achieve success. Why some entrepreneurial ecosystems are more successful than others, and which are the most important attributes of the entrepreneurial ecosystem by entrepreneurs' opinion was the focus of research conducted by the World Economic Forum (2013). This research has enabled the attributes that define an entrepreneurial ecosystem to be grouped into these 8 pillars (Ibid, p. 6): Accessible Markets, Human Capital Workforce, Funding and Finance, Mentors, Advisors, and Support Systems, Regulatory Framework and Infrastructure, Education and Training, Major Universities as Catalysts, and Cultural Support. WEF study provides a detailed overview of what each of these pillars coverage, and points out that according to the collected replies entrepreneurs considered the following pillars as the most important for the growth of companies in an ecosystem: accessible markets, human capital/workforce and funding and finance. Stam & Spigel (2016) also highlight the key role that employees ie. talents in all areas of expertise have, and point out that universities are an excellent source of start-up talents. Next to the human capital, financial capital plays a key role also, ie. strong and supportive

base of financiers consisting of venture capitalists, business angels, seed investors and other forms of financing. State financial incentives for SMEEs, might be of great importance especially in underdeveloped countries in transition, as shown by study of Ateljević et al. (2016). Namely, it was determined that increasing incentives from the Development Fund (in the form of grants or soft loans for establishment of start-ups) leads to an increase in the Gross Value Added, ie. growth and the development of SMEEs, especially start-ups.

One of the main pillars of every entrepreneurial ecosystem is university also because it generates an adequate environment that can provide the human capital ie. talents (academics and students) for entrepreneurial activity (Guerrero et al., 2017). This brings us to the next important issues – the role of university in an entrepreneurial ecosystem and the occurrence of university-centered entrepreneurial ecosystem.

Entrepreneurial university – the changing role of university in a knowledge-based economy

The university is increasingly seen as one of the most important instruments in the regional economic and social development (Coduras et al., 2008). Therefore, transformation of university from educational to the entrepreneurial institution is vital. Etzkowitz (2002) pointed out the changes through which the university itself has passed, and named them 'academic revolutions'. As the traditional role of the university is assigned education, ie. the generation, storage and transmission of knowledge across generations of graduates. The first academic revolution, according to Jencks and Riesman (as cited in: Etzkowitz, 2002), meant adding research activities to the traditional education activities as the one of main missions, and this role of university is being developed in the late nineteenth and early twentieth century. This development has led to the merger as well as to a conflict between the sphere of education and the sphere of research. Namely, each help the other, but there are tensions between these two roles because some universities consider that professors give too much attention to research activities which separate them from their traditional roles as lecturers, and vice versa.

The second academic revolution refers primarily to the fact that the university is increasingly taking on the mission of economic and social development (Ibid). Namely, in the late twentieth and early twenty-first

century university gets so-called 'third mission' (Etzkowitz & Ranga, 2011). Besides the traditional functions of the university related to the education and research the role of active actor in socio-economic development has been added. According to the quoted Etzkowitz and Ranga, 'third mission' is largely the result of government policy to strengthen relationships between universities and businesses, but it is also the result of a tendency that companies are increasingly using research infrastructure of universities in achieving their research and development objectives and tasks. On this way companies transfer a part of their indirect costs related to research and development on the state, who largely provides the financing of (state) universities.

Universities do not only retain a leading role in the creation of knowledge and research, but also get new roles. The universities expand their capabilities from education and research, to the creation of new start-up companies (so-called spin-offs) through programs of entrepreneurial education and development of incubators. Modern universities provide new educational and research formats, such as interdisciplinary centers, start-up centers as well as various hybrid organizations such as science parks and incubators (Etzkowitz & Ranga, 2011). This presents the contemporary stage in development of the university which is denoted as the creation of the so-called 'entrepreneurial university'. The emergence of entrepreneurial university is reflected in a new type of institution of higher education that integrate the function of economic development with the function of education and research, with significant implications for national and regional economic development.

Karpov (2017) names university that is positioned as a corporate entity in the knowledge economy – University 3.0. In fact, this metaphor is used to represent the three missions of the university: University 1.0 was primarily focused on its educational role, University 2.0 has been focused on education and research, and University 3.0 added to these missions the third – commercialization of knowledge. In most developed countries economists are already talking about the University 4.0, which would have the ability to 'solve unsolvable problems for the industry', and this model of university is associated with the increasingly popular concept of Industry 4.0 (Ibid).

Universities not only produce qualified human resources of a given region/country but are also a source of knowledge that stimulates the

development of entrepreneurship through training, consulting, licensing, development of research joint ventures and, finally, establishment of start-ups (spin-offs). In fact, there are many ways of commercialization of research results at universities (ie. new products and technologies) including (Pries & Guild, 2007; Harrison & Leitch 2010): patenting, licensing, collaboration in research and development with industry partners, as well as creation of new start-up ventures (spin-offs).

University spin-off companies are a special type of start-up companies founded by academic inventors in order to exploit the technological knowledge they have gained through research at university to develop new products and services (Bigliardi et al., 2013). University spin-offs transform technical and technological inventions obtained during research at the university into new products for their commercial exploitation. University professors and students can create spin-off companies to commercialize results of their R&D, and the universities themselves are interested in sharing the profits and expertise, and therefore create and 'nurture' the spin-offs through the process of business incubation ie. scientific and business incubators (Rogova, 2014). However, it should be noted that some of the studies show that even in the most developed countries such as the United States, newly established businesses, realized on the basis of university research, make not more than 2-3% of all newly formed start-ups in the country (Harrison & Leitch, 2010, p. 1247), so their potential has yet to come. This is related to the resolution of the many problems and challenges in incubation process.

University-centred entrepreneurial ecosystem

Because of the importance that university have today in the development of innovative entrepreneurial organizations as pillar of entrepreneurial ecosystems, university-centered entrepreneurial ecosystems attract more and more attention (Malecki, 2018). Malecki points out that universities are among the most often mentioned factors ie. institutions in the entrepreneurial ecosystem after entrepreneurs themselves, and are identified as hubs of such ecosystems. But not all universities are the same, nor are equally important for the development of the entrepreneurial ecosystem. Most valuable type of university is the one who has the role of 'institutional node' (Ibid, p. 9), and that is the part of a specific regional innovation system (RIS). Such university by establishment of the various intermediary organizations, such as the

technology transfer offices (TTO), university incubators, and collaborative research centers, in different ways contributes to the development of innovative start-ups. However, to become an university entrepreneurial ecosystem takes time. It is alleged a case study of the university which has taken more than 16 years to go through the evolution from TTO into a hub university model (Ibid). There is also a case study which describes evolution of a university incubator into university-based ecosystem by taking new roles, based on the social capital that enables networking of members at national and international level with the aim of obtaining the necessary resources, primarily knowledge (Ibid).

When it comes to the structure of the innovative and entrepreneurial university ecosystem Karpov (2017) makes a distinction between basic and meta level. Basic level includes projects of business ventures, small innovative enterprises (SIEs), start-ups, business incubators, investment spots, offices for knowledge distribution, technology transfer offices (TTO), and innovation and technology centers. Meta level includes technological consortia, unifying educational institutions and high-tech businesses, the integration of the university division dealing with scientific research and scientific organizations; science parks, creating a common creative space for high-tech companies and research teams; as well as industrial parks that provide the necessary infrastructure for materializing scientific innovation.

Universities, therefore, can also create their own entrepreneurial ecosystems. It is alleged that the university-centered entrepreneurial ecosystem represents: "a composition of educational programmes, infrastructures (incubators, research parks, technology transfer offices, etc.), regulations (business creation normative, property rights, etc.), culture (role models, attitudes towards entrepreneurship, etc.) as well as relatinships with government, investors, industry, and other socio-economic agents" (Guerro et al., 2017). This kind of entrepreneurial ecosystem is important because it allows the talents (members of the university community – students, academics, alumni etc.) to develop and commercialize innovations and realize their entrepreneurial initiative (Ibid). But the question is: Why some universities are more successful in entrepreneurial initiatives that generate more technology start-ups or why their start-ups are more successful? One study (Graham, 2014) presented the results of the survey where 61 expert was consulted to answer the question: "Which universities would you identify as having

created/supported the world's most successful technology innovation ecosystems?" Out of 120 universities from 25 countries around the world, experts ranked among the top ten universities as follows: MIT US, Stanford University, US, University of Cambridge, UK, Imperial College London, UK, University of Oxford, UK, Technion, Israel, UC San Diego, US, UC Berkeley, US, ETH Zurich, Switzerland, NUS, Singapore (p. 11). Also, the experts tried to identify the success factors that contributed to such a ranking of universities and among the most important groups of factors they listed: institutional entrepreneurship and innovation culture, strength of university leadership, university research capability, the local or regional quality of life, regional or government support, effective university strategy, and powerful student-led entrepreneurship drive (p. 15-16). Similarly, Guerrero et al. (2017, p. 179) notes that among the factors that trigger development of entrepreneurship on the university the most important are: creating an environment that encourages entrepreneurial activity (incubation mechanisms), the profile of students, academics and other staff, the profile of potential companies (high-tech, medium-tech, non-tech), and a phase of the entrepreneurial process (exploration, exploitation, consolidation). We see that among the factors, the authors identified, a significant place was given to support during the phase of business creation by incubation mechanisms. The support is also important in later stages when incubators have to ensure the survival of entrepreneurial ventures based on the provision of facilities such as TTO, employment offices etc., administrative staff, access to the results of university research as well as assistance in obtaining external financial support. Incubation mechanisms that provide entrepreneurial university should support the university community in all phases of the entrepreneurial process by providing infrastructure (research facilities, centres of small-university business, technology transfer offices, liasion offices, and incubators themself), resources (physical, financial, commercial, technical, etc.), business support services (mentoring, seed funding etc.), and networking (by organizing workshops, business angels platforms etc.) (Ibid., p. 178).

The role of university entrepreneurial incubators is to provide resources and services during the exploitation of entrepreneurial initiative of students, graduates and academics. Resources and skills of entrepreneurial oriented university can be tangible and intangible, and should contribute to the creation of technology-based university spin-offs that are competitive as well as the university. Among those resources financial

resources are among the most important (in particular financial resources obtained from government programs), and human resources (talents of all types of expertise), but also a specific type of physical resources (specific research facilities, for example).

A special type of incubator is a science and technology park, which is also established for the purpose of linking scientific research, which usually takes place in universities and technology-based businesses in order to create innovation and increase the competitiveness of the economy (Mijačić, 2011). Science and technology parks are similar to business-technological and business-innovation incubators, which are usually closely associated with the university (mostly technical and engineering faculties of an university), but also with businesses and local governments. For us, of particular interest are incubators and scientific and technological parks in which universities appear as founders and also within the start-up companies are established to commercialize their research.

The potentials and resources for development of university-centered entrepreneurial ecosystem - the case of Serbia

Knowledge spillovers from universities have been identified as key sources in strengthening innovation performance of firms in the region indicating that spatial (geographical) proximity of universities has a significant impact on the establishment and performance of companies, especially in sectors that are knowledge intensive (Baptista & Mendonca, 2010). Baptista & Mendonca pointed to studies that have showed that new knowledge-based and technology-based companies are likely to be located near the university in order to have access to the spillover of knowledge in the relevant fields. The local presence of the university may generate positive externalities, through performance of research and development activities that generate knowledge, as well as through education and training of people, who become capable to absorb such knowledge (Ibid). Based on numerous studies, Baptista & Mendonca (2010) develop hypothesis about the positive impact of the number of higher education institutions in a particular region as a determinant of establishment of firms in the region and sectors based on knowledge. At the same time, universities are seen as an important source of knowledge not only through the development of research activities, but also as the primary generator of qualified human resources that are able to use such

knowledge. Furthermore, the newly graduated students can be an important channel for the dissemination of the latest knowledge from academia to the local industry in the field of high technology, so it can be expected that the knowledge held by newly graduated students is embodied in new businesses in the immediate environment, and that regions with higher number of graduates at the university is likely to have a greater number of new companies. Universities which have more students and generate a greater number of graduates can attract more companies and also contribute to the establishment of new companies that will be geographically located close to the university.

Studies have shown that the number of graduates is in correlation with the startup rates (Motoyama & Bell-Masterson, 2014). On the other hand, when it comes about funding of university research, the Kauffman Foundation cites study that points out that more funding for scientific research does not necessarily mean more start-ups (Kauffman Foundation, 2015). Moreover, Kauffman Foundation emphasizes the fact that the universities were among the institutions that in 2014 received more than US $ 140 billion of federal funds for research and development. At the same time, per year, on average, only a few hundred spin-offs arising from research-intensive universities (Ibid).

Considering all mentioned above, we can start from the assumption that the presence of universities in a given country/region is significant potential to create new entrepreneurial organizations, particularly in the sectors that are intensive in knowledge and technology. Bearing all this in mind, we will emphasize the potentials of Serbia in this regard. As we mentioned above, the literature suggests that the creation and development of entrepreneurial organizations are influenced by the number of graduates at the university in a particular region, so we will first show the movement of these indicator in the Republic of Serbia (Table 1 in Appendix). The graduates represent potential, both in terms of highly qualified personnel for existing companies, as well as future entrepreneurs.

In addition to the number of graduates, the number of researchers has a great influence for the establishment of start-up companies, particularly in the knowledge-intensive industries. Researchers in Serbia are engaged in independent research institutions (institutes), in research and development units in enterprises, and in the higher education (universities) research

institutions. With regard to the topic of our work, we will look only to the number of researchers and associates at universities that have research units (see also Table 1 in Appendix).

In addition to the number of graduates and researchers for development of new start-up companies, which commercialize scientific research, external support especially in the area of counseling and the initial funding at an early stage, and from public sources is especially important (Harrison & Leitch, 2010). These sources of funding can come in the form of equity investments, funds from the university, from programs of the government and international organizations, and even from institutional investors, such as venture capitalists and business angels.

As we can see in Table 1 in Appendix, the number of graduated students and researches in Republic of Serbia slightly increasing during the whole period from 2010 to 2016. But what is worrying is that the funds allocated for scientific research throughout the period decreased, so that the funds allocated in 2016 to universities were less than funds allocated in year 2011 (Table 1). Although the funds invested in research and development (R&D) at universities and public institutes (especially those that come from the state) do not automatically lead to an increase in the number of start-ups that are formed by the employees from universities and scientific research institutions, investment in R&D leading to scientific discoveries and patents which may find application in new products and technologies that give rise to the development of economy. Thus, the decline in investment for scientific research represents a worrying trend in Serbia.

The question is: Which are the possible finacial sources for students and academics entrepreneurship initiative ie. university start-ups? Research conducted in the Republic of Serbia (Eric et al., 2012) shows that start-ups the greatest financial assistance expected from the state, but that funding from venture capitalists and business angels (3.3.% and 5%, respectively) has not be presented to a greater extent. Due to the lack of favorable financial resources coming from private founds or wealthy individuals, so-called business angels, as well as from venture capitalists, loans approved by the State Development Funds or Development Banks/Agencies are of great importance and significantly more favorable compared to loans from commercial banks.

In Serbia, the most important role in the placement of start-up loans (for all start-ups not only for university start-ups) played Development Fund of the Republic of Serbia, who from 2006 (when it started to give loans to start-ups) up to 2017, approved about 12 billion RS dinnars for this purpose, which amounts to over 100 million euros (Ljušić, 2017). Given that the Development Fund of RS is the only institution that has approved this type of loans in Serbia, except in some years when this type of lending, with significantly fewer financial resources, has approved the National Agency for Regional Development (now RAS) it is statistically significant to considere only the loans from Development Fond for the analysis of start-up credits in Serbia (Ljušić, 2017). Movement of the above mentioned variables for the years 2010-2016 are summarized in Table 2 in the Appendix. As Ljušić pointed out, since 2006, when the RS Development Fund started granting loans to start-ups until 30.11.2017., a total of 8,264 contracts were concluded. According to the Business Registers Agency (BRA) on the date 30.11.2017., there were 3,318 active businesses, but only 1,238 of them are active with at least one employee (Ljušić, 2017, p. 44). From these data we can see that survival rate is on average slightly higher than 40%, but as Ljušić noticed, only 15% of projects ie. start-ups with at least one employee have survived from the cumulative number of startups that have received loans from DF by the end of 2017. Since the survival rate for start-ups who received a loan from DF to start a business is about 40%, it tells us that the obtaining start up loan from DF is not a guarantee for the survival of these businesses. But, as Stefanović et al. (2018) stress, new start-ups, although characterized by low survival rates, often achieve high growth rates, and this is especially true for innovative start-ups. It is necessary to provide a range of financial but also non-financial incentives (training, education, mentoring, consulting) for start-ups in order to assure their survival in the condition of tough competition.

In Serbia, the development of business incubators and science and technology parks at universities is in its infancy. The scientific and technological park established by the university exists only in Belgrade. Science and Technology Park in Belgrade was founded in partnership of the Government of the Republic of Serbia (on behalf of the Government, the Ministry of Education, Science and Technological Development), the City of Belgrade and the University of Belgrade, and support startups/teams and growing high-tech companies in the development and commercialization of innovative products. In the Science and Technology

Park in Belgrade are located: the Business Technology Incubator of Technical Faculties (BITF), which implements a support program designed for start-up companies/teams, and Innovation Fund – an institution that provides financial support through the Grant Program for early development of start-ups and other programs to support the development of innovation. With the support of Science and Technology Park up to now over 80 start-ups was established (Science and Technology Park Belgrade, 2018). Science and Technology Parks in Novi Sad and Nis (within the universities) are still in the construction phase.

Bearing in mind that in Serbia the effects of university incubators and technology parks in the establisment of spin-offs and start-ups still can not analyzed, except in Belgrade, we can analyze the broader spillover effects of knowledge and innovation from universities, ie. their influence on the development of early entrepreneurial activity at national or regional level. To get the true insight into the impact of universities and research institutions in Serbia for the development of entrepreneurship, we will look at the number of new entrepreneurial organizations of the Republic of Serbia for the period 2010-2016 (Table 2 in Appendix). Ministry of Economy of Republic of Serbia in its annual Report on Small and Medium Enterprises and Entrepreneurship give a data on number of new founded businesses per 1,000 active inhabitants, and their survival rate. According to this Report, survival rate of start-ups (established in year n-2) for the period of 2010 to 2016 ranges between 59.1 (in 2012) and 70.9% (in 2016) – in average about 64%, which is somewhat higher average survival rate compared to the average rate of surviving start-ups who received a loan from the Development Fund. This is understandable when one bears in mind that the first result applies to all newly established businesses, the latter only at start-up projects that meet the strict criteria of the Fund for a loan.

Conclusion

The paper has shown the new role of university in the contemporary age of knowledge economy, which is reflected not only in changing the curricula and methods of transmission of knowledge to students, but also in its active role as economic agent. The so-called 'third mission' of university means adding a role of economic development to its traditional roles of education and research. This mission comprehends commercialization of university inventions not only by patenting or

licensing, but also through establishment of start-up companies. University 3.0 is not only the source of talents in all fields of expertise, but also a center of enterpreneurship ecosystem due to its incubation mechanisms. As noted, there is a correlation between number of graduated students, as well as academics/researchers from university and number of start-ups which are established at university, and in the national economy as a whole. Also, besides talents, financial incentives in pre-incubation and incubation phases, especially from state, are needed in order to assure a grater number of start-ups and its higher survival rate. The correlation between the number of start-ups and variables identified in the paper as determinants of importance for the development of entrepreneurial ecosystem, at national and regional level, will be the subject of our analysis in subsequent research.

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Appendix

Table 1. *The number of graduate students, researchers,expenditures for research in the Republic of Serbia in the period 2010-2016*

Year	Number of graduated students at Universities	Scientists researchers and Associate researchers at University scientific-research institutions	Expenditures for research works, RSD thousand	
			Total	For tertiary education (Universities)
2010	46 162	10 370	13 272 750	11 802 428
2011	47 523	11 896	15 185 376	13 999 017
2012	47 797	10 574	16 215 130	15 021 970
2013	50 728	11 717	16 305 139	15 028 591
2014	50501	11 442	16 823 689	13 796 235
2015	50 326	12 351	17 610 434	14260714
2016	51 596	12 203	16 312 531	13 779 088

Source: *Statistical Pocketbook of the Republic of Serbia for years: 2013, 2014, 2015, 2016, 2017, and 2018.*

Table 2. *Number of new businesses and the receivers of start-up loans from the Development Fund of RS in the period 2010-2016*

Year	Number of newly established businesses per 1,000 active inhabitants	Surviving businesses (established in the year n-2) per 1,000 active inhabitants	Survival rate of business entities (established in year n-2)	Number of startups which received loans from Development Fund of Republic of Serbia[a]	Number of active startups – recipients of loans from Development Fund of Republic of Serbia[a]
2010	15.1	11.4	61.8	1234	634
2011	13.9	10.8	63.8	258	159
2012	13.3	9.0	59.1	39	29
2013	13.4	8.8	64.0	33	26
2014	12.5	8.1	64.2	6	6
2015	13.3	8.6	67.9	41	39
2016	13.1	8.2	70.9	187	185

Source: *Ministry of Economy (2016). Report on Small and Medium Enterprises and Entrepreneurship for 2016,* Available at: http://www.pks.rs/SADRZAJ/Files/Izvestaj%20o%20MSPP%202016%20(1).pdf

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INNOVATIONS AS THE FOUNDATION OF THE HIGHER EDUCATION DEVELOPMENT

Tomislav Brzaković[1]*; Aleksandar Brzaković*[2]

Abstract

Innovations are essential for creating qualitative changes in education, especially when it comes to increasing efficiency and improving quality. On the other hand, education can foster innovations by developing appropriate skills, such as critical thinking, creativity and imagination. The subject of this paper is the importance of innovations, new methods of learning, technologies and curricula in higher education. The aim of the paper is to consider, from the theoretical point of view, modalities and experience related to introducing innovations in higher education, which was the basis for empirical research carried out on a sample of 145 respondents. The collected data were processed using the application SPSS system, descriptive and comparative statistics. The paper confirms that higher education innovations, which are often associated with new and improved products or services, are considered a key of modernization and improvement of higher education institutions and the whole society, as well as modern technologies, especially information and communication technologies. They all significantly expand the possibilities of introducing innovative forms of teaching and knowledge testing in higher education institutions.

Keywords:*innovations, higher education, university brand.*
JEL classification: M31, I21

Introduction

Innovations include the implementation of new ideas, knowledge and practices, as well as their improvement (Kostoff, 2003; Mitchell, 2003). Theories and policies on innovation are mainly focused on the business sector (Lekhi, 2007), because business organizations must constantly introduce new products or services; they have to improve the efficiency of

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production processes, organization or marketing in order to survive in the cutthroat competition. Insufficient innovation (Forai & Raffo, 2012) can make labor costs higher and limit options for productivity. Innovations can breathe new life into stagnated markets; they can be a mechanism of any organization for improving the ability to adapt in a changing environment (Damanpour & Gopalakrishnan, 1998; Hargadon & Sutton, 2000).

There are four basic types of innovation: (1) innovations of products or services (introduction of new or significantly improved goods or services); (2) process innovations (methods of production or delivery); (3) marketing innovations (implementation of new marketing methods, significant changes in design, product placement, product promotion or prices); (4) organizational innovations (new organizational methods, etc.). Considering all elements mentioned above, educational institutions can introduce new products and services, such as new curricula, textbooks or educational resources; new service delivery processes, such as the use of information and communication technologies, new methods of organizing activities (e.g. communication to students and parents), as well as new marketing techniques, such as the differential cost of postgraduate courses.

The role of education is to encourage innovation by developing appropriate skills, such as critical thinking, creativity and imagination. It also requires innovation in the education sector itself. Educational innovations can improve learning outcomes and quality of education. Also, changes in the education system or teaching methods can help the adaptation of the educational process to the environment. New trends in personalized learning rely heavily on new ways of organizing educational institutions and the use of information and communication technologies (ICT). ICT enables the application of innovative pedagogical models (based on games, on-line labs and real-time estimates), which enhance creativity, imagination and problem solving knowledge. In educational gaming, students communicate through video games, simulations or virtual worlds based on imaginary or real worlds (Raju et al., 2011; Aldrich, 2009), whereby students become designers and game makers (Prenski, 2008). Online laboratories allow students to simulate scientific experiments through nano robotics, 3D printing and many other techniques, using equipment online (Jona et al., 2011). The potential benefits of online labs are a lower cost of access, a flexible approach,

better learning (Ku, Ahfock & Yusaf, 2011). Assessment of knowledge and skills in real time using ICT enables teachers to monitor learning process more effectively and enable the active participation of students in discussions (Enrikuez, 2010). International cooperation (international projects) that overcomes geographic distance gives students insights into other cultures and enable multicultural communication.

The Aim of This Research

The subject of this paper is to discuss the importance of introducing innovations, new methods of learning, technologies, and curricula in higher education. The aim of the paper is to observe, from the theoretical point of view, the modalities and experience related to innovations in higher education, as the basis for empirical research carried out on a sample of 145 respondents.

The questionnaire consisted of 20 questions related to three types of innovations in higher education that unite the following categories:

- Products or services (new curricula and educational resources);
- Technology, tools and instruments (using ICT in e-learning, new systems for learning management, online courses, interactive guide through studies, networking with colleagues, etc.)
- Learning methods.

The first group of questions is related to innovations in higher education based on the introduction of new products/services, such as various courses, projects, expert practices, visiting lecturers, who are leaders in their field, foreign lecturers, etc. The other group of questions includes the respondents' opinions on the importance of information technologies applied in higher education, while the last group of questions focuses on innovations in higher education based on the introduction of new teaching methods, such as interactive teaching, the link between theory and practice, student-assistants, etc.

Defining the Research Hypothesis

In this paper we have tested one general hypothesis (H_0) and one special hypothesis (H_1).

H_0: Innovation in higher education is an important factor for encouraging critical thinking and creativity of students, and therefore an essential component of modernization and improvements of higher education institutions and the whole society.

H_1: Modern technologies, particularly information and communication technologies (ICT), significantly expand the possibilities of introducing innovative forms of teaching and knowledge testing in higher education institutions, as well as the development of students' career.

Theoretical review

Knowledge and skills, as a rule, stimulate thinking, creativity, imagination, curiosity, self confidence, leadership, governance, cooperation and believes, but also the ability to absorb innovation. It is nowadays very common to find classrooms with students challenged to recognize and use a wide range of knowledge sources in order to find new solutions. According to Voss & Zomerdijk (2007), education can be considered a journey in a long period of time that consists of several components and numerous elements.

Increasing competition among academic institutions is becoming more and more evident (Karapetrović et al.,1999). Melevar & Akel (2005) point out that in the education market, where students recognize themselves as buyers, universities must implement strategies for maintaining and improving their competitiveness, based on a set of unique characteristics. Corporate identity is a powerful competitive advantage (Brzaković et al., 2016a). Brand is one of the most important resources of an organization (Normann & Ramirez, 1994). It has the potential to be, if managed properly, one of the most important strategic assets, capable of providing true competitive advantage on the market, sustainable development (Brzaković et al., 2017) and financial profits. The primary task of brand management is to build a strong brand (Brzaković at al., 2016c). A brand is priceless, if it can hasten and simplify consumer decisions, reduce purchasing risk, create and deliver expectations. Using a number of methods to estimate and reduce risk, the brand reduces the possibility of making a wrong decision (Brzaković et al., 2016b). Pesch et al. (2008) consider that the adoption of customer orientation in the academic environment means that universities must consider educational experience from the students' perspective.

According to Hoit & Brovn (1999), the choice of universities is influenced by nine factors: availability of a courses, employment opportunity, academic reputation, location, quality of teaching, quality of the institution, costs, reputation and financial segment.

In recent years, the introduction of computers into classrooms is often considered the most significant innovation of educational system. According to Cuban (2001), computers have the potential to enable individualized teaching and learning, increase transparency of students' progress and enable teachers to easily monitor progress and to adapt to students; they also have the potential to engage students more than traditional teaching methods.

Unfortunately, the empirical evidence of teaching innovations is not very comprehensive. Aslami & Kingdon (2011) tried to identify which teaching methods are the most effective. The authors believe that the answer lies in more innovative methods; for example, the involvement of students in discussions improves mathematical skills. Kane et al. (2011) point out that a teacher who uses questioning and discussion as a teaching method will probably increase students' success. Westbrook et al. (2013) focused on developing countries and found that new teaching methods, even those less innovative than e-learning, are more effective than traditional teaching methods.

Innovations related to teaching methods require teachers able to innovate. Excellent teachers are capable to motivate students and choose the most productive method of teaching for each specific topic.

Methodology

All the collected data were processes by SPSS applicative system, using descriptive and comparative statistics.

The modalities of the answers to all questions have ordinal nature (from 1 for the lower grade to 5 for the highest grade). The attitudes of the respondents are graded on the scale as following: 1-insignificant, 2-minorly significant, 3- moderately significant, 4-significant and 5-very significant, and the median value is 3 - moderately significant. Therefore, there are presented descriptive statistics of arithmetic mean and variances

for each question, as standard measures of central tendency and dispersion of values of the observed characteristics.

Research

Products and services

The respondents' attitudes on innovations in higher education related to products/services are covered by a group of 10 questions presented in Table 1. Table 1 presents descriptive statistics of analyzed groups of questions related to the introduction of different products/services from the aspect of innovations in the higher education process. The respondents on average estimated each of the questions with a high grade that is significantly above the median measuring scale.

Table 1: *Descriptive statistics of products or services*

		N	Mean	Std. Deviation
1.	Evaluate the usefulness of introducing short courses in order to acquire knowledge applicable in practice and enable independent work (e.g. accounting course, JAVA, etc.)	143	4.6853	.64371
2.	Evaluate the level of your own interest in attending short educational courses.	135	4.2519	.99039
3.	Evaluate the significance of students' involvement in scientific and research processes, beside the educational ones (projects...).	144	4.4653	.82710
4.	Evaluate the significance of internship in different institutions, as a potential employment opportunity.	144	4.7708	.55114
5.	How much is important to keep in touch with university communities through Alumni club – club of former students (networking with colleagues, professional improvement through lectures etc.)?	144	4.3333	.87706
6.	How important do you think is to form an interactive virtual guide through faculty?	144	4.0972	1.08595

7.	Evaluate the significance of guest-lecturers, business leaders, renewed speakers, foreign professors.	144	4.4931	.75722
8.	Express your interest in different cultural events in the faculty (exhibitions, film projections, theater plays etc.)	144	4.3333	.95346
9.	Evaluate the significance of a start-up incubation centre, which can be of assistance in self-employment process and career development.	144	4.6597	.63865
10.	Evaluate the significance of availability of information about employment needs of domestic labor market.	143	4.5944	.75281

Source: *Authors' calculations*

Specifically, within the second question of the mentioned group, the respondents expressed their opinion about courses they would like to attend. 57 respondents answered this question, which represents 40% of the sample. Summarized, the result is as following: there is an evident domination of the individuals (about 25%) who would like to attend some foreign language course (English, Spanish, German, Italian), as well as individuals interested in the accounting course. On the second place, there are one-fifth of the respondents interested in specialized courses in the field of information technologies (different software packages, programming, web design, etc.). Less interested are individuals with preferences related to personal development in the field of public appearances, communication skills, business communication and so one. Their answers are given in the Table 2.

Table 2: *Name a course you would like to attend*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		88	60.7	60.7	60.7
	Quick memory	1	.7	.7	61.4
	E-commerce, Financial analist	1	.7	.7	62.1
	ECDL	1	.7	.7	62.8
	English language	3	2.1	2.1	64.8
	Excel (MS Office)	1	.7	.7	65.5

	iOS programming	1	.7	.7	66.2
	Italian language	2	1.4	1.4	67.6
	JavaScript, some of the design frameworks, type B	1	.7	.7	68.3
	Communication skills, public speech course	1	.7	.7	69.0
	Language course, a software program course	1	.7	.7	69.7
	MS Project course	2	1.4	1.4	71.0
	Sales skills course	1	.7	.7	71.7
	Linux server	1	.7	.7	72.4
	Marketing, communicology	1	.7	.7	73.1
	Media performance	1	.7	.7	73.8
	German language	2	1.4	1.4	75.2
	HR courses	1	.7	.7	75.9
	Prezi course	1	.7	.7	76.6
	Business communication	1	.7	.7	77.2
	Internship in companies	2	1.4	1.4	78.6
	Entrepreneurship, marketing, internet marketing	1	.7	.7	79.3
	Programming	3	2.1	2.1	81.4
	Accounting	14	9.7	9.7	91.0
	SEO optimization	1	.7	.7	91.7
	Spanish language	7	4.8	4.8	96.6
	Statistics	2	1.4	1.4	97.9
	Web design	2	1.4	1.4	99.3
	Wordpress	1	.7	.7	100.0
	Total	145	100.0	100.0	

Source: *Authors' calculations*

Technology, tools and instruments

Respondents estimated the introduction of various technologies, tools and instruments from the aspect of the creation of a recognizable brand in higher education based on the four questions presented in Table 3. Each of the offered uses of different technologies, tools and instruments in a higher education process is rated high above the average grade, starting from 4.60 for the lowest, up to 4.73 for the highest grade. The dispersion of respondents' answers is also quite uniform, according to this criterion.

Table 3: *Descriptive statistics of technology, tools and instruments*

		N	Mean	Std. Deviation
1.	How much is important to be able to watch Power Point presentation with recorded voice in the time of your choosing, beside traditional lectures in the classroom?	145	4.6276	.79008
2.	How much is useful to watch recorded lectures via Moodle on cell phone, tablet, PC...?	145	4.6621	.73806
3.	Evaluate the possibility to take tests online.	145	4.6000	.84492
4.	Evaluate the importance of video presentations and other materials related to curricula.	143	4.7343	.67083

Source: *Authors' calculations*

Learning methods

When it comes to respondents' opinions about the introduction of new learning methods in order to improve higher education, the questions are presented in Table 4, alongside with the results of descriptive statistics.

Table 4**:** *Descriptive statistics of learning methods*

	N	Mean	Std. Deviation
1. Evaluate the importance of innovations (new learning methods etc.) in higher education.	144	4.7431	.63407
2. Evaluate usefulness of students being demonstrators in classrooms.	143	4.2797	.93752
3. Evaluate the usefulness of more frequent examination through tests (two or more tests).	144	4.3403	.86229
4. Evaluate the importance of the interactive approach in the classroom.	144	4.5208	.67904
5. Evaluate the importance of theory and practice connection during lectures and exercises.	145	4.7448	.59837
6. Evaluate the priority of problem solving and creativity oriented knowledge in relation to learning facts.	143	4.6014	0.7704

Source: *Authors' calculations*

Each of the offered alternatives related to the introduction of innovations (interactive teaching methods, the introduction of presenter/demonstrator students into the teaching process, connection between theory and practice, problem solving oriented knowledge) was evaluated with high grades by the respondents and, also, grades are approximately equal between themselves.

Analysis and results

Hypothesis testing

H_0: Innovation in higher education is an important factor for encouraging critical thinking and creativity of students, and therefore an essential component of modernization and improvements of higher education institutions and the whole society.

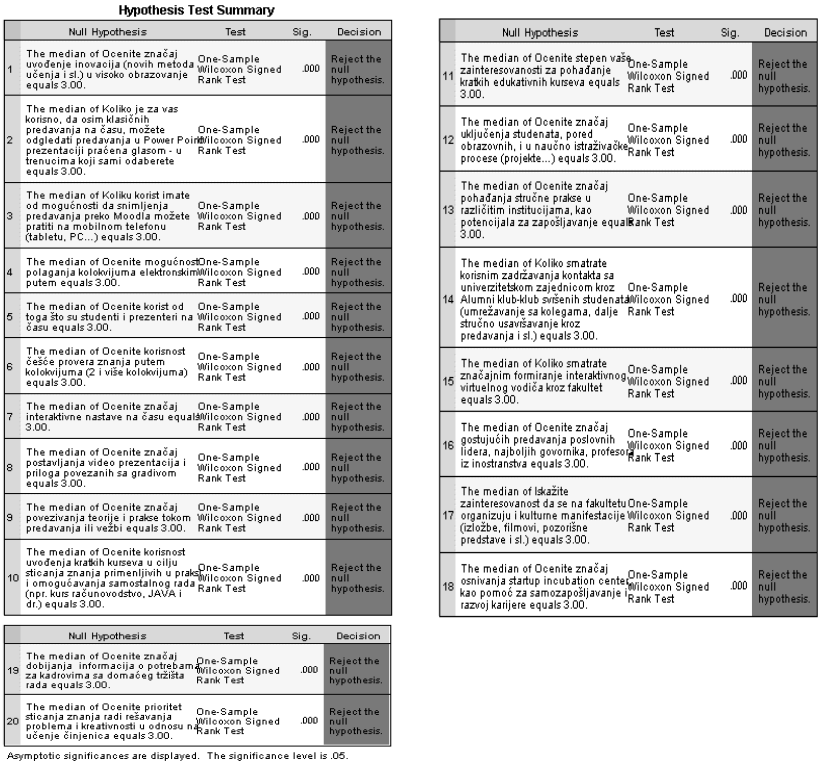
In the testing process of this hypothesis, we have used respondents' answers contained in all question groups mentioned, since the confirmation of this hypothesis applies to all types of innovations in

higher education. The testing reveals the opinions of respondents related to products/services, methods and modern technologies that higher education institutions should introduce into their programs, whose aim is to improve whole education process, regarding critical thinking of students, encouraging their creativity, independence, etc. In this way, we can create favourable conditions for their adequate employment and perspective work positions, which, as the final result, influences the development of the whole society.

The descriptive analysis has already indicated that the average values showing the significance of all the analyzed factors are greater than the median, but in order to draw this conclusion from the level of the sample to the population level, we have to make a formal statistical test. If the respondents consider that the mentioned factors are more than moderately significant for the process of modernization and progress of higher education institutions, the median of the significance of the given factor will be statistically significantly higher than 3.

Due to the ordinal nature of the data and the previously unknown distribution, instead of the parametric t-test, the confirmation of this hypothesis was tested by a non-parametric alternative to the t-test, known as the *Wilcoxon signed-rank test.* The zero hypothesis of this test is that at the population level the median is equal to some predetermined value. The results of the Wilcoxon signed-rank test are shown in Table 5.

Table 5: *Results of the Wilcoxon signed-rank test*



Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of Ocenite značaj uvođenje inovacija (novih metoda učenja i sl.) u visoko obrazovanje equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
2	The median of Koliko je za vas korisno, da osim klasičnih predavanja na času, možete odgledati predavanja u Power Point prezentaciji praćena glasom - u trenucima koji sami odaberete equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
3	The median of Koliku korist imate od mogućnosti da snimljenja predavanja preko Moodla možete pratiti na mobilnom telefonu (tabletu, PC...) equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
4	The median of Ocenite mogućnost polaganja kolokvijuma elektronskim putem equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
5	The median of Ocenite korist od toga što su studenti i prezenteri na času equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
6	The median of Ocenite korisnost češće provera znanja putem kolokvijuma (2 i više kolokvijuma) equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
7	The median of Ocenite značaj interaktivne nastave na času equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
8	The median of Ocenite značaj postavljanja video prezentacija i priloga povezanih sa gradivom equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
9	The median of Ocenite značaj povezivanja teorije i prakse tokom predavanja ili vežbi equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
10	The median of Ocenite korisnost uvođenja kratkih kurseva u cilju sticanja znanja primenljivih u praksi i omogućavanja samostalnog rada (npr. kurs računovodstvo, JAVA i dr.) equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
11	The median of Ocenite stepen vaše zainteresovanosti za pohađanje kratkih edukativnih kurseva equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
12	The median of Ocenite značaj uključenja studenata, pored obrazovnih, i u naučno istraživačke procese (projekte...) equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
13	The median of Ocenite značaj pohađanja stručne prakse u različitim institucijama, kao potencijala za zapošljavanje equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
14	The median of Koliko smatrate korisnim zadržavanja kontakta sa univerzitetskom zajednicom kroz Alumni klub-klub svršenih studenata (umrežavanje sa kolegama, dalje stručno usavršavanje kroz predavanja i sl.) equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
15	The median of Koliko smatrate značajnim formiranje interaktivnog virtuelnog vodiča kroz fakultet equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
16	The median of Ocenite značaj gostujućih predavanja poslovnih lidera, najboljih govornika, profesora iz inostranstva equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
17	The median of Iskažite zainteresovanost da se na fakultetu organizuju i kulturne manifestacije (izložbe, filmovi, pozorišne predstave i sl.) equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
18	The median of Ocenite značaj osnivanja startup incubation center kao pomoć za samozapošljavanje i razvoj karijere equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
19	The median of Ocenite značaj dobijanja informacija o potrebama za kadrovima sa domaćeg tržišta rada equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
20	The median of Ocenite prioritet sticanja znanja radi rešavanja problema i kreativnosti u odnosu na učenje činjenica equals 3.00.	One-Sample Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Source: *Authors' calculations*

The first column of the table "Null Hypothesis" defines zero hypotheses in the form "the median of the given factor is equal to 3". The Sig column shows the p-values of the Wilcoxon signed-rank test, based on which were made recommendations for whether the null hypothesis should be discarded. In all 20 cases, the Wilcoxon signed-rank test suggested the inequality of the median and the hypothetical value 3 and the rejection of the zero hypotheses. Since all the averages within the descriptive statistics (Tables 1, 3 and 4) showed a value that is significantly above 3, it is possible to confirm the general hypothesis at the selected level of the 5% significance.

H_1: Modern technologies, particularly information and communication technologies (ICT), significantly expand the possibilities of introducing

innovative forms of teaching and knowledge testing at higher education institutions, as well as the development of students' career.

In the case of hypothesis testing, the starting point was the following: if the respondent considers that one of the above factors of the first group of questions is significant (related to products or services as a form of innovation of a higher education institution – innovative forms of teaching, educational resources, and different models, which enable students' employment) the general attitude about modern technologies will be formed considering how much the mentioned factor of this domain is influential in the process of introducing various innovative products or services within certain profession. In other words, the introduction of various innovative methods into the teaching process, whose final consequence are the employment opportunities for students and the development of their career, is primarily based on the application of different information and communication technologies. This hypothetically results in the association between the assessment of products and services on one hand and modern technologies on the other and it can be measured by the coefficient of correlation. As the general hypothesis in the testing process proved that respondents consider that each of the products/services offered is significant from the aspect of the teaching process modernization, it is expected that the correlation analysis will indicate the existence of a positive correlation between the groups of these variables (questions).

Results of the correlation analysis based on the Spearman coefficients are shown in Table 6.

Table 6: *Spearman correlation coefficient*

Cipher		Q2	Q3	Q4	Q8	Total of significant correlations
Q10	Correlation Coefficient	.714*	.079	.082	.680*	2
	Sig. (2-tailed)	.038	.348	.332	.032	
	N	143	143	143	142	
Q11	Correlation Coefficient	.049	.591*	.036	.220*	2
	Sig. (2-tailed)	.569	.026	.678	.011	
	N	135	135	135	133	

	Correlation Coefficient	.183*	.234*	.675*	.568*	
	Sig. (2-tailed)	.028	.005	.032	.000	
Q12	N	144	144	144	144	4
	Correlation Coefficient	.286*	.354*	.419*	.112	
	Sig. (2-tailed)	.024	.021	.011	.547	
Q13	N	142	144	144	143	3
	Correlation Coefficient	.416*	.512*	.484*	.363*	
	Sig. (2-tailed)	.009	.021	.034	.002	
Q16	N	144	143	144	142	4
	Correlation Coefficient	.512*	.414*	.510*	.613*	
	Sig. (2-tailed)	.011	.041	.036	.009	
Q17	N	144	144	144	142	4
	Correlation Coefficient	.398*	.471*	.117	.369*	
	Sig. (2-tailed)	.025	.039	.588	.044	
Q18	N	144	144	144	142	3
	Correlation Coefficient	.471*	.660*	.348*	.451*	
	Sig. (2-tailed)	.041	.034	.039	.025	
Q19	N	143	143	143	141	4
Total of significant correlations		7	7	5	7	26

Source: *Authors' calculations*

Note: *significant for 0.05 level (2-tailed)

Q2	How much is important to be able to watch Power Point presentation with recorded voice in the time of your choosing, beside traditional lectures in the classroom?
Q3	How much is useful to watch recorded lectures via Moodle on cell phone, tablet, PC...?
Q4	Evaluate the possibility to take tests online.
Q8	Evaluate the importance of video presentations and other materials related to curricula.
Q10	Evaluate the usefulness of introducing short courses in order to acquire knowledge applicable in practice and enable independent work (e.g. accounting course, JAVA, etc.)
Q11	Evaluate the level of your own interest in attending short

	educational courses.
Q12	Evaluate the significance of students' involvement in scientific and research processes, beside the educational ones (projects...)
Q13	Evaluate the significance of internship in different institutions, as a potential employment opportunity.
Q16	Evaluate the significance of guest-lecturers, business leaders, renewed speakers, foreign professors.
Q17	Express your interest in different cultural events in the faculty (exhibitions, film projections, theater plays etc.)
Q18	Evaluate the significance of a start-up incubation centre, which can be of assistance in self-employment process and career development.
Q19	Evaluate the significance of availability of information about employment needs of domestic labor market.

In Table 6 evaluations of different products/services as a type of innovation of higher education institutions are crossed with the evaluations of the importance of individual factors related to ICT technologies, as a measure of innovation in the teaching process. For each combination of crossings, there are shown three fields: the value of the correlation coefficient, the p-value, and the number of observations (generally in the range 133-144). At the end of the right side and at the bottom of the table, it is summarized for how many correlation coefficients there is confirmed statistical significance.

In general, the largest number of correlations is statistically significant; for 26 of possible 32 correlation coefficients statistical significance has been confirmed. Taking into account the results of this analysis, it can be concluded that the analyzed hypothesis has been confirmed.

Conclusions and recommendations for further research

The subject of this paper was to discuss the importance of introducing innovations, new methods of learning, technologies and curricula in higher education programs, while the aim of the study was to, based on theoretical research, examine the modalities and experience of introducing innovations in higher education through empirical research. The questionnaire consisted of 20 questions related to the three categories of innovation in higher education: products or services (such as new

curricula or educational resources), technology, tools or instruments (using ICT in e-learning services, new systems for learning management, online courses, interactive faculty, networking with colleagues, etc.) and learning methods (interactive classes, introducing students to the teaching process, linking theory and practice, acquiring problem solving knowledge). The collected data were processed with the application SPSS system using descriptive and comparative statistics. The opinions of respondents about higher education innovations related to products/services, technology, tools, instruments and learning methods were graded by high scores, significantly above the median scale. In this paper, the zero hypothesis (H_0) is set up and tested:*Innovation in higher education is an important factor for encouraging critical thinking and creativity of students, and therefore an essential component of modernization and improvements of higher education institutions and the whole society.* The hypothesis was tested with a non-parametric alternative to a t-test known as the Wilcoxon signed-rank test and it was confirmed. The hypothesis H_1 has also been tested in the paper*: Modern technologies, particularly information and communication technologies (ICT), significantly expand the possibilities of introducing innovative forms of teaching and knowledge testing at higher education institutions, as well as the development of students' career.*To test this hypothesis, we have used Spearman correlation test and it was found that the largest number (26 of the 32) of correlations were statistically significant, and it could be concluded that the analyzed hypothesis was confirmed.

Given that educational innovations represent an act of creating and disseminating new educational instruments, new practices, organizational forms, technologies that significantly extend learning opportunities contributing to their diversity, making education more interesting and more pleasant for students is an important incentive to continue the scientific research of this significant area.

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USING INFORMATION TECHNOLOGY APPLICATIONS IN EDUCATION AT FACULTIES

Marina Milovanović[1]; Jasmina Perišić[2]

Abstract

This paper shows the importance of using Information Technology in education at faculties, for example lessons from the Mathematics, Statistics, and e-Business courses. The research on students of the first and second year of the Faculty for Entrepreneurial business and management of non-real estate (60 students) and students of the fourth year of the Faculty of Economics and Finance (25 students) was described. The students of the first year studied Mathematics material with the help of software tools we created in Adobe Flash, with the same content as in classical teaching, but with the accentuated power of visualization, with plenty of animations, illustrations, etc. In the second year of Statistics, we included the use of the SPSS software package, and in the course of the e-Business course, using the Moodle. A survey conducted at the end of the research showed that students are very interested in this kind of teaching.

Keywords:*IT, education, lecturing, Flash, SPSS, Moodle*
JEL classification*:* **C88, I21.**

Introdaction

This paper presents a broad overview of the role information technology (IT) tools can play in helping faculty students. The main goal is to provide the introductory teacher who is considering using IT in the classroom with some background of how the IT technology tools have evolved a sense of the research findings and open questions on how technology influences student learning, and specific advice for implementing technology. We highlight some of the common technological tools currently in use in mathematics, statistics and e-

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business (electronic business) courses and how they can be used to support students learning.

Modern methods in IT approach to learning include the whole range of different possibilities applicable in mathematics lectures for different levels of education with different levels of interactivity (Herceg, 2009; Milovanović, 2005, 2014, 2015; Milovanović et al., 2011, 2012, 2013, 2015, 2016, 2017; Takači, et al., 2006, 2008). The authors usually work on suggestions on using different kinds of software in education, especially in the field of mathematics: geometry, algebra, numerical analyses etc., as well as the definite integrals (Herceg, 2009; Milovanović, 2011, 2012, 2013; Milovanović et al., 2011, 2012, 2013, 2015, 2016, 2017).

All the above-mentioned resulted in an idea of making applicative software which would be helpful in modern and more interesting approach to the field of teaching mathematics and rising the students' knowledge from the scope of definite integrals to a higher level. The aim of our research was to recognize the importance of multimedia in the teaching process as well as to examine the student's reaction to this way of learning and teaching. Therefore, we have developed experimental software with multimedia lessons about the definite integral and tested them in class in order to see how they would affect teaching process and results.

Research on the role of technology in teaching and learning statistics has been increasing over the last decade. In 1996, a special International Association for Statistical Education (IASE) Roundtable have been convened in Granada, Spain to discuss the current state of research on the role of technology in statistics education at that time. While much of the work reported at the roundtable (Garfield & Burrill, 1997) was on the development of new tools to help students learn statistics, there was a clear call for more research on appropriate ways to use these tools to promote student learning. It was suggested that a new research agenda was needed to identify appropriate methodologies for future studies on this topic as well as to explore new ways to use technology in studying this topic (Hawkins, 1997).

Statistical packages are software designed for the explicit purpose of performing statistical analyses. Statisticians have used several packages

for many years, including *SPSS* (http://www.spss.com), *S-plus* (http://www.insightful.com), *R* (http://www.r-project.org), *SAS* (http://www.sas.com), and *Minitab* (http://www.minitab.com).

We used in our research software SPSS and tested it in class in order to see how they would affect teaching process.

Learning Management System (LMS) is a web-based technology used to plan, implement, and evaluate the learning process (Alias & Zainuddin, 2005). LMS systems offer a wide range of navigation links and views (templates, modules) to simplify communication between learners in the learning process (Romero et al., 2008). These systems allow teachers to distribute information to students, create teaching materials, prepare tasks, tests, discussions and workshops, and manage distance learning.

Students have been offered the opportunity to learn in common on forums, chat rooms, news, workshops, etc. Such systems can store information about student activities (reading, writing, passing tests, communicating with other students). LMS support a wide range of functions (Psaromiligko et al., 2011), such as course management, time organization, communication tools, student tools, content management, evaluation tools and school management.

Moodle represents a free, PHP open source web application for implementing e-learning process. Its modular design makes it easy to create new electronic courses, modules and manage educational content. We used Moodle at the e-business course (Perišić et al., 2014, 2015, 2017, 2018).

Course of mathematics

In this paper, we would like to emphasize the importance of using multimedia software in teaching and learning mathematics, because visual presentation offers much more possibilities. Therefore, using multimedia lessons on definitive integrals enables students to actually see not only the final solution, but also the „movements“ that have led to it.

In Figure 1 we can see one of the examples of the theorem and the consequences for a definitive integral, which is shown from both the formula and the graphical step by step. In Figure 2, one of the most

important theorems on a definitive integral is shown. The Newton-Leibniz formula is carried out systematically. The software also showed the application of a definitive integral to the calculation of the surface of some figures in the plane, as well as the calculation of the volume of some bodies in the space. In a large number of examples, the solutions were gradually presented, followed by animations, which first depicted in the coordinate system what was given in the task, then the figures and points obtained in their cross-section and at the end of the surface of the obtained figure or volume of the body obtained (with the animation of the rotation figure, to the body formed by its rotation). One example is shown in Figure 3.

Figure 1: *An example of Theorems and Consequences*

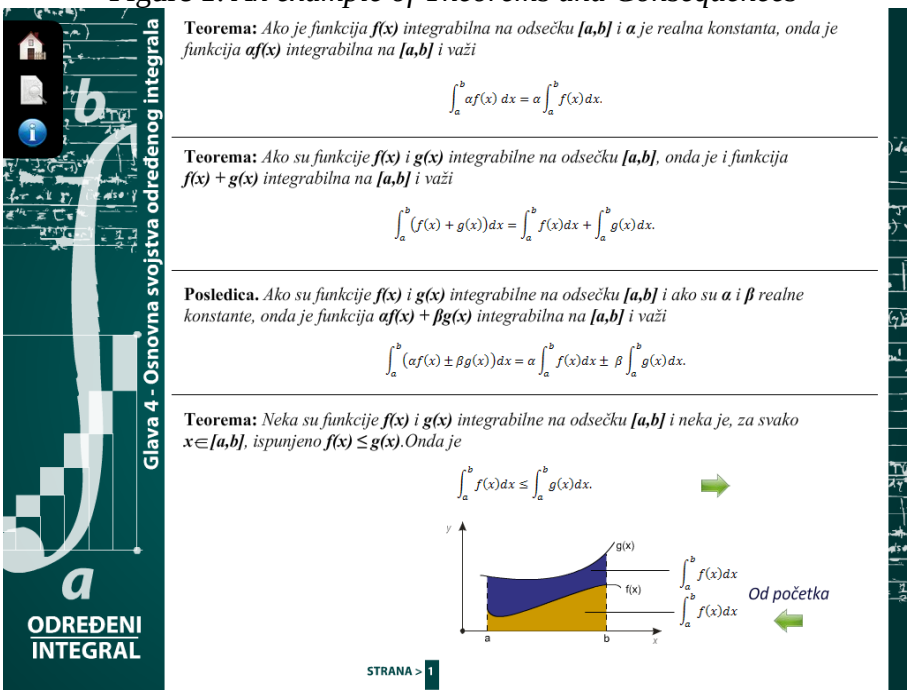


Figure 2: *An example of Theorem - Newton - Leibniz formula*

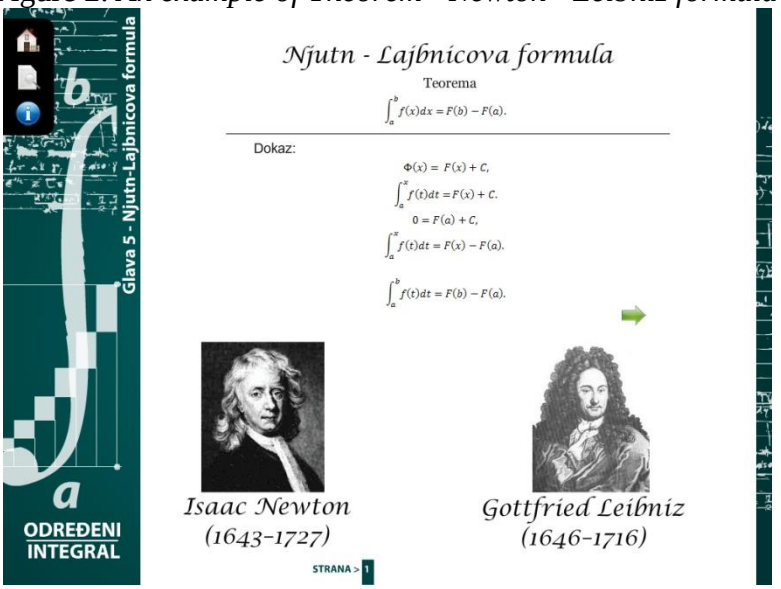
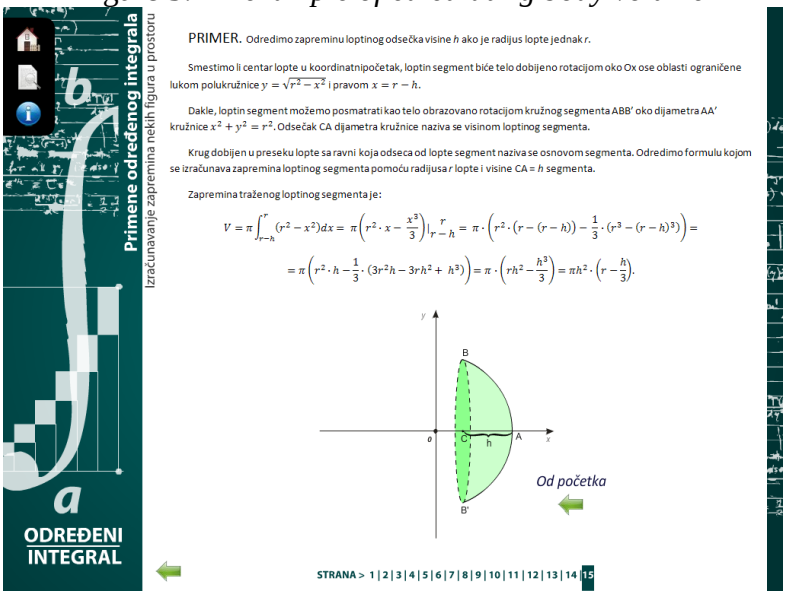


Figure 3: *An example of calculating body volume*



Course of Statistics

For the Statistics course, we chose the SPSS program as one of the most represented in the teaching, Figure 4. In the paper, the process of data entry to the database, the data processing by the Descriptive method and the results shown in Table and graphically, is shown in the example of one task.

Example:
In this example, a part of the research that has been presented, forty-eight (48) students took part in the Mathematics test. Results ie.the points of the participants obtained on the test (from 0 to 100) were entered in the SPSS database and processed by the Descriptive Statistics method, as shown in Figure 5. The results of descriptive statistics (minimum, maximum, arithmetic mean and standard deviation).

Figure 4: *IBM SPSS Statistics program*

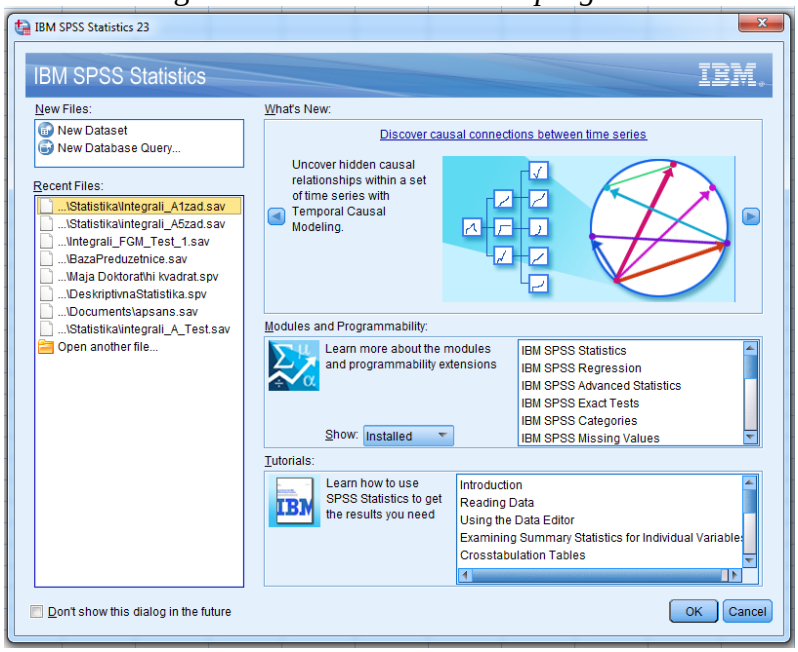


Figure 5: *Database Descriptive statistics in SPSS (step 2)*

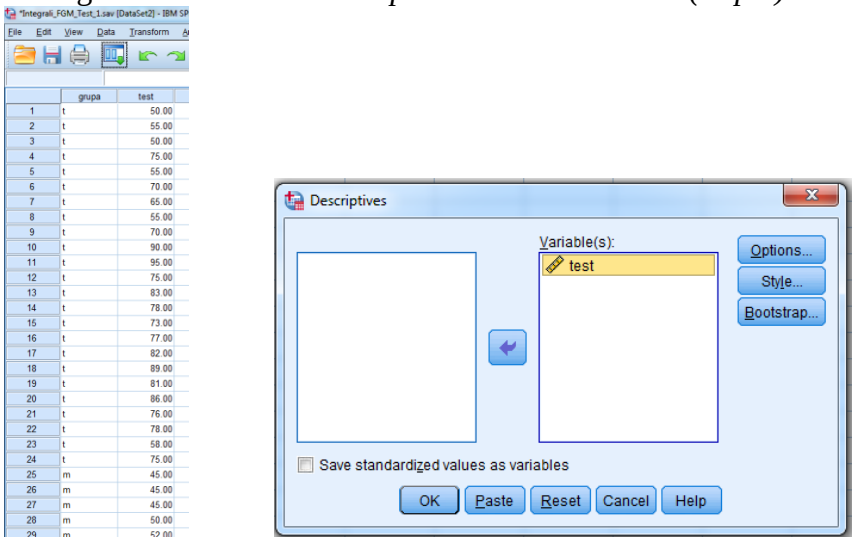
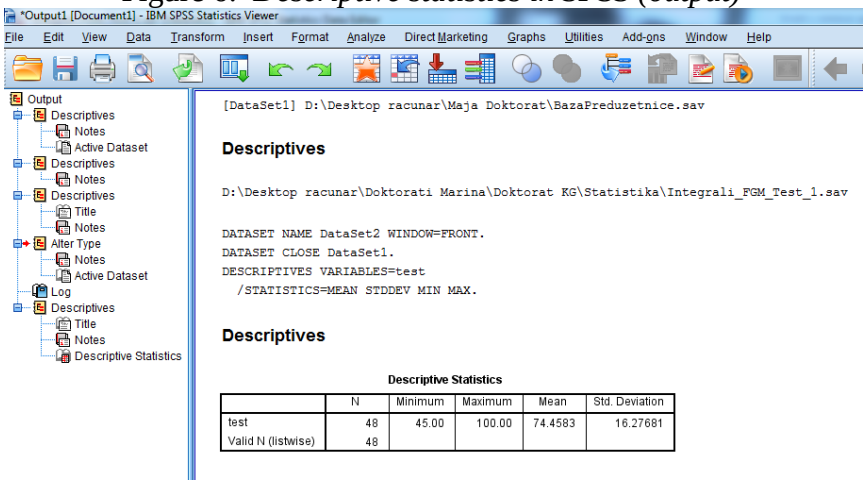


Figure 6: *Descriptive statistics in SPSS (output)*



E-business course

Figure 7 shows the home page of the MAL (Moodle Adaptive Learning) e-learning system. In the course E-business as shown in Figure 8. Thematic units ie. learning materials are exceed on weekly level: electronic business; Internet; electronic education and mobile technology; blog and internet business plan; HTML and CSS; electronic commerce

and electronic marketing; Joomla, social networking and e-business in public administration; Sugar CRM; internet marketing and Google services.

Figure 7: *display of MAL system*

Figure 8: *Learning materials of E-business course*

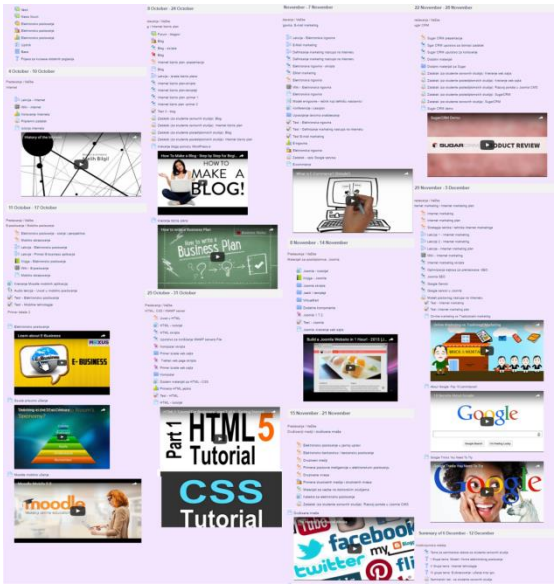


Figure 9 shows an example of a lesson in the E-business course.

Figure 9: *An example of a lesson in the E-business course*

Figures 10 and 11 show the test and task in the course E-business.

Figure 10: *An example of a test in the course E-business*

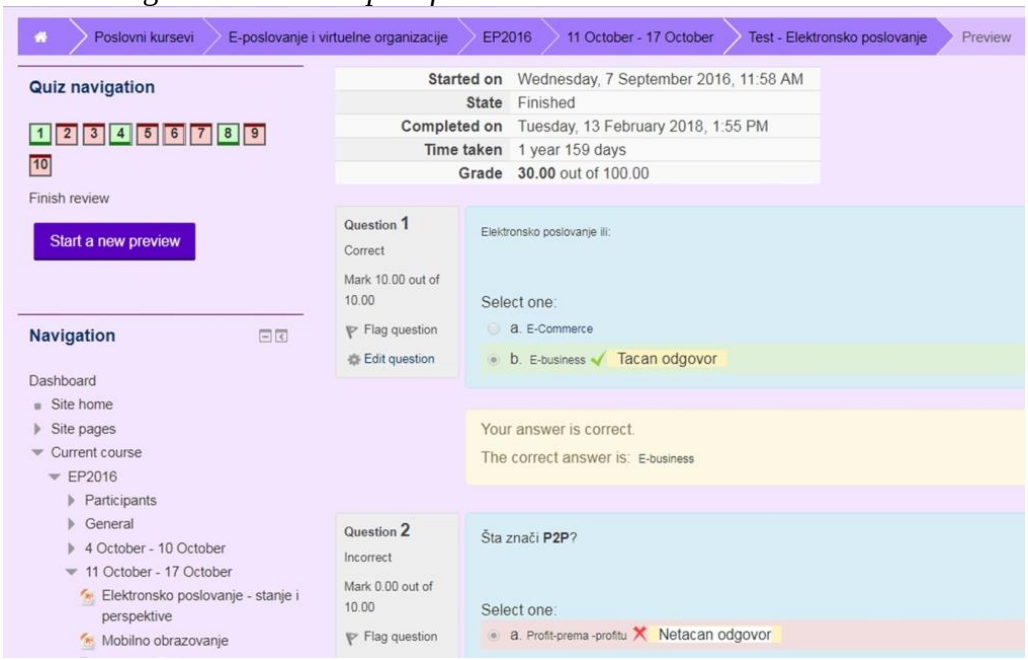
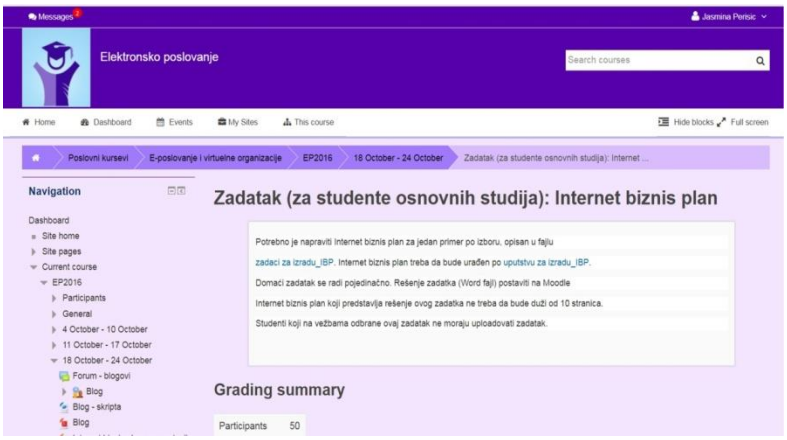


Figure 11: *Example of the task in the E-business course*



Research Methodology

Aim and questions of the research

Thanks to the experiences of some previous researches and results, some of the questions during this research were as follows:

1. What do students from the experimental group think about multimedia lectures? Do they prefer this or traditional way and why?
2. Do students think it is easier to understand and learn the matter individually and during the classes by multimedia lectures?

Participants of the research

The research on students of the first and second year of the Faculty for Entrepreneurial business and management of non-real estate (60 students) and students of the fourth year of the Faculty of Economics and Finance (25 students) was described. The students of the first year studied Mathematics material with the help of software tools we created in Adobe Flash, with the same content as in classical teaching, but with the accentuated power of visualization, with plenty of animations, illustrations, etc. In the second year of Statistics, we included the use of the SPSS software package, and in the course of the e-business course, using the Moodle.

Methods, Techniques and Apparatus

The main information source for mathematical course was software created in Adobe Flash, which proved to be successful and illustrative way for creating multimedia applications in mathematics lectures (Bakhoum, 2008). Our multimedia lecturing material was created in accordance with methodical approach, i.e. cognitive theory of multimedia learning (Mayer, 2001; Mayer, 2005), as well as with principles of multimedia teaching and design based on researches in the field of teaching mathematics (Atkinson, 2005). This material includes a large number of dynamic and graphic presentations of definitions, theorems, characteristics, examples and tests based on systematic method with accent on visualisation. An important quality of making one's own multimedia lectures is the possibility of creating combination of traditional lecture and multimedia.

Students who had a course in Statistics studied with the SPSS program. The material includes examples that we have dealt with the mentioned software tool. Students could solve problems in a much faster and more efficient way. In that way, students made conclusions about dependent variables by changing independent variables (their relationship, correlations, etc.).

The process of learning at the course E-business implied using MAL system. The survey implied using the TAM (Technology Acceptance Model) questionnaire. The TAM questionnaire was used to to evaluate students' attitudes towards the use of the MAL system. When the courses were completed, the students were interviewed. In order to get as objective results as possible, participation (students) in the interviews was voluntary and anonymous, and the interviewer was not a member of the teaching staff at any of the faculties.

Results

When asked whether they prefer classical or IT way of learning (lectures and individual work), students answered the question as shown in Figure 14, explaining it with the following reasons:

— *Mathematical course*:

- 'It is much easier to see and understand some things, and much easier to comprehend with the help of systematic animation.'

- ‘Much more interesting and easier to follow, in opposite to traditional monotonous lectures with formulas and static graphs.’
- ‘More interesting and easier to see, understand and remember.’
- ‘I understand it much better this way and I would like to have similar lectures in other subjects, too.’
- ‘This enables me to learn faster and easier and to understand mathematical problems which demand visualisation.’
- ‘Quite interesting, although classical lectures can be interesting – depending on teacher.’

— *Statistical course*:

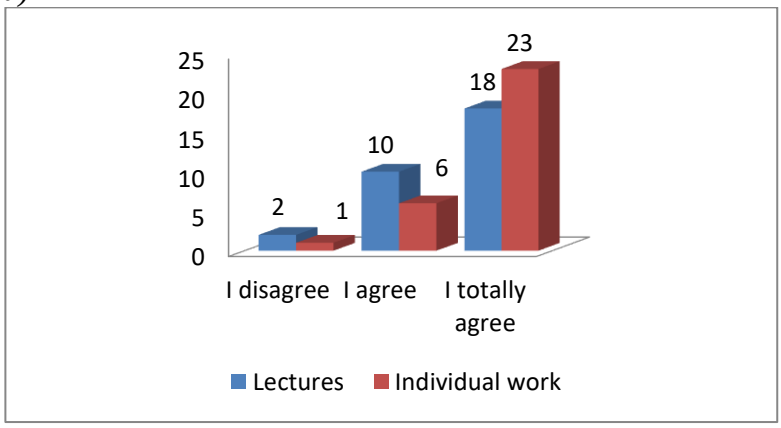
- I liked that by directly changing the values of parameters we could see changes in statistical tests
- The graphs have helped me a lot in understanding certain problems
- The tasks were resolved much faster and easier with the help of the SPSS software package

— *E-business course*:

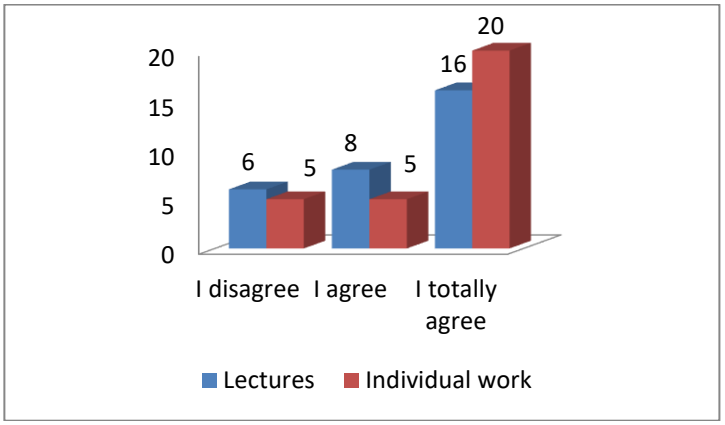
- Using the MAL system has improved my learning effectiveness
- Using the MAL system has improved the effect on the course
- I find that the MAL system is very useful

Figure 12: *Students’ answers to the question: whether the computer should be used in lecturing and learning mathematics? (a – Mathematics, b – Statistics, c - e-Business course)*

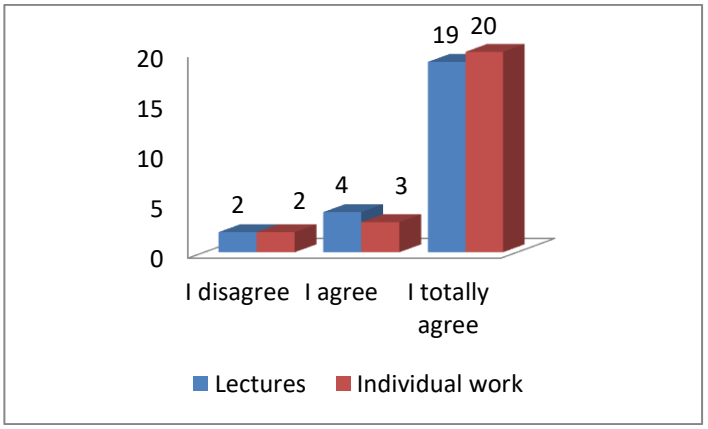
a)



b)



c)



Discussion and Conclusions

In the previous period, e-learning using IT technologies has become significant and important topic in the field of teaching methodology. In research of authors (Despotović-Zrakić et al., 2012; Joksimović et al., 2015), it has been proven that students improve their skills if they learn using IT.

Many research works in different scientific fields, including mathematics and statistics have proven IT makes learning process much easier and productive.

Research on learning the definite integrals with software packages Mathematica and GeoGebra (Herceg & Herceg, 2009) has shown that students who had used PC in learning process had higher scores on tests. Although this research was conducted with different multimedia teaching tools for the same subject – the definite integral as one of the most important areas in mathematical analyses – our results only proved the universality of multimedia in the process of teaching mathematics.

It is important to try to find the way to access and utilize appropriate technology to help students learn statistics. The GAISE College Report (Franklin et al., 2000; Franklin & Garfield, 2006) lists some issues to consider when selecting technological tools to use in helping students learn statistics:

- Ease of data entry, ability to import data in multiple formats
- Interactive capabilities
- Dynamic linking between data, graphical, and numerical analyses
- Ease of use for particular audiences
- Availability to students, portability.

It is a general attitude that no one software or IT tool not to cover everything domains of learning. The advantage is that most of this software is free for users. Therefore, rather than thinking about one IT tool for students to use, we encourage teachers to think about what sets of IT tools will help student best learn statistics in each unit of the course. What learning materials is used to graphically represent data in one unit may not be the best to illustrate sampling in another.

The functionality of the Moodle platform can be enhanced implementing techniques and additional plug-ins modules to evaluate knowledge, skills, attitudes, habits and student preferences and get more precise student details. For that reason, IT tools can be used to improve cognitive characteristics of students and to promote positive attitudes towards discussion with peers (Martín-Blas & Serrano-Fernández, 2009). A TAM questionnaire has been used in our work to evaluate student attitudes towards the MAL system. The attitude of students to each question from the TAM questionnaire was positive. Students believe that the MAL

system is easy to use in terms of interaction with the system, finding information, and useful in terms of improving the efficiency of the learning process. In addition, students have a positive attitude towards the use of the MAL system and intend to use MAL system in the future.

During our research teachers emphasized, that IT software and toolshave made students work easier and have proved to be motivating for them. As shown in Figure 14, a great number of them insisted that IT software and tools make easier understanding, learning and implementation of knowledge. Students' remark, and consequently one of our research's conclusions, was that IT tools and software represent an important aspect of teaching and learning process.

Guidelines for Further Researches

There are a few questions that you should especially pay attention to in the future: How much time will students need to explore the technology? How can the teacher make sure that videos and simulation games do not become "play time" for students? How much teacher demonstration should precede student use of the technology and how much debriefing afterwards? How many different technologies are students expected to use? For which technologies should students learn commands (i.e., software packages)? Which technologies will be demonstrations only (i.e., applets)? Incorporating many technologies can be overwhelming for students and place conceptual understanding in second place to technological skills.

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RESEARCH ON THE NEED TO USE NEW APPROACHES AND DIGITAL TECHNOLOGIES IN EDUCATION

Tatjana Janovac[1], Pavle Brzaković[2]

Abstract

The development of science and technology adds to the strength of the national economy and social structure of each country. Education should be the subject of continuous evaluation related to systemic, organizational and institutional solutions, as well as the methodological orientation aimed to the use of new methods and techniques in the process of knowledge acquiring. One of the key elements for achieving success is the introduction of digital technology into the acquiring knowledge process. The aim of this research is to intensify the application of new approaches and digital technologies in the educational process. The testing of hypothesis is enabled by the cross-tabulation method and the chi-squared test. Data processing and hypothesis testing were performed using the statistical software IBM SPSS, version 21. The results of the research can help efficient planning and redefining education policy in order to improve digital literacy.

Keywords:*approach, education, digital technologies, education policy.*
JEL Classification*: I25, O10, O3*

Introduction

Education is strategically important for the economic and social development of each country. A stable knowledge-based economy can be achieved with the help of a defined national policy in the field of education. In order for education to be an initiator of the development, it is necessary to establish a link between economy and education. It is necessary to identify what are the needs, demands and expectations of the users of the education services and all interested parties and define the development strategy accordingly. It is also necessary to establish a link between the research community and the creators of the education policy.

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Defining and implementing the appropriate strategy is crucial for the quality of education. When there is a large number of strategies in question, it is necessary to select the most adequate one, and in these cases it is possible to apply multi-criteria decision-making methods, which will be the subject of further research (Urošević et al., 2018; Karabašević et al., 2018).

Changes caused by scientific and technological development, recession or globalization, in general, have a direct impact on the field of education. The process of transition (Kirin et al., 2014), in which the Republic of Serbia found itself, led to the reduction of industrial production, the devastation of industrial capacities, reduced productivity in the industrial sector, outdated industrial equipment and technology, the reduction of competitiveness of the main industries and companies, reduction of the number of employees in the industrial sector, which inevitably created a decrease in the share of the industrial sector in GDP of Serbia. The process of transition caused the mismatch between the educational and the economic sectors, which created the lack of certain occupational profiles, as well as certain knowledge and the elimination of some job positions. The period after the long and difficult transition (Kirin et al., 2014) involves changing the entire economic structure of a country, reforming the legal and educational system, liberalization of the economy, strengthening state institutions and creating mechanisms for the direct foreign investments. Further development of the economy should be based on the diversity of education, research and innovation that will put the Republic of Serbia in the rank of high developed countries.

In order for education to make a difference, the education system should be efficient and effective, high quality and accessible. The concept of "modern education" should offer different content, approaches, methods, as well as the application of new technologies in the educational process and help students to acquire different competencies related to the application of new knowledge. When it comes to accepting the concept of "modern education", it is necessary to motivate all participants in the educational process. Since motivation is a complex and dynamic process, it is necessary to choose an adequate motivation strategy (Janovac et al., 2018).

Digitization in education is one of the strategic priorities of the development of the Republic of Serbia. The Ministry of Trade, Tourism and Telecommunications in cooperation with the Ministry of Education, Science and Technological Development is implementing a capital project for the improvement of information and communication infrastructure in schools in the Republic of Serbia. The program entitled "Digital School" (Ministry of Trade, Tourism and Telecommunications, 2010) aims to provide each school in Serbia with a computerized classrooms that will enable students access to the computers and the Internet within classes and extracurricular activities. With this project, the line ministry supports Serbia's economic growth.

New approaches to the knowledge acquiring

Knowledge is the most important human resource. Possession of knowledge (Wood, 2011) is crucially important for personal and social development. The knowledge acquiring process contributes to individual progress and the development of certain competencies necessary for inclusion in social processes. However, the way of acquiring knowledge is very different now and in the past. The process of transferring and acquiring knowledge accompanies the development of societies. Knowledge and skills were once being acquired exclusively based on experience and transmitted orally, so the education process itself was informal.

Over the past few decades, information and communication technologies have penetrated all spheres of human activity and the overall development has created the conditions for their application in the educational process. Under the influence of modern technologies, education, as well as the need to gain an ever-increasing knowledge, has changed drastically over the past few decades. Computer programs for learning have become an attractive tool for acquiring knowledge, because they combine verbal-conceptual and audio-visual information, which makes different learning requirements more concrete and far more interesting. Educational software enables interactive learning, quick access to useful information, instantaneous correction of errors and verification of acquired knowledge and skills.

From traditional toward modern education

Nowadays, the education system differs greatly from the period of thirty years ago or more, just like the process of knowledge acquiring itself. New information is generated every day, and general development continuously requires new knowledge and skills. New communication and information technologies offer great opportunities for acquiring practical knowledge. In addition to the advantages provided by modern technology, there are some practices that should not be changed. A lot of important methods of learning and students' development come from experiences that are difficult to transmit electronically. A result of the digitalization era there may be a loss of comprehensive knowledge, which is a major problem for the economy of each country.

Models of education systems are different in European countries. For example, in France, there is still an emphasis on traditional forms of teaching, while in the United Kingdom and some Scandinavian countries, new methods and modern technologies have become primary teaching methods. In Estonia, programming and coding are mandatory in elementary education; they use robots for interactive learning of programming and coding. In this country, schools have great autonomy, they have the freedom to create programs within a digital strategy, and they have developed an online learning system and an interdisciplinary approach to teaching.

According to the results of the PISA test (OECD, 2015), the largest international student testing, the top of the list of countries with the best education belongs to Singapore, followed by Japan, Estonia, China, Finland, Canada, Vietnam, South Korea, and other countries. The Dominican Republic, i.e. the knowledge of students from that country, is among the worst ranked countries. In 2015, the testing was conducted by the Organization for Economic Co-operation and Development (OECD), it included 540,000 students from 73 countries and the overall score was created summing points from three areas: reading literacy, mathematical and scientific literacy and ability to solve problems.

Table 1: *Average scores of 15-year-old students on the PISA science literacy scale, by education system, 2015*

Education system	Average score	s.e.	Education system	Average score	s.e.
OECD average	493	0.5			
Singapore	535 ▲	1.6	Hungary	470 ▼	2.7
Hong Kong (China)	527 ▲	2.7	Greece	467 ▼	4.3
Canada	527 ▲	2.3	Chile	459 ▼	2.6
Finland	526 ▲	2.5	Slovak Republic	453 ▼	2.8
Ireland	521 ▲	2.5	*Malta*	447 ▼	1.8
Estonia	519 ▲	2.2	*Cyprus*	443 ▼	1.7
Korea, Republic of	517 ▲	3.5	*Uruguay*	437 ▼	2.5
Japan	516 ▲	3.2	*Romania*	434 ▼	4.1
Norway	513 ▲	2.5	*United Arab Emirates*	434 ▼	2.9
New Zealand	509 ▲	2.4	*Bulgaria*	432 ▼	5.0
Germany	509 ▲	3.0	Turkey	428 ▼	4.0
Macau (China)	509 ▲	1.3	*Costa Rica*	427 ▼	2.6
Poland	506 ▲	2.5	*Trinidad and Tobago*	427 ▼	1.5
Slovenia	505 ▲	1.5	*Montenegro, Republic of*	427 ▼	1.6
Netherlands	503	2.4	*Colombia*	425 ▼	2.9
Australia	503	1.7	Mexico	423 ▼	2.6
Sweden	500	3.5	*Moldova, Republic of*	416 ▼	2.5
Denmark	500	2.5	*Thailand*	409 ▼	3.3
France	499	2.5	*Jordan*	408 ▼	2.9
Belgium	499	2.4	*Brazil*	407 ▼	2.8
Portugal	498	2.7	*Albania*	405 ▼	4.1
United Kingdom	498	2.8	*Qatar*	402 ▼	1.0
Chinese Taipei	497	2.5	*Georgia*	401 ▼	3.0
United States	**497**	**3.4**	*Peru*	398 ▼	2.9
Spain	496	2.4	*Indonesia*	397 ▼	2.9
Russian Federation	495	3.1	*Tunisia*	361 ▼	3.1
B-S-J-G (China)	494	5.1	*Dominican Republic*	358 ▼	3.1
Switzerland	492	3.0	*Macedonia, Republic of*	352 ▼	1.4
Latvia	488 ▼	1.8	*Algeria*	350 ▼	3.0
Czech Republic	487 ▼	2.6	*Kosovo*	347 ▼	1.6
Croatia	487 ▼	2.7	*Lebanon*	347 ▼	4.4
Vietnam	487 ▼	3.7			
Austria	485 ▼	2.8			
Italy	485 ▼	2.7			
Iceland	482 ▼	2.0	**U.S. states and territories**		
Luxembourg	481 ▼	1.4			
Israel	479 ▼	3.8	*Massachusetts*	527 ▲	6.0
Buenos Aires (Argentina)	475 ▼	7.2	*North Carolina*	500	5.4
Lithuania	472 ▼	2.7	*Puerto Rico*	410 ▼	7.1

Source: *National Center for Education Statistics (2015)*

Unfortunately, Serbia was not a participant in this international testing in 2015, so we do not have a real insight into the knowledge of Serbian students. Since the results of the new PISA testing held in 2018, which included the Republic of Serbia, will be published in 2019, the year 2018 could not be covered by this research.

A good test result of students from Asian countries (Singapore, Japan, China, Vietnam, and South Korea) can be explained by the economic take-off of Asian countries through technological development and innovations. Also, the reason for the success should be sought not only in a well-established and disciplined education system, but also in promotion of a culture of quality and education culture in East Asian countries. The basic instruments of social and economic development of these countries are science and education.

Modern way of life and the technology development change the way we live and work. The development and improvement of technology affect the economy, changing the structure of jobs and demand for certain occupational profiles, knowledge and skills. In line with the changes, the way we acquire knowledge changes, and consequently we have a need to change the whole education system.

Since digitization imposes itself as a development path, education must adapt to the new digital economy. Reform of the education system implies new definition of strategies in line with technological changes and demands of the education users. When it comes to the choice of development strategies, multi-criteria decision-making process (Urošević et al., 2018, Karabašević et al., 2018) can significantly contribute to decisions related to sustainable solutions.

Advantages of learning using digital technologies

Educational software mainly use program support for learning (courseware), based on Web and complemented by computer-mediated communication (CMC). The structure of educational software for self-learning depends on the goals set for learning and the nature of the teaching content. The most commonly used are linearly structured materials, in which students are instructed to work step by step. Instructions for adopting new contents, tasks for students, questions for self-evaluation etc. are taking turns. Learning through educational software guarantees a higher level of knowledge. The software enables teaching material to be quickly and better managed with constant knowledge testing. This avoids a campaign approach to learning and provides continuous improvement. Students are encouraged to pay more attention and better to concentrate. In addition to learning within educational institutions, the use of educational software is also possible at home, independently. One of the most important elements of interaction is providing feedback on what has been done (Bjelja & Janovac, 2012).

Application of interdisciplinary approach and new technologies in teaching has many advantages, especially when it comes to personalization of learning, increased level of motivation, training of students to create and use new knowledge, creation of a continuous learning culture, as well as the development of critical thinking and problem solving with the help of digital content.

Research methodology

The aim of this research is to point out the need for the application of new approaches and digital technologies in the educational process. For this purpose, an empirical research with two questionnaires was made. The first survey was intended for the management of the school (director, psychologist/pedagogue, coordinator of professional practice), while the second survey was intended for secondary school students. In the first survey participated 11, and in the second survey 408 respondents. The surveys were conducted in three schools of economy: the First Economics School in Belgrade, the Economic School "Nada Dimić" in Zemun and the secondary school "Kosta Cukić" in Novi Beograd. Surveys were conducted in October, 2017. Table 2 shows the frequencies of respondents (school management) of the first survey.

Table 2: *Characteristics of the first survey respondents (n=11)*

Characteristics of the respondents (management)		**Number of the respondents (n)**	**Structure (%)**
Profession	Coordinator of professional practice	7	63,6
	Director	1	9,1
	Pedagogue/Psychologist	3	27,3
Do you consider professional practice an important element of the educational process?	Yes	11	100,0
	No	-	-
Do you think that it is necessary to introduce changes in knowledge acquiring, in line with the modern concept of education?	Yes	10	90,9
	Ne	-	-
	I do not know	1	9,1
What should be changed in the	Redefine study programs	1	9,1

process of knowledge acquiring?	Approach	7	63,6
	Introduce new advanced methods	3	27,3
What are the reasons for the introduction of changes?	Outdated teaching methods	4	36,4
	Modern approach to practical knowledge acquiring	6	54,5
	Uncoordinated study programs with market demands	1	9,1
Do you consider educational software an adequate learning tool?	Yes	10	90,9
	No	1	9,1

Source: *Author's calculation*

According to the respondents' profession (school management), it can be noticed that there is 63.6% of professional practice coordinators in the sample, 27.3% of pedagogues/psychologists and 9.1% of directors. As far as we observe the frequencies of the management's responses to the questions from the first survey, we can conclude the following: all respondents consider that professional practice is an important segment of the educational process, while 90.9% of the respondents consider that the changes in line with the modern concept of education are necessary in knowledge acquiring process. When it comes to acquiring new knowledge, 63.6% of respondents believe that it is necessary to change the approach, 27.3% of respondents consider that it is necessary to introduce new advanced methods, while 9.1% of respondents consider it is necessary to redefine study programs. More than half of the respondents (54.5%) believe that modern approach for acquiring practical knowledge is the main reason for the introductions of the changes. Most respondents (90.9%) believe that educational software can be an active learning tool.

Table 3: *Characteristics of the respondents of the second survey (n=408)*

Characteristics of respondents (students)		**Number of respondents (n)**	**Structure (%)**
Sex	Male	160	39,2
	Female	248	60,8
Do you consider professional practice important for acquiring practical knowledge?	Yes	398	97,5
	No	10	2,5
Where would you like to do professional practice?	In an organization (bank, company)	306	75,0
	At school	10	2,5
	At a faculty that focuses on applied knowledge	62	15,2
	I have no opinion about the place of the professional practice	30	7,4
Would you like to get a certificate for acquiring certain knowledge and skills after completing professional practice?	Yes	398	97,5
	No	10	2,5
Would you like to acquire new knowledge using educational software?	Yes	364	89,2
	No	44	10,8

Source: *Authors' calculation*

According to the respondents' (students') sex, it can be noticed that there is 60.8% of female respondents and 30.2% of male respondents in the sample. If we observe frequencies of students' responses to the questions from the second survey, it can be noticed that the majority of respondents (97.5%) believe that the professional practice is important for acquiring practical knowledge. Most respondents (75.0%) have the desire to attend a professional practice in an organization (bank, company) and the majority (97.5%) would like to get a certificate for acquiring certain skills and knowledge after completing professional practice. Most respondents (89.2%) have a desire to gain new knowledge through the use of educational software.

Based on the analyzed theoretical background and the aim of the research, we have set the following hypothesis:
H_1: There is a statistically significant connection between the requirement for changes in acquiring new knowledge and concrete changes.
H_2: Respondents of the different professions (coordinators of the professional practice, director, pedagogue/psychologist) and students of different sex have the same attitude on educational software.

Testing of both hypothesis is made using the method of cross-tabulation and chi-squared test. Statistical software used for the data processing and hypothesis testing was IBM SPSS version 21.

Research results and discussion

Determination of the statistically significant connection between the requirement for changes in acquiring new knowledge and concrete changes

One of the tasks of this research is to examine whether there is a statistically significant connection between the requirement for changes in acquiring new knowledge and concrete changes (in the sample related to school management). It was set the following hypothesis.

H_1: ***There is a statistically significant connection between the requirement for changes in acquiring new knowledge and concrete changes.***

To test the proposed hypothesis, it will be used cross-tabulation method, i.e. determining the frequency or proportions of cases in each of the categorical variables (Coakes, 2013).

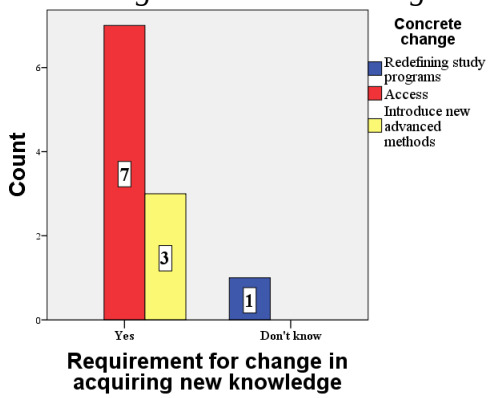
Based on the cross-tabulation of two categorical variables, ***the requirement for changes in acquiring new knowledge*** and ***the concrete changes,*** in Table 4, it can be noticed that among these respondents who insist on the necessity of changes in acquiring new knowledge, 7 respondents consider that it is necessary to change the approach (70%), while 3 respondents believe that it is necessary to introduce new advanced methods (30%) in order to acquire new knowledge in accordance with the modern concept of education. When it comes to respondents who are not sure whether the changes in acquiring new knowledge are necessary, 1 respondent thinks that it is necessary to redefine the study programs.

Table 4: *Testing the independent variables: requirement for changes in acquiring new knowledge and concrete change*

			Concrete change			
			Redefine study program	**Approach**	**Introduce new advanced methods**	**Total**
Requirement for changes in acquiring new knowledge	**Yes**	Frequency	0	7	3	10
		Structure (%)	0,0%	70,0%	30,0%	100,0%
		% group in the sample	0,0%	100,0%	100,0%	90,9%
	I do not know	Frequency	1	0	0	1
		Structure (%)	100,0%	0,0%	0,0%	100,0%
		% group in the sample	100,0%	0,0%	0,0%	9,1%
Total		Frequency	1	7	3	11
		Structure (%)	9,1%	63,6%	27,3%	100,0%
		% group in the sample	100,0%	100,0%	100,0%	100,0%

Source: *Authors' calculation*

Chart 1: *Frequency of requirements for changes in acquiring new knowledge and concrete changes*



Source: *Authors' calculation*

Pearson's chi-square test was used to determine the significance of the result (Table 5). To make the result significant, the significance value should be 0.05 or less (Gravetter, & Wallnau, 2013; Green & Salking, 2014). Considering that in the concrete case the significance value is lower than 0.05, we consider that there is a connection between the variables: the requirement for changes in acquiring new knowledge and concrete changes.

Table 5: *Pearson's chi-squared test*

	Value	Number of degrees of freedom	Significance value
Pearson's chi-square	11,000	2	,004
Probability percentage	6,702	2	,035
2-side linear connection	4,225	1	,040
Total number of observations	11		

Source: *Author's calculation*

The chi-square test of independence showed a significant connection between the requirement for changes in acquiring new knowledge and the concrete changes χ^2 (2, n = 11) = 11.0; p = 0.004; p < 0.05.This means

that the proportion of respondents related to the requirement for change in acquiring new knowledge significantly varies according to what exactly should be changed in acquiring new knowledge. This implies that the assumption H_1 is approved: ***There is a statistically significant connection between the requirement for changes in acquiring new knowledge and concrete changes.***

Determination of statistically significant difference in the attitudes of management and students on the application of educational software for acquiring new knowledge

One of the tasks of this research is to examine whether there is a statistically significant difference in the opinions of the management (coordinators of the professional practice, director, pedagogue/psychologist), as well as among the students of different sex regarding the application of educational software for acquiring new knowledge. It was set next hypothesis.

H_2: ***Respondents of the different professions (coordinators of the professional practice, director, pedagogue/psychologist) and students of different sex have the same attitude on educational software.***

To test the proposed hypothesis, it will be used a cross-tabulation method, i.e. determining the frequency or proportions of cases in each of the categorical variables.

On the basis of the cross-tabulation of two categorical variables: ***occupation*** and ***educational software*** in Table 6, it can be noticed that 6 coordinators of the professional practice consider that educational software is an active learning tool (85.7%), while 1 of them considers that educational software is not an active tool for learning (14.3%). When it comes to directors, 1 respondent believes that educational software is an active learning resource. When it comes to pedagogues/psychologists, 3 respondents think that educational software is an active learning resource. If we observe the whole sample, 90.9% of the management believes that educational software is an active learning tool.

Based on the cross-tabulation of two categorical variables: ***sex*** and ***educational software*** in Table 6, it is noted that 142 male students want to gain new knowledge using educational software (88.8%), while 18 of them do not want to acquire new knowledge using educational software

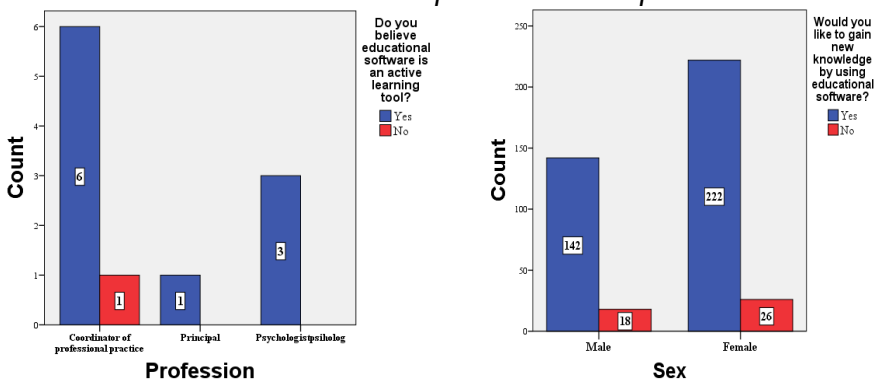
(11.2%). When it comes to female students, 222 of them want to gain new knowledge using educational software (89.5%), while 26 of them do not want to acquire new knowledge using educational software (10.5%). If the whole sample is observed, it can be noticed that 89.2% of students want to gain new knowledge using educational software.

Table 6: *Testing the independent variables: profession and educational software; sex and educational software*

			Educational software		**Total**
			Yes	**No**	
Profession	Coordinator of professional practice	Frequency	6	1	7
		Structure (%)	85,7%	14,3%	100,0%
		% group in sample	60,0%	100,0%	63,6%
	Director	Frequency	1	0	1
		Structure (%)	100,0%	0,0%	100,0%
		% group in sample	10,0%	0,0%	9,1%
	Pedagogue/ psychologist	Frequency	3	0	3
		Structure (%)	100,0%	0,0%	100,0%
		% group in sample	30,0%	0,0%	27,3%
	Total	Frequency	10	1	11
		Structure (%)	90,9%	9,1%	100,0%
		% group in sample	100,0%	100,0%	100,0%
Sex	Male	Frequency	142	18	160
		Structure (%)	88,8%	11,2%	100,0%
		% group in sample	39,0%	40,9%	39,2%
	Female	Frequency	222	26	248
		Structure (%)	89,5%	10,5%	100,0%
		% group in sample	61,0%	59,1%	60,8%
	Total	Frequency	364	44	408
		Structure (%)	89,2%	10,8%	100,0%
		% group in sample	100,0%	100,0%	100,0%

Source: *Author's calculations*

Chart 2: Distribution of respondents according to profession and sex related to the use of educational software



Source: *Author's calculations*

To determine the significance of the results it was used Pearson's chi-squared test (Table 7). To make the results significant, the significance value should be 0.05 or lower.

Table 7: *Pearson's chi-square test*

		Value	Number of degrees of freedom	Significance value
Profession	Pearson's chi-square	,629	2	,730
	Probability percentage	,960	2	,619
	2-side linear connection	,521	1	,470
	Total number of observations	11		
Sex	Pearson's chi-square	,059	1	,808
	Probability percentage	,059	1	,808
	2-side linear connection	,059	1	,808
	Total number of observations	408		

Source: *Author's calculations*

The chi-square test of independence did not show a significant connection between respondents and the application of educational learning software χ^2 (2, n = 11) = 0.629; p = 0.730; p > 0.05. In other words, the proportions of the coordinator of the professional practice, the director and the pedagogue/psychologist do not differ when it comes to the attitude that educational software is an active tool for learning. Although the result of

the comparison is not statistically significant, it only proves that educational software is, in relative terms, an active tool for learning, in the opinion of the coordinator of professional practice, as well as and in the opinion of the director and the pedagogue/psychologist. Also, it should be concluded that the majority of management staff (90.9%) believe that educational software is an active learning tool.

The chi-square test of independence did not show a significant connection between the sex of the students and the application of educational learning software χ^2 (1, n = 408) = 0.059; p = 0.808; p > 0.05. In other words, the proportions of male and female students do not differ in the desire to acquire new knowledge using educational software. Although the result of the comparison is not statistically significant, it only proves that the desire to acquire new knowledge by using educational software is present, to the same extent, both for male and for female students. Also, it should be concluded that most students (89.2%) want to gain new knowledge using educational software.

Finally, the set assumption $\boldsymbol{H_{2\ is}}$ proven: ***Respondents of the different professions (coordinators of the professional practice, director, pedagogue/psychologist) and students of different sex have the same attitude on educational software.***

Conclusion

The influence of knowledge on the development of society is becoming more important than any other resource. Education is an important factor when it comes to the effective and fast economic development. Creating a stable knowledge-based economy can be achieved with the help of a defined national policy.

In order for research in the field of education to fulfil an important social role, it is necessary to establish a good communication between the research community and those interested in using research findings, including the creators of educational policies.

The results of the empirical research indicate that changes in the approach to knowledge acquiring are necessary and they have to be in line with the modern concept of education and the digital economy. The education system needs to be brought closer and adjusted to the users, which means

adapting learning methods and techniques, improving existing study programs and introducing new ones in line with market demands.

The results of empirical research indicate that most students (89.2%) want to gain new knowledge using educational software. Also, majority of the school management (90.9%) believes that educational software is an active learning tool.

Learning through digital technologies ensures a higher level of knowledge acquisition, better students' motivation, continuity in learning. The results of this empirical research can contribute to the efficiency of planning and redefining education policy in order to improve digital literacy.

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EFFECTIVENESS OF THE USE OF DIFFERENT EDUCATIONAL SOFTWARE IN TEACHING BIOLOGY IN PRIMARY EDUCATION

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Abstract

Implementation of information systems and the use of educational software (ES) in the teaching process is a way of following the contemporary trends of the European education system. Different types of ES with the contents corresponding to the national curriculum and in the Serbian language are available to the teachers teaching Biology in the primary school in Serbia, but the effects of their application are unknown. The aim of this research is to investigate the effect of two different types of ES in the Biology teaching in the primary school on students' performance. The results show that the ES has been constructed according to the model of programmed teaching, which contributes to better performances in Biology in relation to the ES which concept is similar to the textbook concept. It has been concluded that it is important for creating the contents in the ES to respect the didactic principles and characteristics of innovative teaching models.

Key words:*Biology education, primary school, performance, students' attitudes, educational software*
JEL classification: C88, I20, I21, I29, L86

Introduction

Education is an area that requires continuous improvement and innovation, most often through the application of modern interactive teaching models supported by information and communication technologies (ICT), which are a natural environment for students. ICT supported teaching involves the application of educational software (ES), computer simulations, virtual reality in and outside the classroom. Learning models in which computer and software applications are

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common are programmed learning, flipped learning, interactive computer-assisted learning... The influence of the above-mentioned learning models supported by ES for better understanding of the biological concepts and concepts of other natural sciences in comparison to conventional teaching approach have been pointed out by numerous authors (in Biology teaching: Drakulić & Miljanović, 2009; Odadžić et al., 2017; Pribićević et al., 2017; Rotbain et al., 2008; Tsui & Treagust, 2007; Županec et al., 2017; in Physics teaching: Cekbas et al., 2003; Kara & Yakar, 2008; Radulović et al., 2016; in Natural Sciences: Cvjetićanin et al., 2013). Educational software designed for the application of programmed teaching, and other teaching models as well, should give a meaningful content to computers in the process of learning and teaching, and therefore the approach to their development should be extremely organized, professional and responsible. The contents presented to students by the ES should be consistent with the set teaching objectives, which contribute to achieving the expected learning outcomes. In the ES, the teaching content should be interactive, enabling students to actively participate in the learning process. Also, a very important characteristic of ES is the existence of feedback at every step of knowledge acquisition. Feedback in the ES allows students to gain additional information in the process of knowledge acquisition, and to immediately correct mistakes and get the correct answers, which encourages their motivation and interest in work (Drakulić & Miljanović, 2010). With the help of the ES, teaching can be individualized and adapted to individual abilities and interests of students.

Biological contents taught in primary schools in the Republic of Serbia offer a range of possibilities for the development and implementation of the ES by their very nature. As a result, there is the educational software at the market of the Republic of Serbia for the implementation of Biology teaching in primary school, which is being developed and distributed by various publishers: Multisoft, Kvark Media, Klett, Bigz, Zavod za udžbenike. By analyzing the published ES of the mentioned publishers, it could be concluded that the contents in them are presented in a very similar manner. Namely, the teaching contents in the software are "copied" from the textbook, and what gives them an advantage for their use in the teaching process is the existence of various interactive tasks and additional interesting things by which that students are actively engaged in the learning process and further motivated for learning the biological contents. Although the published software has a number of advantages for

its use in Biology teaching, the following question arises: "Does every educational software model necessarily lead to advancement and improvement of the student's knowledge?" The main purpose of this study was to determine the effects of the two models of educational software in the implementation of biological contents in primary school on the students' performance. In one of the applied models of ES, the teaching contents of the subtopic 'Chordate' is structured according to the programmed teaching model, and the content of this software is presented in details in the doctoral dissertation of the author of this paper. Another model of ES, which effects have been examined in this paper, is the outcome of the publisher 'Bigz', and the teaching content of the subtopic 'Chordate' has been designed and presented in the manner similar to the textbook presentation of the content.

Methodology of Research

General Background. The experimental approach was used in this research. According to the aim of the research, the pedagogical experiment was conducted with parallel groups. A student from the experimental group (E) learned the teaching subtopic 'Chordate' within the Biology classes for the sixth grade of the primary school by using the ES with the content structured according to the programmed teaching model. At the same time, the students of the control group (C) learned the same teaching contents in the conventional way by using ES, which concept is similar to the textbook concept. The two groups were then evaluated to identify effects of the applied two different ES on the students' performance in Biology.

Sample. The convenience sample consisted of 250 students from two primary schools in Novi Sad, who participated in the research. In order to calculate the sample size, the application http://www.raosoft.com was used. According to the data obtained by the Republic Bureau of Statistics of the Republic of Serbia, the entire population of all sixth-graders from Novi Sad was around 3.600 students, and our sample of 250 students represented a convenience sample, since it was in range from 186 to 310 students. The range borders were defined with the confidence level of 95%, i.e. 99%, for the value of margin of error of 7%. In total, every group (E and C) consisted of 125 students. The students' age ranged from 11 to 12.

Research Procedure. The experiment was carried out in the school year 2015/16, during regular Biology classes, on the contents of the subtopics 'Chordate', in the second semester of the sixth grade of primary school. The students in the E and the C groups were taught by the same Biology teacher. According to the curriculum for the sixth grade of primary school (Official Gazette - Educational Gazette, no. 5/2008), the teaching subtopic 'Chordate' was taught during 19 classes, and included the implementation of 12 teaching units, one experimental exercise, five classes of repetition, and one class of systematization of the teaching contents. The teaching units within the teaching subtopic 'Chordate' are the following: (1) Chordate: basic characteristics of Chordate on the basis of the example of Amphioxus, in comparison to the previous groups of animals; (2) Vertebrate: a structure and diversity; (3) Fish: a way of life, structure and correlation with the habitat (a carp); (4) The practicum exercise: Dissection of fish; (5) Variety of fish and their significance; (6) Amphibians: a way of life, structure and correlation with the habitat (a frog). Reproduction and development; (7) Diversity of amphibians and their significance; (8) Reptiles: a way of life, structure and correlation with the habitat (a lizard); (9) Diversity of reptiles and their importance, extinct reptiles; (10) Birds: a way of life, structure and correlation with the habitat; (11) Variety of birds and their significance; (12) Mammals − a way of life, structure and correlation with the habitat; (13) Variety of mammals and their importance (Curriculum of Biology for the sixth grade of primary school, Official Gazette of the Republic of Serbia, no. 5/2008). Duration of the experiment was ten weeks in total for both groups, simultaneously.

At the beginning of the research, prior to teaching the subtopic 'Chordate', both the experimental group and the control group of students were tested with the pre-test at the regular Biology class in order to synchronize the previous knowledge of students in both groups. The pre-test in both groups of students was carried out the same day. After pre-testing, teaching of the subtopic 'Chordate' was implemented with different models of educational software: ES with the contents structured according to the programmed teaching model in the E group, and ES of the publisher 'Bigz' with the contents presented as in the textbook of the same publisher.

In *the experimental group* of students, Biology classes were held in the Biology classroom by applying the programmed learning supported by

'Chordate' education software. During the teaching of all 12 teaching units, the contents were implemented in the frontal application of ES by Biology teachers. At every step of the way, the students were involved in solving tasks which successful solving led them to a new step, i.e. the process of new information or a task. The implementation of the exercise took place in the Biology classroom by using the instruction handout, a group work, and the laboratory-experimental teaching method. Classes of repetition were implemented in the Biology classroom based on the frontal teaching form, verbal-textual and demonstrative-illustrative teaching methods, without the use of ES. In *the control group* of students, the lessons which presented the teaching material of the subtopic 'Chordate' were held in the Biology classroom with the dominant application of monologue and dialogue teaching methods, by using overhead projection cells and illustrations from the Biology textbook for the sixth grade of primary school published by the publishing house 'Bigz'. At the classes, the Biology teaching software for the sixth grade of primary school published by the publishing house 'BIGZ' was used only in its final part, because of its simple structure and the content. The implementation of exercises and lessons for the content repetition were carried out in the same way as in the experimental group of students. In the C group, the teaching was slightly changed in comparison to the existing work, the usual teaching, because the teacher used the software in the final part of the class, which had not been used before.

Upon completion of the experimental research, the differences in the students' achievements in the E and C groups were analyzed, taking into account their achievements on the post-test.

Instruments. The pre-test and the post-test were the instruments which were structured and applied in the research. Each of these tests included tasks grouped into three different cognitive levels: the level of knowledge (Level I), the level of application (Level II), and the level of analysis and reasoning (Level III). The cognitive levels were established according to the model of the study TIMSS 2007 (Martin et al., 2008), which was used to categorize the questions for the tests. The maximum number of points that could be gained was 30 on each individual test within Level I, the students could gain 40 points within Level II, and maximum 30 points within Level III. Thus, the total maximum number of points which students could gain on all the tests was 100. The pre-test contained tasks related to the teaching subtopic 'Invertebrates', while the post-test

contained tasks related to teaching subtopic 'Chordate'. The Cronbach's Alpha values for the pre-test (α=0.847), and the post-test (α=0.842), showed a high reliability of the tests. According to Green and Salkind (2007), the reliability coefficient should be at least 0.70 for the test to be considered reliable. During the research, all participants were tested simultaneously in the school environment, and every test lasted for 45 minutes.

Presentation of two ES models for the Biology teaching implementation.

1. *The first ES model*, in which the content of the teaching subtopic 'Chordate' was structured according to the programmed teaching model, was created in the Adobe Flash 9 computer application. The display of a part of this ES was given in the paper written by Županec et al. (2013). The teaching content in this ES was structured in a way that students could adopt it either independently, or in a form of cooperative learning. There are six sections in every ES unit: Teaching Content, Final Test, For Those Who Want to Know More, Glossary, Content Overview, and Photo Gallery. The section Teaching Content shows the contents of a teaching unit that includes several information (from 6 to 9), which follow gradually one after another, thus allowing the gradual adoption of the teaching contents part by part, at the student's own pace of work. Most of the information is presented on two to four slides due to very rich illustrations. The section Teaching Contents contains the tasks that follow every information given for reading, and the student is given a feedback after solving the task no matter if he/she has answered the question correctly or not. If the student gives an incorrect answer, he/she gets additional information to realize his/her mistake, being obliged to return to the previously read information in order to read it again more carefully and adopt it. After repeated reading of the information, the student answers the same question again. If the student's answer is correct, he automatically switches to solving the next task. Only when the student answers correctly all the questions set within one information, he/she can move on to reading the next information, i.e. a new part of the teaching content, one after another, until he/she fully adopts the content of one teaching unit. The tasks that follow after the information belong to different types: Multiple-Choice-Single-Answer, Fill-in numbers, Fill-in expressions, and Multiple Fill-in expressions. This structure of the Teaching Contents results in a great interactivity in teaching, based on the game and a constant activity of students by using the software. The Final Test contains questions which answers consolidate all individual

information in a whole. After every task completed, the student receives feedback on whether he/she has answered the question correctly or not. Since every question in the final test is equivalent to a certain number of points, the total number of points and the grade for acquiring the teaching unit is shown to the student upon solving the last task. The Photo Gallery contains all the images found in the teaching material and the test, enabling students to have a complete visual, illustrative insight into the learnt content. The Photo Gallery also contains new, additional images, which aim is to make students understand the anatomy of a group of vertebrates more clearly, to find out the details, as well as similarities and differences among certain groups of these animals. The Content Overview contains the most important theses from the teaching unit that is being processed. This section of the software is especially significant and intended for students of the average and under-average skills, since they often have a problem to extract important information from unimportant ones in the lot of information. In the section For Those Who Want to Know More, the students interested in Biology have the opportunity to read additional interesting information related to each vertebral group. The Glossary section provides explanations of all new and key biological terms from the teaching subtopic 'Chordate'.

2. *The second ES model* used in this research has been enclosed to the Biology textbook for the sixth grade of primary school published by the publishing house 'Bigz' (Bukurov et al., 2009). In this ES, there are four sections within every teaching unit from the teaching subtopic 'Chordate': Teaching Content, Key Words, Knowledge Check, and Puzzles. The section Teaching Content provides the content of an entire teaching unit, which is given in a form of one or two general paragraphs or a small number of images. The teaching unit that explains the structure and characteristics of a particular group of animals consists of only one picture, which does not mark all internal organs. In the teaching unit that explains the diversity of a particular group of animals, there are several images of the representatives of that group. Based on the presented contents of one teaching unit, and by analyzing the contents of other teaching units in the same software, it can be concluded that the complete teaching material is given in a very concise form, reminding of an overview of the teaching content. It does not provide sufficient information for students to independently master the teaching material. Illustrations are incomplete and do not provide sufficient information, since only some parts of the internal structure of animals are marked.

Such a concise summary of the teaching content can only help pupils with lower achievement ability, since it contains extracted most important facts from the lesson. The presentation of the content of the lesson with the software is not sufficient at regular Biology classes. However, it is only a supplement to the Biology textbook for the sixth grade of primary school of the same publishing house ('Bigz'), which is much more informative, more illustrative, and more transparent in the presentation of the teaching material. In the Knowledge Check section, a number of open-type questions are asked (for example, What is the role of hair in mammals?). Questions do not have the offered answers, and therefore this part of the software can have a purpose in the final part of the class, when the teacher repeats the teaching content with the students in a method of a dialogue. The Puzzle section allows students to repeat the teaching content in a more interesting way in comparison to the Knowledge Check section. This section includes the following games: quiz, find a pair, guess terms, and associations. In the Quiz game, students are asked questions of multiple choices. After giving the answer, the student receives a feedback on the accuracy of his/her answer, and regardless of the outcome of the solved task, the student automatically moves to solving the next task. Therefore, if the student has not correctly solved the task, he/she does not have a possibility to read additional explanation in order to realize his/her own mistake. The game Find a Pair, which is at the same time a memory game and a knowledge game, is about the diversity of certain groups of animals, while the games Guess Terms and Associations are interesting for students, holding their attention for a longer time. Due to the concise presentation and insufficient illustrations of the teaching contents of the subtopic 'Chordate', this ES model is used in this research exclusively in the final part of the class, for the purpose of repeating the teaching contents.

Data analysis. For the statistical processing of data obtained on the knowledge tests (pre-test and post-test), the SPSS 14.0 program was used. The research analyzes the following statistical parameters: arithmetic mean (M) and standard deviation (SD). ANOVA was used with contrast tests and t-test in order to determine the relationship between two variables.

Results and Discussion

Students' Performance on the Pre-test

Table 1 contains the descriptive statistics of the pre-test, and the corresponding *t* value.

Table 1: *Descriptive statistics and the t value for performance on the pre-test*

Cognitive Levels	**Group**	**N**	**M**	**SD**	**df**	**t**	**p**
Knowledge	E	125	21,21	5,421	248	-,079	>.05
	C	125	21,27	7,293			
Application	E	125	22,14	8,798	248	-,307	>.05
	C	125	22,48	8,486			
Analysis and Reasoning	E	125	12,63	6,732	248	-,293	>.05
	C	125	12,88	6,668			
Total achievement on the pre-test	E	125	55,98	16,524	248	-,285	>.05
	C	125	56,63	19,355			

As it could be seen in Table 1, there was no statistically significant difference in the mean score of the students in two groups determined on the pre-test in general, and in individual cognitive levels. On the basis of the performances accomplished on the pre-test, the E and C groups were equalized according to the students' knowledge of the teaching subtopic 'Invertebrates'.

Students' Performance on the Post-test

Table 2 contains statistical parameters obtained for performance of the E and C groups.

Table 2: *Descriptive statistics and the t value for performance on the post-test*

Cognitive Levels	**Group**	**N**	**M**	**SD**	**df**	**t**	**p**
Knowledge	E	125	26,99	3,407	248	9,209	<.05
	C	125	21,66	5,499			
Application	E	125	34,10	5,418	248	5,820	<.05
	C	125	29,14	7,857			
Analysis and Reasoning	E	125	22,87	4,804	248	11,594	<.05
	C	125	14,23	6,807			
Total achievement on the post-test	E	125	83,97	11,385	248	10,131	<.05
	C	125	65,03	17,525			

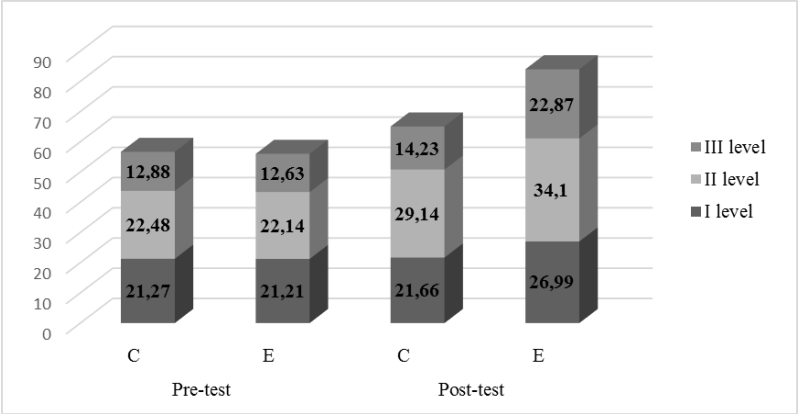
Based on the results of the t-test (Table 2), it could be seen that there were significant differences in the student's achievement in favor of the E group, both in the post-test in general and at every individual level of knowledge on the same test. The differences were especially expressed in the tasks of the most difficult level, the third level of knowledge (on average 8.64 points in favor of the E group), which required the application of the acquired knowledge, analysis and reasoning. Thus, the obtained difference in the achievement between students of the E and C groups in the post-test was not only the difference in quantity, but also in the quality of their knowledge, skills and habits in Biology. Significantly better achievement of students from the E group than from the C group was the result of an adequately selected and implemented software 'Chordate', which was structured and modified according to the programmed teaching model in the implementation of the teaching subtopic 'Chordate' for the sixth grade of primary school, in the E group of students in comparison to a more traditional approach to teaching this content by applying the software for teaching, published by the publishing house 'Bigz'.

A comparative analysis of the students' achievements in the E and C groups during pedagogical research

In order to better understand the students' achievement during the pedagogical research, Figure 1 shows a comparative overview of the

students' achievements in the E and C groups from the two knowledge tests.

Figure 1: *A comparative overview of students' achievements in the E and C groups from the knowledge tests in individual cognitive levels*



The results shown in Figure 1 indicated the great progress of students from the E group in solving tasks in the post-test, both at individual cognitive levels and in general, in comparison to their achievement in the pre-test. In the post-test, students from the C group were more successful only in solving the tasks of the second level, while the achievement in solving tasks of the first and the third level remained the same as on the pre-test.

A combined variance analysis was used to examine the significance of differences in the students' achievement between two knowledge tests in general, and at individual levels of knowledge within each group. This analysis showed a significant effect of the interaction between the measurements and the group, i.e. the change in the students' achievement from the post-test to the post-test, which was different in different groups, both on the tests in general (Vilks Lambda = 723, F = 95,241, df = 1/248 , p <, 000), as well as at individual levels of knowledge (the first level: Vilks Lambda =, 823, F = 53,514, df = 1/248, p <, 000; the second level: Vilks Lambda =, 897, F = 28,361 , df = 1/248, p <, 000; the third level: Vilks Lambda =, 754, F = 81,028, df = 1/248, p <, 000).

Table 3 shows changes in the students' achievement from E group on the post-test in comparison to the pre-test.

Table 3: *Changes in the students' achievement from E group during the pedagogical research*

Cognitive level	**Comparison of two tests**	**$M_1 - M_2$**	**SD**	**SE**	**t**	**p**
I	Pre-test and post-test	-5,784	5,502	,492	-11,754	<.05
II	Pre-test and post-test	-11,960	8,006	,716	-16,701	<.05
III	Pre-test and post-test	-10,240	7,954	,711	-14,394	<.05
Total	Pre-test and post-test	-27,984	15,636	1,399	-20,010	<.05

As it could be seen in Table 3, the students from the E group significantly advanced in the post-test in general and at individual levels of knowledge in comparison to the post-test. A significant progress of students from the E group on the post-test in comparison to the pre-test was a result of the application of ES with the content structured according to the programmed teaching model. Application of such software required from students a constant attention and activity. Information in the ES were presented clearly with a great number of illustrations that contributed to their better understanding by students who had a range of different knowledge and abilities. Students below average abilities, who found biological contents difficult, had the opportunity outside the classroom to read additional explanations within every incorrectly solved task from every information, which further helped them to master the teaching material and achieve the pace of better students. Students with exceptionally good predispositions and backgrounds had the opportunity to read additional contents at home within the section For Those Who Want to Know More. Answers to interesting questions additionally motivated students of all psychophysical and perceptual abilities for the given teaching contents. Using software was very easy for students, and therefore they were not tired or frustrated in any way. The use of educational software with content structured according to the programmed teaching model resulted in a significant intensification of students from E group, and the advancement of Biology teaching.

The Table 4 shows changes in the students' achievement from C group on the post-test in comparison to the pre-test.

Table 4: *Changes in the students' achievement from C group during the pedagogical research*

Cognitive level	**Comparison of two tests**	**$M_1 - M_2$**	**SD**	**SE**	**t**	**p**
I	Pre-test and post-test	-,392	6,135	,549	-,714	>.05
II	Pre-test and post-test	-6,656	7,739	,692	-9,616	<.05
III	Pre-test and post-test	-1,352	7,655	,685	-1,975	>.05
Total	Pre-test and post-test	-8,400	16,090	1,439	-5,837	<.05

As shown in Table 4, the students from the C group achieved approximately the same results on the post-test, i.e. at the first and the third cognitive level, as on the pre-test, and that difference between these two tests was not statistically significant. However, comparing the results of students from the C group, which they achieved on the tasks of the second cognitive level in the post-test compared to the pre-test, there was noted a significant progress in the post-test. This difference in the achievement of students from the group C in tasks of the second cognitive level in the post-test, compared to the pre-test, had an impact on the significance of the difference in the post-test as a whole in comparison to the pre-test as a whole.

The consequence of this achievement of students from the C group in the post-test was slightly changed traditional way of working. What distinguished Biology classes during pedagogical research, and prior to its beginning, was the application of software in the final part of the class. Although this software contained very little text and illustrations, interactive tasks contributed to greater interest of students in the teaching subtopic 'Chordate', which resulted in better mastering of the teaching material and more successful solution of the second cognitive level tasks. Educational software of the publishing house 'Bigz' did not contribute to a more successful solution of the tasks at the first and the third cognitive levels, since the contents of the teaching subtopic 'Chordate' contained a large number of facts, highly abstract concepts which required a large number of illustrations in order to be understood. Considering that only

one or two images are given in the software within the teaching material of every teaching unit, failure to meet the principles of obviousness and abstractness most likely resulted in a low achievement of students when solving tasks of the first and the third level.

Based on the obtained results, it could be concluded that the students from the E and C groups significantly improved on the post-text, in comparison to the pre-test, and the progress was more emphasized in students from the E group.

A number of authors from around the world have come to similar results in the field of the application of ES in the teaching of natural sciences. Cepni et al. (2006) examined the efficiency of the ES with content created according to the programmed teaching model (E group) in comparison to the traditional teaching (C group). The results of the research showed that the achievement of students from the E group in the post-test was 10% higher than the achievement of students from the C group. Yusuf & Afolabi (2010) examined the efficacy of an individual and group-applied ES with programmed teaching content (in E1 and E2 groups) in the implementation of ecological contents on the achievement of students in comparison to the traditional teaching (in the C group). The analysis of the results found that the students of the E1 and E2 groups attained statistically significantly higher achievement in the post-test compared to the students of the C group. Efe & Efe (2011) conducted a research in the first grade of the secondary school with the aim of examining the efficiency of the ES and traditional teaching in the implementation of the teaching topic 'Cell'. Students who learnt cytology by using the ES, which contained a large number of simulations, were much more successful in solving the tasks of all cognitive levels compared to the students from the C group. Kara & Kahraman (2008) examined the efficiency of the ES in the Physics classes, in the implementation of the teaching topic 'Power and Pressure' for the seventh grade of primary school, with the content created based on the programmed teaching model (E group) in comparison to the traditional teaching (C group). The results of the post-test showed that the achievement of students from the E group was statistically significantly higher than the achievement of students from the C group. Another important conclusion derived from this research, by means of retest, was that the knowledge acquired by applying the ES was longer remembered in students from the E group in comparison to students from the C group. Philip et al. (2011) conducted a

research in the third grade of secondary school, with the aim to examine the efficacy of the ES in teaching Mathematics, in the implementation of the teaching topic 'Matrix and transformations' in comparison to traditional teaching. The results of the research showed a statistically significant increase in the achievement students from the E group in the post-test in comparison to the achievement of the students from the C group. In addition to this significance, the authors also found that the ES with the teaching content structured according to the programmed teaching model developed a positive student's attitude toward mathematics learning, and improved interpersonal relationships (Philip at al., 2011). They also pointed out that public services in the field of education should provide all students with the possibility to learn mathematics by using the ES with the teaching content created according to the programmed teaching model.

By reviewing the results of the research conducted by other authors, we note that they are in agreement with the results obtained in this research, that the application of the ES with teaching content structured according to the programmed teaching model provides very good results and effects, much better than the traditional learning.

Conclusion

This research analyzes the effects of two different models of the ES on the students' performance in teaching the Biology contents in the primary school. The findings revealed that the students who were taught by the ES with the contents created according to the programmed teaching model made statistically significant achievements in their test scores on all thee levels (knowledge, application, and analysis and reasoning) on the post-test, in comparison to the students who studied in the traditional way with an additional minimal use of the ES, which is similar to the textbook concept. It could be concluded in the comparative analysis of the students' achievements of both groups at the end of the pedagogical research, in comparison to its start, that the students from the E group in the post-test at all three levels of knowledge significantly improved in comparison to the pre-test, while the students from the C group advanced in solving the tasks of the second level (applying knowledge).

Since in our country there has not been published software with the content structured according to the programmed teaching model, we

should not ignore the ES that is attached to the Biology textbooks. With their careful preparation and amendments in terms of the content enrichment with text, numerous illustrations, short films, simulations, various interactive tasks as well as with the quality control and reviews by the eminent professors, the ES would be more useful, more reliable, and more efficient in Biology learning. There are many reasons to use the ES in the teaching process, but it is important that the content in them is formed respecting the basic didactic principles and characteristics of innovative teaching models of specially programmed teaching.

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INNOVATION IN EDUCATION USING NEW TEHCNOLOGIES AND DISTANCE LEARNING PLATFORMS

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Abstract

This paper presents application of new technologies and innovations applied in educational systems. In this paper are given the development of distance learning systems, learning via internet and the advantages and disadvantages of distance learning. In addition, this paper consider new technologies and software applications for better understanding teaching material at difference level of education.

Keywords: *distance learning, e-learning, innovation in education, IoT in education*
JEL classification: A2, O33, O39.

Introduction

This paper presents the development and innovations in the field of information technology; the upgrading of teaching also takes place. The integration of Information and Communication Technologies in the teaching process transforms traditional teaching and reproductive teaching into new teaching, which is ready to respond to the demands and needs of a contemporary student, to increase the quality of education: better student motivation, engagement, use of different sources of knowledge, development of functional abilities of students, and as the goal of everything is to increase the learning outcomes. The main goal in teaching is to use information technologies, apply them towards the emancipation development of students, and focus on the quality of teaching. Therefore, new learning strategies are being dev1eloped that are development-oriented for students. The conveyance of Technical training

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today has experienced a transformation into what we currently perceive as Technology instruction (Vries, 2018).

Containing contents are multimedia-designed, which ensures multiple perceptions of students. In this way, the more versatile work of the students is encouraged, the acquired knowledge and skills are more permanent, more applicable, all because the student is fully self-active and engaged, motivated by his own aspiration and desire for education.

History of distance learning

Development of eLearning is connected to development, technical improvement and also better affordability of computers. Already in the late eighties and the nineties of the last century the first form of electronic education- Computer-Based Training (CBT) was born. However, distance education begins to evolve from the invention of the printing press and the introduction of postal services, via telephone, radio shows, film, television to the Internet and the emergence of modern techniques and technologies. All of this has affected the methodology and the development of distance education. Distance learning is actually older than learning via the Internet. This kind of education existed even before people knew about computers and the Internet. As the popularity of distance learning has grown, problems have also been encountered (Hubackova, 2015). Complaints on the practice and legitimacy of some distance-learning providers have prompted demands to regulate this type of education. In 1926, the National Council for Local Studies was organized to review distance-learning programs and establish guidelines for their work. The National University Association has accredited the distance learning programs administered by colleges and universities for Enlargement already in 1915. The quality of the content of distance learning programs is based on the identified standards.

By the twentieth century, distance learning methods and study materials developed a high degree of efficiency. Technological innovations such as telephones, radios and increased mobility have shown promise as an instrument for distance learning.

- The first period (second half of the 19th century) includes correspondence education, which becomes a legitimate

educational process due to the reduction of postal services in Europe and America.

- The second period relates to the end of the sixties and the beginning of the seventies of the twentieth century. It was then the use of radio, television and audiotapes in combination with traditional methods and forms of teaching work. In this period, universities and institutions from Great Britain, Canada, Japan and America play a special role.
- The third period is called a period of modern distance learning, because we connect it to multimedia computer systems and interactive television.

Image 1: *Distance learning system*

Source: *MEF Belgrade, www.mef.edu.rs*

Distance Learning

UNESCO defined distance education as "an educational process and system in which all or a significant proportion of the teaching is carried out by someone or something removed in space and time from the learner."

Distance education requires:

- Structured planning
- Well-designed courses
- Special instructional techniques
- Methods of communication by electronic and other technologies

Types of Distance learning educations (Burns, 2011) are given in Table 1.

Table 1: *Types of distance learning education with examples*

Types of Distance Educations	**Examples**
Correspondence model	– Print
Audio-based models	– Broadcast: IRI – Narrowcast: IAI (via audio tape or CDs) – Two-way radio – Audio conferencing and telephone – Broadcast radio
Televisual models	• Broadcast television (educational and instructional) • Videoconferencing • Video
Computer-based multimedia models	• Interactive video (disc and tape) • CD-ROMs • Digital videodiscs (DVDs/VCDs) • Interactive multimedia
Web-based models	• Computer-mediated communication • Internet-based access to World Wide Web resources

	• Online courses (e-learning) • Online conferences (webcasts and webinars) • Virtual classes/schools (cyber schools) and universities
Mobile models	• Hand-held devices • Portable media players (podcasting) • Cell phones and smart phones • Tablets • E-readers

Source: *Mary Burns, Distance Education for Teacher Training Modes, Models, and Methods.*

There is a possibility of attending elementary school, secondary school, faculty, as well as distance courses. Minor pupils need a parent's license for such education. The student / student / teacher meeting only takes place at the final test / exam. Until then, their communication is two-way, which can be asynchronous and synchronous.

Asynchronous learning is done so that the learner can independently select content and links with other documents according to his own interest, and uses discussion groups or e-mail for interaction with the teacher. The advantage of this learning is the ability to study content at any time and from any place, but the lack of getting feedback in a delayed time.

Synchronous learning envisions the presence and activity of all stakeholders including teachers. Feedback is obtained in real time and everyone is actively involved in solving tasks. This type of learning is recommended as a supplement to asynchronous learning. A special advantage is the daily interaction with the teacher and the possibility of critical review of attitudes.

Most definitions related to distance learning point to the following characteristics:

- Separate lecturers from users
- Institutional accreditation - the program was accredited or certified by an institution or agency

- Use of interactive multimedia tools
- Two-way communication
- Possibility of meeting the participant face to face

The term that relates to distance learning are: correspondence education, home learning, independent learning, external learning, self-development, technology-based learning, learning at the center of which is learning, open learning, open access, flexible learning and distributed learning.

Analysing the Strategy for the development of education in Serbia until 2020, the necessity of possession is obvious certain knowledge and skills related to the application of information and communication technologies (ICT), and it can be noted that the Internet has changed the way and dynamics the dissemination of knowledge and information in all areas, (Markovic, 2017).

The Strategy for the Development of Education in Serbia by 2020 pointed out that it is development ICT applications in education need to be achieved:

- Establishing a modern educational system that is tailored to the needs information society;
- Development of digital educational content;
- Teacher training for ICT use;
- Raising the level of knowledge and skills for using ICT in the broadest population;
- Ability to apply ICT in the workplace in the way it is being raised degree of efficiency, improves the quality of work and provides better jobs;
- Introduction of the modern concept of e-learning and open-source distance learning;
- ICT is an integral part of educational programs, educational programs and teaching processes adapted to the needs of the information society, and teaching staff trained for modern forms of teaching;
- Development of the concept of education and learning throughout life;
- Inclusion of social groups with special educational needs, which includes acquiring knowledge and skills in the field of ICT adults,

who did not have the opportunity to get them. "(Strategy for the Development of Education in Serbia until 2020, 2012).

Advantages and Disadvantages of Distance Learning

The adventages and benefits of distance learning are:

- Distance learning enables users to participate in quality classes, and when it is impossible due to distance, schedule and similar circumstances. Wide availability allows simultaneous participation of a large number of users.
- Education is effective, so with minimal time it is possible to achieve maximum performance. Education is effective, costs must be reduced to 40%, and training time up to 60% in comparison to classical classes. The level of knowledge after education must be greater or at least equal to alternative classroom learning in the classroom.

The disadvantages of distance learning are:

- Distance learning requires the user to have certain knowledge and skills in order to be able to use it. Without certain computer literacy, the material integrated with the electronic component of learning becomes completely useless.
- By providing a more independent definition of learning modes and time, distance learning gives students greater responsibility. In certain forms, they themselves have to motivate and individually evaluate the need for learning, which can lead to questionable results and objectively poor progress in the learning process.

Image 2: *Features of distance learning technology*

Source: *ksu.edu.kz*

A distance learning model presented over five generations

First generation - Correspondence model

The model of correspondence and self-study has been used since the second half of the nineteenth century when correspondence education has become legitimate in Europe and the United States. It represents the oldest form of distance learning. Corresponding schools are created and developed with the appearance of a press, or with the development of the postal system and the printed word. Allow students to receive learning materials by post, as well as to send out the results of tasks.

How successful a successful model of correspondence will depend directly on the learner. The interaction between the participants and the lecturer is slow and completely unachievable with the other participants.
The advantages of written materials are spontaneity, because it is used without training, then the attention of users is focused on content, and not on the medium, easy to use, learning speed is variable, low price, time independence.

Lack of written material is a limited view of reality, passive learning, no feedback.

Second generation - Multimedia model

The multimedia model appeared in the late sixties and early seventies of the twentieth century. This model is characterized by the appearance of radio, television and audio tapes, as well as computer disks with didactic programs, interactive tape, CD-ROMs and DVD-ROMs. By combining multiple media at the same time as text, image, sound, video, and animation, a multimedia model is created. The relationship between lecturers and students is limited by means of communication.

Third generation - Telecommunication model

Telecommunications model implies one-way or two-way communication between two or more spatially distant users in real time. The advantage of the third generation is the possibility of interaction among students. The

most popular form is video conferencing. The disadvantage of this model is that few institutions have the necessary resources.

Fourth generation - Flexible learning model

This model of learning was created by the development of Internet services, primarily the multimedia part of the Internet or the web, thereby increasing the educational qualities of the Internet. The key characteristics of the flexible learning model are interactivity, non-linearity and collaboration. Students communicate in different ways.

Fifth Generation - A Model of Intelligent Flexible Learning

The Intelligent Flexible Learning Model is based on Internet-based delivery, intelligent object-based databases and automated response systems, which reduces training costs compared to traditional training or the first three distance learning models.

Development of Distance Learning from a Technological Aspect

The first level represents a wide range of technologies and media, starting with reading printed materials, via radio and television, to electronic mail and social networking. Students and teachers are expected to have adequate media and digital abilities in the educational process.

The second level shows the development of hardware and software from non-computers, used for individual learning, to using networked computers, web tools, distance learning systems. The development that follows is aimed at social networking, creating and sharing online information.

The third level is represented by the development of traditional tools that support teaching process based on training to tools that enable social networking and self-guided learning.

The fourth level represents the progress of media and digital literacy, the evolution starting from the transfer of teaching materials to unlimited interaction and discussion among course participants as well as individual participation in creating content for learning. Putting pupils / students into

the challenge of creating digital products as learning outcomes brings learning to what is happening in the real world.

IoT in education

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data (Hendricks, 2015; Brown, 2016). IoT involves extending Internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets, to any range of traditionally dumb or non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled. With the arrival of driverless vehicles, a branch of IoT, i.e. the Internet of Vehicles starts to gain more attention, (Hamid, 2019).

Internet things have many common definitions, and one of the shortest is a global network that connects smart things (from the IoT-A project, Internet of Thing Architecture). Therefore, smart devices, various sensors, computer resources, data storage devices, communication devices with users, actively participate in communication. Communication is done between things that create and use data independently, and not between people. Some of these devices are thermostats, cars, garage doors or any other thing that can use this data, so for example, the electric motor closes the window if the value obtained from the thermostat exceeds a given temperature value.

Definitions of Internet things differ depending on the perspective from which they are viewed and the breadth of view of the processes that are taking place, but the majority is about connecting everyday things to the internet, measuring, collecting, storing and exchanging data with other things and people, activities based on the collected data.

It could be said that this is a kind of technological revolution that represents the future of computers and communications, and its development depends on technical innovations in many important areas, from wireless to nano technology.

Internet things will create tens of millions of objects and sensors, and everyone will produce real-time data, so Big Data technology will be needed to process all these data and process them. Nowadays data represent assets that can be converted into money. In order to convert this information into money, computers are needed that can make sophisticated decisions based on that data and knowledge. Thus, the Internet will become a very important strategic market that will lead to an increase in revenue in enterprises and a reduction in costs.

Image 3: *IoT.*

Source: *Wikipedia, IoT.*

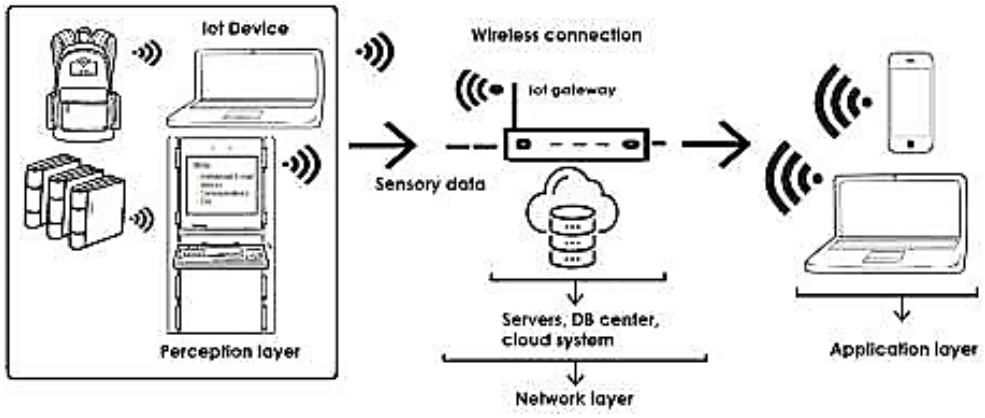
Since 2008, the number of connected devices on the Internet has exceeded the total number of people on Earth. Soon the Internet of Things will become an everyday life for each of us. Global companies like Google, Apple and Samsung are investing large amounts of money in the development and use of this technology.

It is based on the convergence of wireless, network and Internet technologies, especially cloud technologies, electromechanical systems, and their cohesion to the smart system.

Architecture of the IoT system

The Internet of Things architecture consists of smart devices that the user manages through the application through the Internet. The user application does not have to communicate directly with things, but with a service that stores, processes data that gets from these things or manages those things. Internet stuff consists of any device connected to the Internet.

Image 4: *Basic Architecture of IoT in Education*



Source: *Bayani, Leiton, Loaiza, Internet of things (IoT) Advantages on e-learning in Smart Cities, 2018*

The thing is a smart device that can be managed remotely from anywhere at any time using a specific communication protocol supported by this device. The device has a unique address, by which it is unique and recognized online, and can send and receive messages from the network, e.g. a smart thermostat that sends instantaneous temperatures at certain time intervals, and the temperature can be regulated over the Internet. The thing is that communication is not done between people, but only between devices that use it independently and generate data.

Architecture of the System, IoT in Education, can be designed as more complex with different layers (Lozanovic, 2016).

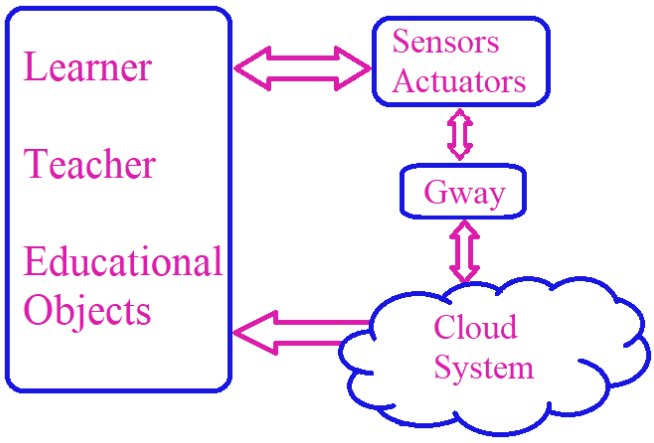
A router is a device that collects all the messages from all smart devices on the network and sends these messages to the cloud, where the service collects these data and generates new messages that send it back, and they then affect a certain interaction of smart devices. The router must know the address and protocol used by the service.

Cloud Service is a set of all received, stored and processed data that came from the device over the network gateway (router) and sent back to the device itself, if the service knows which device communicates with which network gateway and through which connection type. Clouds also contain information about users and user applications, and this is all stored mostly in the database.

The application is user software through which the user manages smart devices, but not directly through cloud services. With the application, the user receives data from a smart device and, based on this, can send a message.

IoT in Education is used in pre-school institutions and elementary schools, and in high schools. Nowadays, IoT in education is most represented at Universities.

Image 5: *IoT role in Smart Education*



Source: *Authors of the paper*

Students, most often in higher schools and universities, increasingly are moving from printed books to tablets and laptops. With all the information available, students are now learning at their own pace and have almost identical experience working from home or in the classroom. On the one hand, this trend offers students more benefits, on the other hand, the learning process is more effective for professors, IoT role in Smart Eduaction is given in Image 5 (Lozanovic, 2018).

Progress in technology connectivity means that teachers do not have to manually review tests (written works) or perform other routine tasks. Cloud-related devices allow professors to gather information about their students, and then evaluate who needs to pay more attention. These statistics also allow professors to adequately prepare a curriculum for future lessons. Outside the classroom, schools and universities can use connected devices to monitor their students, employees, and resources and equipment. The dramatic drop in prices for processing power (CPUs), storage and bandwidth, on the one hand, as well as the rise of clouds, social media and mobile devices, gives the opportunity to analyse large data and turn it into meaningful information by just allowing these applications. Such monitoring capabilities should lead to more secure environments. For example, students might have an insight into the hours of city transport and, accordingly, organize their duties.

Nowadays, learning is more and more interactive. Learning today is not limited to the combination of texts and images, but it is much more than that. Most textbooks are paired with websites that include additional materials, videos, assessments, animations, and other materials that support learning. This gives a broader perspective to students to learn new things with a better understanding.

Mobile devices or tablets really change the way they learn something, which can be considered a very powerful and creative tool. Also, these types of devices allow students and professors, for example, to create 3D graphic textbooks with videos. The possibilities of implementing IoT are almost unlimited. For example. various sensors of such devices are associated with applications that provide the best way to learn new things.

IoT also can be used for development of engineering management and it is very important for education of future Engineering managers and industry managers (Djurovic-Petrovic 2011).

Working on the Digital-Smartboard and its application in teaching, it is designed as an upgrade of formal education, skills development and skills, the application of knowledge and practice, where emphasis is placed on skills acquisition, and the advancement of knowledge digital board is used in all teaching subjects, for presentation of prepared content, broadcasting of music, films, checking of acquired skills. Working on a smart-digital SMART board enables students to use their own computers, etc.

Automatic monitoring of pupils' presence through radio frequency identification technology (RFID) is one of the possible applications for elementary and secondary school. An RFID chip can be embedded in a student's booklet or mobile device, and can be monitored continuously. This way it is possible to monitor the movement of pupils at school during the day: who they are learning and with whom they play on vacation. We might see certain groups that get better grades by each other or complement their knowledge or skills. Loadable IoT devices like watches and ray headphones for virtual reality can find entry into even more classrooms. Security and privacy issues arise in any potential use of the Internet of Things, and such a way of monitoring students is no exception. There is huge potential and considerable risk. We have to ask ourselves whether we should follow our students to the tiniest details.Public Management Influence on the State of Innovation Sectore in Servia and South East Europe, can be done with modernizing the educational system (Djurovic-Petrovic, 2011).

Image 6: *Smart Classroom with IoT System*

Source: *www.cyberschool.id*

Conclusion

Electronic learning becomes a daily phenomenon both in teaching, in school, and outside. It takes on wider conditions and therefore needs to be started as soon as possible with its application. The resources for implementing e-learning are numerous and provide various content that is in function of overcoming the intended teaching content. The existence of rich electronic resources of teaching content creates opportunities for different design of these contents through new teaching technologies.

In such conditions, electronic learning is relatively easy to organize. It is necessary to have minimal technical and technological conditions, basic informatics literacy of pupils, and most importantly the teacher possesses ICT (Information and Communication Technologies) competencies, creativity and motivation for modernizing the teaching and learning process.

In addition, the teacher must be well aware of the prescribed content to be achieved in the classroom and, therefore, select and modulate available content from e-learning resources, but also to create their own resources. In this way, resources will become more numerous, which will contribute to the increasing popularization of e-learning in the classroom. The exchange of experiences on the application of e-learning in student-student, teacher-teacher and teacher-learner relationships opens up new paths for creative, innovative organization of teaching through modern technologies.

As we see, the benefits of IoT technologies are really great and have the potential to significantly improve almost all the spheres of our lives and therefore education.

The present is completely dependent on the Internet, because today with the help of the Internet we can take out personal documents, have insight into bank accounts, find the location we need, etc.

The development of technology is progressing at a high speed, and so many things become smaller, better, cheaper, smarter, more accessible. All these Internet things will make our daily life easier, simpler, so we do not have to resist technology and innovation, but accept them with all the

positive and negative sides they bring. For the development of Internet things and their implementation we can say that there is only a sky border. However, the security of data in such a network is a major problem. The information that these smart devices collect and exchange is not secure enough, and there is a high risk of hacking, especially when it comes to personal data from users. In a rush to bring new connected devices to market, security and privacy are often ignored. If companies and manufacturers of these devices do not introduce changes that will eliminate these defects, they risk their abuse.

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COGNITIVE SCHEMES AS AN INNOVATIVE EFFECTIVE LEARNING STRATEGY

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Abstract

New tendencies, developmental educational models and theoretical perspectives tend to emphasize more on the significance of developing effective learning strategies, constructive and creative problem solving and learning from various sources. One of such approaches is based on the application of educational electronic games, or responder in classes. The main feature of this approach is faster feedback on understanding to students during class.The central goal of this research was to determine how different teaching approaches in physics influence on high school students' performance. The results showed that the students in E group achieve higher achievement on the knowledge test and lower mental effort, unlike the students in C gruop. The approach in E gruop has significantly increased the interactivity and engagement of students, and the lower values of self-perceived mental effort imply that more space has been generated in the working memory for perceiving and processing new information.

Key words:*educational electronic games, instructional efficiency, instructional involvement, teaching Physics, mental effort*
Jel classsification: I20, I21, C18, C71

Introduction

There is considerable evidence that science classes from elementary school through to university are generally failing to provide most students with an understanding of science (Wieman & Perkins, 2006). Based on the lower understanding of scientific principles and rules, students

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develop a negative attitude towards the sciences, especially physics, describing her as difficult and demanding (Olusola & Rotimi, 2012; Stefan & Ciomoş, 2010; Williams et al., 2003; Osborne et al., 2003). That is a reason why today invested a great effort in order to raise the quality of education system (Markov at al., 2012). Therefore, new tendencies, developmental educational models and theoretical perspectives tend to emphasize more the significance of developing effective learning strategies, constructive and creative problem solving and learning from various sources (Gajić, 2014). Information technology offers more opportunities for improving this situation (Wieman & Perkins, 2006). One of that is classroom response systems or clickers. Clickers are a simple technology which use simple, off-the-shelf networking to send a signal from each student's handset to the instructor's computer (Trees & Jackson, 2007). The teacher asks a question which can be in the form of text, images or videos through the projector and students through their mobile phones or appropriate responders give a response to it (Licorish et al., 2018; De Freitas, 2006; McCaffrey et al., 2014; Balta et al., 2018). As soon as the students' answers immediately receive feedback whether their answer is correct, while the teacher receives information on whether students correctly understand the concept which was learned during the course of time. In the traditional lecture format students rarely receive feedback but he is an important contributor to student learning (Trees & Jackson, 2007). Approach based on clickers provide an opportunity for all students in the classroom to interact and contribute their viewpoint, encourage students to actively respond to ideas and questions (Trees & Jackson, 2007). Therefore, the learning environment of the large course transform from impersonal, passive, and anonymous to personal, active, and responsible (Trees & Jackson, 2007). This puts the students in the position of a subject that approaches the problem in a creative and critical way, while developing their creativity (fluency, originality, flexibility, sensibility, etc.) and capability of critical approach to interpretation of the text, confrontation of opinions, argumentation, and individual work (Gajić, 2014).

This type of teaching approach is considered to be supported by cognitive theories because it provides the possibility that complex information can be explained to with less complex ones which can be successively displayed. These knowledge elements can be presented as appropriate cognitive schemes (Levin, 2018). According to Von Glasersfeld (1998)

Piaget emphasized that for the “construction of a scheme”, it is need to be reconsidered of the three parts:

1. Recognition of a certain situation;
2. association of a specific activity with that kind of item;
3. expectation of a certain result.

Therefore, cognitive schemes can be used to describe the mental operations and constructs by the students. One of the complex, but fundamental concepts in teaching physics is the concept of force. According to Di Sessa (1993) and Levin (2018) a key learning difficulty for learning concepts like a force is in individuals encounter force in such varied ways in their experience in the world. Depending on context, students are likely to need quite different strategies to determine how force acts in any given situation (Di Sessa, 1993; Levin, 2018). Because of the complexity of the concept itself, the student often finds misconceptions, that is, information received from their teachers is not properly understood and connected. All information that is subsequently adopted and related to the notion of force are also misapplied. Some of the most frequently used misconception are: 'there is no motion without a force', 'force (weight) and mass are the same', etc. The first misconception 'there is no motion without a force' should be replaced with the expert belief 'there is no acceleration without a force' (Di Sessa & Sherin, 1998). This clearly distinguishes between distance, motion and acceleration, and the effect of force on them. The applied knowledge test particularly highlights misconceptions and thus gives information to the teacher whether the student correctly understood the learned concept or there is some ambiguity. Using this information, a teacher can easily detect and correct mistakes in student thinking. Properly adopted concepts and their correlations with other concepts will be more understandable to students who will more easily accept and recombine information in their long-lasting memory, which can be lead to achieving less cognitive load. When we talk about the load in the teaching process it is necessary to define mental effort as a measurable part of the cognitive load. Cognitive load could be generally defined as a requirement for working memory resources necessary for fulfilling the goals of the cognitive activities in certain situations (Paas et al., 2003; Sweller et al., 2011). There are three types of cognitive load: intrinsic, extraneous and germane cognitive load. Intrisic cognitive load is caused by internal or intellectual complexity of the task of teaching material, therefore, it is not influenced by teaching instructions. Extraneous cognitive load is directly under the influence of

teaching instructions and it presents an unnecessary load, while germane cognitive load is also under the influence of teaching instructions, but it represents a preferred load. Germane cognitive load refers to the mental resources devoted to acquiring and automating schemata in long-term memory (Debue & Van De Leemput, 2014). Knowing the invested mental effort and student achievement it is possible to calculate instructional efficiency and instructional involvement. Paas and Van Merrienboer in their paper (Paas & Van Merriënboer, 1993) presented a way in which, based on standardized values of mental effort and achievement, can be calculated instructional efficiency (E) (1):

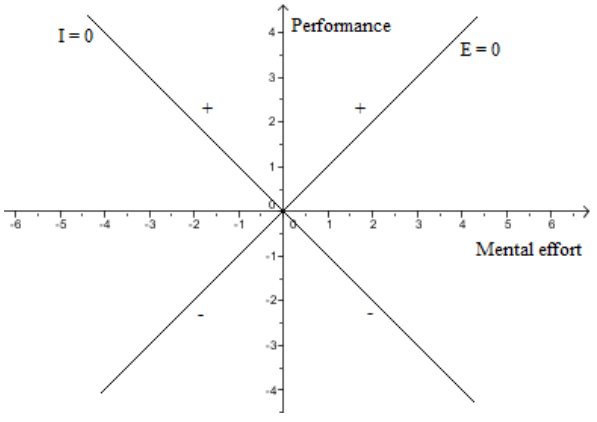
$$E = \frac{|R - P|}{\sqrt{2}} \qquad (1).$$

Pass with associates (Paas et al., 2005) determined a formula for calculating instructional involvement (I) (2):

$$I = \frac{R + P}{\sqrt{2}} \qquad (2).$$

Instructional efficiency clearly indicates the effectiveness of applied instructional instruction, while instructional involvement points to the motivational effects that students experience in learning. Instructional efficiency and instructional involvement can be presented graphically. Incorporating these graphic forms gives information on the full effect of a particular teaching approach on student performance (Figure 1).

Figure 1: *Graphical presentation of instructional efficiency and instructional involvement (adapted according to Cerniglia, 2012).*



Based on the defined positive or negative parts of the obtained curves for instructional efficiency and instructional involvement and their intersection is obtained that is suitable for teaching instructions are considered those that have a positive value and efficiency instructional and instructional involvement, or whose intersection point is located in the upper part of the graphic.

Methodology

The actuality of education is emphasized by changing the basic paradigm of social development – development of a knowledge society in which intellectual capital is becoming a major factor of progress (Radulović et al., 2011) An essential component of effective learning is to encourage student innovation (Markov et al., 2012). Today's teachers tend to achieve a better transfer of knowledge from teacher to student by implementing different teaching techniques, and to make students understand the basic concepts of physics, not just memorize it (Stamenkovski & Zajkov, 2014). Therefore, it is important to examine the effects of teaching approaches at all levels of education (Gajić, 2004, 2005a,b, 2006, 2007, 2008; Budić et al., 2009; Budić et al., 2011; Radulović et al., 2011) and identify as many determinants as possible which can better and more fully describe student performance caused by this approach (Radulović & Obadović, 2012; Radulović et al., 2016; Markov et al., 2012; Radulović & Rančić, 2011; Radulović & Stojanović, 2018a). Therefore, the central goal of this research was to determine how different teaching approaches in physics influence on high school students' performance. Under student performance, it is understood that student achievement on the knowledge test and self-perceived mental effort.

According to the central goal, the research tasks were formulated:
1. Determine whether there is a difference between students in the experimental and control groups in terms of their achievement on the knowledge test, depending on the applied teaching approach.
2. Determine whether there is a difference between students in the experimental and control groups in the perception of mental effort depending on the applied teaching approach.
3. Compare the instructional efficacy and involvement of applied teaching approaches.

Instruments

The efficiency of teaching and the quality of knowledge significantly depend on the involvement of conscious control over the application of a certain strategy, self-regulation in the learning process, and the methods of testing and assessment (Gajić et al., 2012). In the research, we used a standardized test of knowledge Force Concept Inventory (FCI) and a scale of mental effort. FCI test was developed by David Hestenes, Malcolm Wells, Gregg Swackhamer, Ibrahim Halloun, Richard Hake, and Eugene Mosca. Psychometric characteristics have been confirmed in numerous studies. The basic goal of the applied test was to determine the quantum of student knowledge related to the understanding of the concept of force as one of the most important concepts in physics. Within each question on the test of knowledge, Likert's five-point scale was assigned. Using this scale the students determined on the basis of self-perception how much they have invested mental effort in solving this task.

Procedure

The control and experimental groups were created on the basis of selection classes within one gymnasium. Preparation with students of the experimental group lasted about a year. Therefore, during the first grade of high school, the students started working on educational electronic games in their physics classes. The teacher had previously carefully selected the questions. In this manner, through interaction with the appropriate respondents, the teaching material determined. Materials of the first grade of gymnasiums from Physics include materials related to the definition of speed, acceleration and force. As discussed above, the most common misconceptions that occur, and which are related to the concept of force, are the misunderstanding of the causal consequence of the relationship between force and acceleration. As students of the experimental group access electronic educational games with the appropriate code, i.e. by logging in or playing a game on the classes of physics, in this way the separation of groups is enabled. With students of the control group was applied a conventional approach to teaching, and done according to the curriculum prescribed by the Ministry of Education. After the pedagogical experiment, students enroll in the second grade of the gymnasium and we want to determine the students' knowledge of the concept of force and what they really remember.

The research sample

The sample consists of the 147 students of the second grade of the general-type gymnasium "Svetozar Marković" in Novi Sad. The experimental group consisted of 73 students, while the control group consisted of 74 students. In order to reduce the influence of teachers, all the teaching units in both groups were taught by one teacher. Student testing was conducted in October 2017.

Data Analysis

For statistical data processing, it was used SPSS.20 program. The following data analyzes were applied: descriptive analysis, ANOVA and neural network model. The model of neural networks is based on the training and testing samples. The importance of an independent variable is a measure of how much the network's model-predicted value changes for different values of the independent variable. Moreover, the normalized importance is simply the importance values divided by the largest importance values and expressed in percentages. An eta-square indicator was used to determine the size of the impact among the variable.

Also, in order to complement the information on the effects of the applied methods instructional efficiency and instructional involvement are calculated and so it is not a doubtful effect of the applied teaching instruction on student performance.

Research results

According to the tasks of research, the results are divided into three parts. The first part refers to the determination of the influence of the applied teaching approach on the student's achievement. The second part refers to determining the influence of applied teaching approaches on self-perceived mental effort, while the third part refers to the determination of instructional efficiency and instructional involvement of applied teaching approaches and the contribution of the predictor (applied teaching approach and self-perceived mental effort) on the explanation of variance of students achievements knowledge test.

In the first part, ANOVA shown that there is statistically important difference of students' achievement on knowledge tests of applied

teaching approaches, F (df = 1, N = 146) = 51.836, p = 0.000, η^2 = 0.263. According to Cohen's criterion, the value of the eta-square indicates the existence of a great impact of the applied teaching approach on student achievement in the knowledge test. In Table 1 are shown a statistical parameter for students' achievement on knowledge tests.

Table 1: *Students' achievement on knowledge tests*

Group	**N**	**Mean**	**Std. Deviation**
C	74	4,78	1,88
E	73	7,15	2,10

As can be seen in Table 1, students in E group achieved higher results on the knowledge test than students in C group. Hence, the use of electronic educational games had a positive impact on the quantum and quality of students' knowledge. In the research Radulović et al. (2016) it was emphasized that multimedia is shown as favorable, since informatics revolution is involved into each aspect of life, and students are in a position to have greater amount of information. The results of the knowledge test showed that students in E group achieved more permanent knowledge than the students in C group. According to Dijanić & Debelec (2015) Star believe that the depth level of knowledge is related to understanding, abstraction, critical thinking and assessment. According to him the informations which are in deep level of knowledge are structured and stored in memory in a way that makes it maximally useful to perform a task-solving process, while the surface level of knowledge is associated with learning by memory, playback, attempts, and errors (Star, 2000, according to Dijanić & Debelec, 2015).

Gender as an independent variable was not shown to be statistically significant predictor of student achievement, F ($df = 1$, $N = 146$) = 0.365, $p = 0.547$. This is an interesting fact since some references shown that there is a gender difference in student achievement in Physics.

In the second part, ANOVA shown that there is statistically important difference between groups in aspect of perceived mental effort, F ($df = 1$, $N = 146$) = 10.331, $p = 0.002$, $\eta^2 = 0.067$. Eta-squared value indicates a medium effect of the applied teaching approach on the students' self-perceived mental effort. Table 2 shows the values of the self-perceived mental effort of students.

Table 2: *The self-perceived mental effort of students*

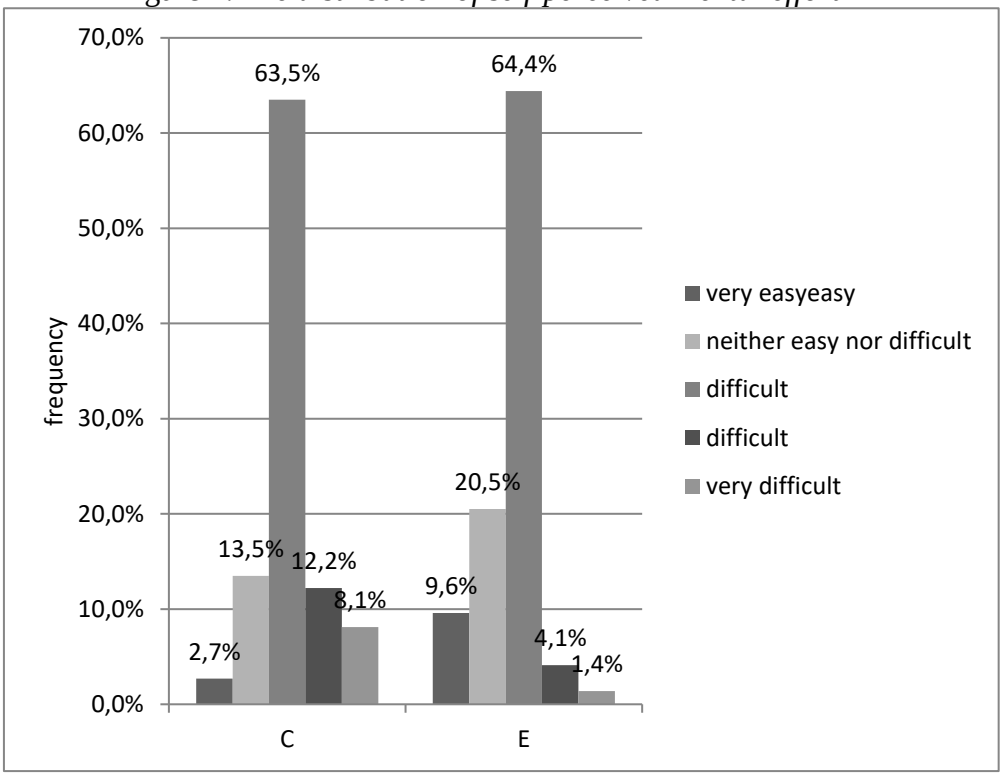
Group	**N**	**Mean**	**Std. Deviation**
C	74	3,09	0,83
E	73	2,67	0,76

As can be seen from Table 2, students of the C group perceived a higher mental effort than students of the E group. The obtained results show that students in E group, perceiving a smaller mental effort left more space in the working memory for processing new information. According to Radulović et al. (2016) application of interactive computer-based simulations, and application of laboratory inquiry-based experiments, in

learning Physical contents, enables students to master the terminology with less cognitive load, transform expressions, and apply them to everyday life situations.

Figure 2 shows the distribution of self-perceived mental effort according to Likert's five-stage scale.

Figure 2: *The distribution of self-perceived mental effort*



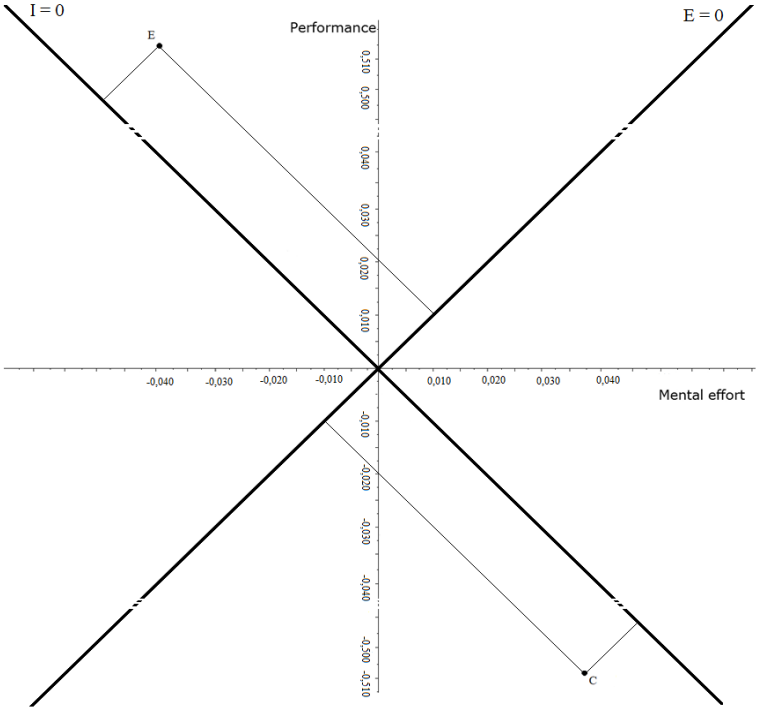
As seen in Figure 1, more students in E group than in C group are question categorized as very easy or easy, while more students in the C group than in E group are the same questions categorized as difficult or very difficult. The obtained distribution indicates that the E approach is more suitable for students because it causes less mental effort and leaves more space in the working memory.

Gender as an independent variable was not shown to be statistically significant predictor of self-perceived mental effort of students, F (df = 1, N = 146) = 0.671, p = 0.414. The obtained data shows that there are no

gender differences in invested mental effort students, and that cognitive demands imposed on teaching content are the same for both sexes.

Based on the standardized values of students achievement and self-perceived mental effort, instructional efficiency (E) and instructional involvement (I) were determined. In Figure 3, their graphic representation is presented.

Figure 3: *Graphical representation of the instructional efficiency and instructional involvement*



As seen in Figure 2, the coordinates of a point which describe a teaching approach based on educational electronic games are located in the upper left quadrant. The value of instructional efficiency for this approach is E_E = 0,394, while the value of instructional involvement is I_E = 0,337. On the other hand, the coordinates that describe the conventional approach are located in the lower right quadrant. The value of instructional efficiency for this approach is E_C = -0,387, while the value of instructional involvement is I_C = -0,334. Based on the numerous values and position of the points it can be concluded that the approach based on educational

electronic games is more suitable for the students because it causes higher achievement, while at the same time it reduces the mental effort of the students.

The obtained data show that there is a statistically significant correlation between self-perceived mental effort and student achievement on the knowledge test, r = -0.401, p = 0.000. Therefore, due to the reduction of self-perceived mental effort leads to an increase in student achievement.
In order to determine the contribution of the predictor, the self-perceived mental effort and applied teaching approach, in order to explain the higher percentage of variance in student achievement, a model of neural networks was used. The validity of the applied model is tested on the training sample which was 85.1% of all population while the test sample was 93.5%. The AUROC (area under the ROC curve) gives the accuracy of the model, which is 0.872. Table 5 shows both the importance and the normalized importance of each predictor in determining the neural network.

Table 5: *Importance and the normalized importance of each predictor of students' achievement*

Predictor	**Importance**	**Normalized Importance**
teaching approach	0.475	90.5%
self-perceived mental effort	0.525	100.0%

It is evident that teaching approach and self-perceived mntaln effort contribute most in the neural network model construction. Therefore it could be said that these components influence on the excellence achievements in Physics.

Discussion

Learning can be defined as a multidimensional phenomenon that manifests itself through the choices of objectives, levels of investment effort and persistence (Bandura, 1991). Therefore, the researcher's task is to define as many ways and mechanisms as possible to better describe the process of learning, acquiring knowledge and student achievement. In the last few decades, a large number of new or somewhat changed teaching approaches have been developed that make it more difficult for teachers

to understand the effects of these approaches. Therefore, the central goal of this research was to determine how different teaching approaches in physics influence on high school students' performance. Under student performance, it is understood that student achievement on the knowledge test and self-perceived mental effort.

The results show that students which used educational games achieve a higher score on knowledge test than the students which used conventional teaching approach. Eta-squared indicator highlighted a strong correlation between the variables. It means that the choice of teaching approach significantly influences on the student achievement. The obtained result additionally emphasized the importance of examining the effects of different teaching approaches. The most common changes in education are aimed at modifying the existing knowledge through several methods of practical application (Markov et al., 2012). The positive influences of the multimedia environment are shown in researches Radulović & Stojanović (2015), Radulović et al. (2016) and Županec et al., (2018). Multimedia is shown as favorable, since informatics revolution is involved into each aspect of life, and students are in a position to have greater amount of information (Radulović et al., 2016).

The second part of the research was related to determining an influence of applied teaching approaches on the self-perceived mental effort. The obtained result has shown that students which used educational games perceive the lower value of metal effort than students which used conventional teaching approach. Similar results were obtained in the research Radulović & Stojanović (2015) and Radulović et al. (2016). They emphasize that it has been shown that using multimedia in teaching physics comes to a decrease in mental effort. Research Županec et al. (2018) showed the positive impact of a multimedia approach based on a flipped classroom in terms of reducing perceptual mental effort can be achieved in the teaching of biology.

According to Holley & Oliver (2010), further studies are needed that can reveal more about how individuals experience and cope with their engagement in formal education. In this study, we examine the ways in which student characteristics and course design choices related to students' assessments of the contribution of clicker use to their learning and involvement in the classroom. Based on the obtained values for self-perceived mental effort and student achievement, the values of

instructional efficiency and instructional involvement for the applied teaching approaches were calculated. The results showed that the values of instructional efficiency and instructional involvement for an approach based on educational electronic games are positive and significantly higher than the values of the instructional efficiency and instructional involvement for a conventional approach. The obtained values do not doubtfully indicate that the approach based on educational games is significantly more convenient for students than the conventional approach. In the research Budić et al. (2018) it is stated that about one-third of elementary school students in the Republic of Serbia believe that their role at the time of physics is just passive, i.e. the role of teachers is extremely dominant. Passive role of students in the teaching process can hardly be achieved by higher motivation, critical thinking, highest levels of scientific reasoning (Radulović & Stojanović, 2018b; Radulović & Dorocki, 2018) which leads to lasting knowledge. Therefore, it is necessary to take particular care of the effects of certain approaches because contemporary society requires the ability of critical thinking and scientific reasoning.

The value of Pearson's coefficient showed that there is a correlation between student achievement and self-perceived mental effort. Therefore, the model of neural networks determined the significant contribution of both predictors (self-perceived mental effort and applied teaching approach) to the explanation of the variance of student achievement. The obtained data points to the complex ratio of the predictors to the outcome or student achievement. Changing one predictor can cause a change of others, and the action of all predictors does not necessarily result in an increase in student achievement. Therefore, the results of this research are of particular importance for physics teachers because they give direct results on the effects of teaching approaches in Physics. The existence of concrete results offers the opportunity for teachers to apply such teaching approaches in accordance with school equipment that will lead to better student performance.

Conclusion

Numerous researchers are striving to uncover many factors affecting student achievement, as well as the strength and direction of affection of these factors. Some of these factors are the teaching approach and self-directed mental effort, whose strengths of influence have been determined

in this research. The results of this research indicate the existence of a strong connection between applied teaching approaches and student achievement. Specifically, if a teaching approach is based on the application of some innovation, the learning process will be more dynamic and interesting for students which will result in higher student achievement on knowledge tests. Also, these approaches have caused less mental effort. Less mental effort causes greater free space in the working memory, ie it is allowed by a greater number of new information to be processed and linked to existing ones in long-term memory. Therefore, approaches based on innovation can be considered suitable for students.

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ECO-INVENTOLOGY

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Abstract

Sustainable development strategy emerged as an answer to the question of how to reconcile seemingly irreconcilable areas such as economics and technology on one side, and ecology on the other-by using optimisation. With accelerated technological development, these requirements are increasingly difficult to meet using standard scientific disciplines and existing optimisation methods. This has influenced the merging of different scientific areas and the emergence of new ones, such as eco-inventology. Its task is to provide satisfactory answers based on idealisation rather than optimisation of such complex systems.Eco-inventology is an applied science, which, with its tools, should provide an inventive solution to non-standard problems of different kinds, which have an impact on technology, economics and ecology. The goal of its use is to eliminate or minimize any adverse environmental effects with minimal financial investment in all areas of human creativity.

Keywords: ecology, inventology, economics, technology, technics.

JEL Classification System: O10

Introduction

The laws of the evolution of biological systems (BS) and engineering systems (ES) show similarity in only 12% of cases (Vincent et al., 2006). Therefore, conflicts often occur in the interaction between BS and ES (Bogatyrev & Bogatyreva, 2012). If it continues this way through the intensification of the conflict, ES will eventually be overcome (Altshuller & Rubin, 1987). However, human lives will begin to resemble those that take place in the artificial ecological conditions that exist in the international space station or submarines. In order to avoid this, it is necessary to build an eco-innovative approach that will be able to

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overcome technical contradictions (TCs) underlying the problems that exist between the ecological systems (EcS) and ES. The Theory of Solving Inventing Problems (TRIZ, Russian abbr.) is considered one of the most effective methodologies for solving TCs existing in the ES (Rajić et al., 2006; Rajić, 2017), but not in the EcS. Eco-inventology is designed to fill that void. Its goal is to provide an inventive solution to the non-standard eco-innovative problems of different genes using their tools, which at the same time reflect on the EcS, ES and the economy. Eco-inventology includes three equally eco-innovative approaches. The first is based on biomimetics, the other on eco-engineering, and the third on the application of the basic laws of evolution EcS and ES. Biomimetics is considered one of the more advanced eco-innovative approaches (Chen & Chen, 2014). In BS, the most important resources used are information and space, which is closer to the notion of ideality (Bogatyrev & Bogatyreva, 2014; Rajić, 2016). For the EcS, the main diversity of the function is achieved by incredible combinations and manipulations with existing materials, with minimal energy consumption.

The main drawback of biomimetics is the risk of investment. On the other hand, in the ES, energy and substance are the most important resources used, which is far from ideal. Nevertheless, the use of bio-engineering creates the possibility of using nature for human benefit without ecological imbalance (Bogatyrev & Bogatyreva, 2014). In both cases, it is necessary to build a reliable eco-innovative methodology, which can interpret and transmit data from EcS to ES, and vice versa, in a way that seeks to achieve the ideality of the ES. In order to reduce the level of subjectivity in this assessment, it is necessary to quantify the levels of achieved ideality ES, which is one of the goals of this paper.

This paper shows the application of eco-inventology in the eco-innovative design of a light bulb for lighting.

Eco-innovation system in literature

In a compound word *eco-innovation,* the abbreviation *eco* stands for *ecology,* while the word *innovation* comprises *engineering* and *economics* (Rajić, 2016). Concerning eco-innovative design, most of the studies published in the literature explained how useful TRIZ is for design and highlight how it can be applied efficiently for this research subject. Fresner et al. (2010) applied it in cleaner production to have a more

rational use of materials and energy to reduce waste and emissions in industrial activities. Chang & Chen (2004) conceived a five steps process based on the technical contradiction of TRIZ that covers a part of the eco-inventive design process, from the problem formulation to the choice of the first design parameters. Some studies had coupled TRIZ with other methods such as Failure Mode and Effects Analysis (FMEA) (Yen & Chen, 2005). FMEA is a structured approach to discovering potential failures that may exist within the design of a product or process. Grote et al. (2007) made design for X tools and life cycle analysis. Various approaches tried to couple TRIZ and quality function deployment (Chen & Liu, 2003; Kobayashi, 2006; Sakeo, 2007). Kobayashi (2006) proposed a Four Steps Method based on the TRIZ Contradiction Matrix to improve the ratio: product value/environmental impact. Sakeo (2007) presented another approach coupling TRIZ and Quality Function Deployment (QFD) but by adding life cycle analysis. Cascini et al. (2011) aimed to bridge systematic invention practice with product life cycle management systems by integrating TRIZ principles within a computer aided design system.

More recently, Yang & Chen (2011) presented an approach based on the coupling between TRIZ, case based reasoning and life cycle analysis (LCA). Their solving tool is based on the coupling between the TRIZ Contradiction Matrix and the Seven Eco-efficiency Axes proposed by World Business Council of Sustainable Development (WBCSD). Samet et al. (2010) conducted research on another way to integrate the WBSCD axis in the eco-innovation process and they presented an evolution of their design tool to support innovation (based on TRIZ tools) to deal with eco-innovation problems. All these approaches and methods extended TRIZ capabilities with the support of other approaches but none of them tried to modify and adapt its tools to deal with eco-design contradictions. Chen & Liu (2001) developed an eco-innovative method based on the inventive principles but without requiring contradiction formulation. Even if they illustrated the capability of their proposed method, there was a lack of a deep initial analysis on the problematic situation leading to uncertainties in the problem formulation. Function-Oriented Search (FOS) is a tool in modern TRIZ that allows navigating between different industries, and consequently selecting the best available technologies to perform the desired function. One general recommendation suggested by FOS is to look at how the required function is performed in Nature (Savelli & Abramov, 2017). Furthermore, all these eco-innovative approaches

focused on product design and not on process design, and operated at a high level of abstraction (not concrete enough). Indeed, they gave only ways or guidelines to explore in order to find an inventive solution, which are often too abstract and hard to translate into a concrete inventive concept.

Basic concepts and tools of eco-inventology

Eco-inventology is a systematic innovative methodology based on the concept of eco-design that takes into account the elements of eco-efficiency recommended by the WBCSD, the laws of the evolution of ES and EcS, as well as the basic principles of inventology (Rajić, 2017).

Eco-inventology is largely based on TRIZ. It is a complex system that encompasses ES development laws, an information fund, substantive and field analysis (so-called sufield-analysis), an inventogy task algorithm (ARIZ, Russian abbr.) and methods of developing human creativity (Rajić et al., 2016). The Law of Ideality is one of the most important laws of ES evolution to TRIZ. The path to idealism of ES is full of barriers that consist of TC and physical contradictions (PCs). TC occurs between certain sub-systems of ES, which can be described by some of its 39 basic parameters (mass, speed, power...). If one of the ES parameters is improved by known methods, then the second one is worsens. In such a situation, optimisation is usually realized. However, eco-inventology seeks the ideal final solution (IFS) to the problem. In the PC there are simultaneously two physical contradictory features, such as close and far, warm and cold, strong and weak and so on. To solve the PC in ES, four groups of separation principles are used: separation in space, time, system structure and separation by phase switches (Rajić, 2017). Each TC contains at least one or more PCs, with the appropriate resources being used for their removal. They can be divided into six groups: substance, energy, space, time, information and structure (Rajić, 2017). Since each of the 39 ES parameters has some kind of resource characteristics, this correlation is given in Table 1.

To construct the rules of eco-inventology, in addition to TRIZ, an ecological concept applied to the r- and K-development strategies for survival of organisms was applied (Beeby & Brennan, 2003). The contradictory requirements that encompass r- and K-development strategies are found in the rules for eco-innovation (Bogatyrev & Bogatyreva, 2014), which are based on the PCs logic. In addition to

applying these rules, whenever possible, it is important to avoid unnecessary and excessive exploitation of resources or processes in EcS, the mechanical imitation of successful EcS models, the maintenance of the same ES state in a variable environment and the new ES should not exacerbate the existing ecological status.

Table 1: *Link between resources and parameters of ES according to TRIZ*

Type of resource	Mark	TRIZ parameter (1-39)
Substance		1, 2, 23, 26, 14
Space		3, 4, 5, 6, 7, 8, 12
Time		9, 15, 16, 25, 39
Energy/ Field		10, 11, 17, 18, 19, 20, 21, 22
Structure		13, 29, 32, 36
Information/ Regulation		24, 27, 28, 30, 31, 33, 34, 35, 37, 38

Determination of the response of the ES users to the improvement of the eco-efficiency parameter

Evaluation of the eco-efficiency of the product, as proposed by WBCSD, is reduced to the analysis of the representation of 7 elements of eco-efficiency. These elements can be linked to 39 ES parameters according to TRIZ (Table 2). According to the WBCSD formula for ecological efficiency, the ES represents the relationship between its value in the market and the harmful environmental impact.

Another formula for eco-efficiency calculation is given by Japan Environmental Management (Sheng & Kok-Soo, 2010). According to her, the emphasis is on reducing material, saving energy, reducing toxicity and increasing recycling of materials. Eco-efficiency is calculated as the ratio between the eco-efficiency of the new and old product. Both of these approaches are based on a global understanding of the relationship between economic benefits and environmental damage from products, rather than on the precise quantitative calculation of particular ES characteristics in relation to EcS. This defect is trying to be overcome by this work.

Table 2: *The eco-friendly elements of the WBCSD and TRIZ engineering parameters of the ES*

Eco-friendly elements of WBCSD	**TRIZ parameters (1-39)**
A-Material reduction	1-8;12;14;23; 26; 32; 39
B-Energy reduction	1; 3; 5; 7; 17-22; 33; 39
C-Toxicity reduction	13; 23; 26; 28; 31
D-Increase recyclability	9-11; 28; 29; 32; 36; 38
E-Resource sustainability	14; 30;34
F-Product durability	13-16; 27; 30; 33-37
G-Product service	9; 15; 16; 24; 25; 27; 35; 39

Source: *Chen & Liu, 2001*

Inventology starts from the fact that in the technical-technological problem one should not look for an optimum but an ideal final solution (IFS) (Rajić, 2017). Once an ideal system is achieved, then its dimensions and energy capacity strive towards zero, and the ability to execute the main useful function (MUF) is not diminished. Idealism always reflects on the maximum utilisation of existing system resources. The cheaper these resources, the greater the chance of using them, the system will be more ideal. The ideality formula was first proposed by Altshuler (Altshuler et al., 1989):

$$I = \frac{\Sigma F}{\Sigma C + \Sigma D} \qquad (1)$$

Where: I is an ideal or an IFS system;
ΣF - total system functionalities (benefits);
ΣC - total system damage;
ΣD - total maintenance costs of the system.

However, due to increased demands for objectivity and validity of the methodology of estimating the achieved ideality degrees in ES, there are efforts to show formula (1) with a more precise quantitative meaning (Azgaldov & Kostin, 2011). The fact that the real system is asymptotically approaching the ideal system by removing contradictions, using all available resources, minimizing components, using new physical, chemical and geometric phenomena and effects without increasing the harmful functions, has to be taken into account (Rajić, 2017). In reality there is no ideal system. In every useful system some harmful effects appear. This very harmful system is always ideal, because no one in particular creates it, it organises itself instead (Rajić, 2017). If the formula (1) expends it is possible to obtain a relationship of so-called ponder masses (Lyubomirskiy, 2015):

$$I = (k1F1 + k2F2 + \ldots + knFn)/[(l1C1 + l2C2 + \ldots + lnCn) + (m1D1 + m2D2 + \cdots + mnCn)] \quad (2)$$

Where: I - IFS; n – parameter number; k, l, m - coefficients representing the significance of useful system functions, costs and harmful functions of the system; F - total system functionalities (benefits); C - total system damage; D - total maintenance costs of the system.

In this form the formula is still non-functional, because the terms have different units. The problem can be solved by switching to normalised parameters without units, but in this case the formula has at least two problems. These are the problems of mathematical and subjective linearity. Namely, if it doubles the functionality of the system, it does not mean that the ideality of the engineering system will increase (Lyubomirskiy, 2015):

$$I1 = \frac{F}{C + D} \wedge I2 = \frac{2F}{C + D} \Rightarrow I2 = 2I1 \quad (3)$$

According to formula (3), it can be seen that many of the small advantages of a system can compensate for one major (limiting) defect. Accordingly, from the point of view of the mathematical linearity, formula (3) should be re-examined. It should also be reconsidered from the point of view of subjective linearity, as technology and technology evolve to meet the needs of users. For this reason, the user is the one who needs to decide whether and how much the ES has been given is satisfactory. It means that his/her answer is different in two different

situations, in spite of what formula (3) claims. Improving any ES means improving one or more of its main parameters.

Inventology is based on TRIZ, which essentially identifies, emphasises and eliminates technical and physical contradictions (TC) in the system (S), and does not tend to create a compromise through optimisation of parameters. The term TC is the key to the TRIZ concept. One TC represents two contradictory features of the system. Improving one part or one feature of a system automatically aggravates some of their other characteristics. In accordance with TRIZ, the problem is solved only if the TC is identified and eliminated. Demonstration of the application of the 40 TRIZ principles, as its most popular tool, is explained on numerous examples of technical-technological (Rajić et al., 2016) and ecological products (Rajić, 2016).

With 76 Innovation Standards, as the following essential TRIZ tool, each class of standards is sub-divided into sub-classes and sub-groups (Rajić, 2017). In order to solve technical-technological problems using TRIZ standards, it is first necessary to determine which class belongs to the given problem, and then to which sub-class and the group it can be classified. Special attention should be given to the fifth class of standards. It is applied when there are complications in the search for substances or fields that are missing. This class increases the degree of ideality of the system on which it is working, because it is focused on the maximum use of resources, both substances and fields that exist in the given system (Rajić, 2017).

Displaying the absolute value of parameter P cannot show whether the selection of this parameter is good or bad, whether it is too much or too little, etc. Therefore, the parameter P for an interval should be normalised (Lyubomirskiy, 2015):

$$\mathrm{Pn} = \frac{\mathrm{P} - \mathrm{Pmin}}{\mathrm{Pmax} - \mathrm{Pmin}} \qquad (4)$$

where: P_n – normalised parameter for the interval P_{min}, $P_{max;}$
P_{min}, P_{max} – minimum allowed and maximum necessary parameter values.
P_{min} and P_{max} have a real physical meaning. Their values are oftentimes established by suitable standards. P_{min} is the minimum allowed value of a parameter, below which the user will not accept a ES asset under any circumstances. Similarly, P_{max} is the maximum necessary parameter value

so that its further overrun will not be essential to the user, so this increase will not necessarily be considered an improvement. Since the quality of ES is determined by several parameters of different meaning for the user, it is necessary to introduce ponder. Then the more important parameter will look like this (Lyubomirskiy, 2015):

$$Pn = \left(\frac{P-Pmin}{Pmax-Pmin}\right)^{K} \quad (5)$$

Where: K - ponder, $0 < K < 1$

On the market with low competition (L leaning towards 0), even small improvements will be interesting, while the user on the highly saturated market (L leaning towards 1) could be disinterested even if he was offered a significant improvement in the parameter of the ES. Therefore, for one parameter the formula should look like the following (Lyubomirskiy, 2015):

$$S = \left(\frac{P-Pmin}{Pmax-Pmin}\right)^{KL/1-L} \quad (6)$$

Where: S – user's satisfaction with the achieved parameter value P;
L - market saturation coefficient, $0 < L < 1$

If the measuring units are such that the improvement of the ES implies a decrease in the parameter value, the formula changes according to the following (Lyubomirskiy, 2015):

$$S = \left(\frac{Pmax-P}{Pmax-Pmin}\right)^{KL/1-L} \quad (7)$$

At this point, total characteristics of the ES can be calculated, and they can be referred to as ideal final solution (IFS) (Lyubomirskiy, 2015):

$$IFS = \left(\prod_{i=1}^{n} Si\right)^{1/n} = (S1S2 \dots Sn)^{1/n} \quad (8)$$

Where: IFS– practical value of the ideal final solution;
Si – user's satisfaction with the value of parameter Pi;
n – parameter number.
In addition, the relative harmful regime Ri can be calculated as a "negative contribution" of each parameter of the ES value (Lyubomirskiy, 2015):

$$Ri = \frac{1 - Si}{\sum_{i=1}^{n}(1 - Si)} \quad (9)$$

Eco-innovation contradiction matrix

The work with an eco-innovative contradiction matrix (Table 3) begins by selecting 1 of the 39 ES parameters in the vertical column, which from an ecological point of view aims to be improved. The type of ecological improvement is indicated by the parameter A - G. The matrix user in the audit process should conclude which parameter of 39 possible in the horizontal row of the matrix will deteriorate as a result of the previous, desired ecological improvement. They analyze the proposed principles in the matrix cell that arise by crossing the parameter from the column and the parameter from the order. In the end, one of the proposed principles that most promises in finding a solution of the problem.

Table 3: *Eco-innovation contradiction matrix (beginner part)*

PARAMETERS (1-39)			**Worsening**				**PRINCIPLES (1-40)**	
			1A, B	**2A**	**3A, B**	**4A, …**	**Name**	**No**
Improving	**1A, B**	Weight of moving object			15, 8, 29, 34		Segmentation	**1**
	2A	Weight of stationary object				10, 1, 29, 35	Extraction	**2**
	3A, B	Length of moving object	8, 15 29, 34				Local quality	**3**
	4A …	Length of stationary object…		35, 28 40, 29			Asimmetry …	**4…**

A case study

Considering that around 20% of the total electricity produced in the world goes on electric lighting, the promotion of eco-innovative lamp design is a very important area (Pendic et al., 2015). There are currently three types of bulbs on the market. These are standard incandescent light bulb (I), fluorescent light bulbs (F) and LEDs - light-emitting diode bulbs (L) (Table 4).

Analysing data from Table 4 it is noticed that the achieved ideality for LED bulbs (S (L) = 98.4%) is significantly higher than in the case of standard incandescent (S (I) = 53.5%) and fluorescent (S (F) = 84.2%). The most convincing parameter in L lamp is reliability (R (L) = 71.8%). Therefore, this parameter needs to be improved. From Table 5 it can be seen that in the case of improvement of parameter 27 (reliability), the parameter 20 (use of the energy of the stationary object) deteriorated, and TC1 (27x20) is generated, whose override is suggested by the principles of n. 23 and 36.

Table 4: *Achieved degree of ideality in the construction of three types of bulbs*

Parameters	**Life span x 1000 (h)**	**Electrical energy consumption (kWh/year)**	**Total costs (electricity+ bulbs) for lighting of 25000h**	**Comfort, points (1-5)**	**IFS (%)**
P (I)	25	130	2.35	5	
P (F)	8	340	4.65	3	
P (L)	1.5	1.100	11.10	2	
Pmin-Pmax	1-30	100-1500	2-12	1-5	
K (0-1)	1	1	1	1	
L (0-1)	0.2	0.3	0.2	0.2	
S (L)/%	95.4	99.1	99.1	100	98.4
S (F) /%	70.1	92.2	92.6	84.1	84.2
S (I) /%	36.2	58.4	54.8	70.7	53.5
R (L) /%	71.8	14.1	14.1	0	
R (F) /%	49	12.8	12.1	26.1	
R (I) /%	35.5	23.1	25.1	16.3	

After studying these two principles, 36 (Phase transition) was selected. This principle suggests that the phenomena that occur at phase transitions are used in the system. In this particular case, the refraction of the light was chosen, which is a result of changes in the speed. The speed of light is determined by the density of matter through which the light passes. If the light passes from the air through the polyethylene bottle into the water, its refraction will happen. This principle is used for the development of the so-called Moser's bulb (Wikipedia, 2016). Since such a bulb cannot work at night, there is a need to correct parameter 22

(energy loss at night), while the parameter 27 (reliability) worsens, and with it, a new TC (22x27) = 10, 11, 35 is being created. The choice fell to Principle 35 (Parameter changes or Transformation of properties). Choosing a solar panel can accumulate the energy of the sunlight in the day, which will be released at night. By correcting the parameter 35 (Ease of repair), the parameter 27 (Reliability) is worsened, resulting in the TC4 (35x27) = 35, 13, 8, 24. By selecting the principle 24 (Intermediary) it is suggested to take some intermediary such as sensors, transistors, batteries ... While the Sun shines the solar cell voltage keeps the transistor closed and the batteries are charging at that time. When the Sun disappears, the resistor allows the transistor to light up and the LED starts to light up until the batteries are emptied. It is recommended to install three 700 mAh batteries, which would be sufficient to provide light throughout the night, i.e. some 8-9 hours. By adjusting parameter 18 (Illumination intensity) the parameter 20 (Using the energy of a stationary object) worsens, and TC3 (18x20) = 32, 35, 1, 15 is produced. By choosing the principle 32 (Color changes), the corresponding light bulb is selected, depending on the different consumer needs for lighting.

Table 5: *The part of Eco-innovation Matrix of Contradictions used for case analysis*

PARAMETERS (1-39)			**Worsening**		**PRINCIPLES (1-40)**	
			20B	**27F, G**	**Name**	**No**
Improving	**18B**	Illumination intensity	**32**, 35, 1,15		Changing the color	32
	22B	Loss of energy		10,11, **35**	Transformation of the physical/ chemical states	35
	27F,G	Reliability	23, **36**		Phase transitions	36
	35G,F	Ease of repair		35,13, 8, **24**	Mediator	24

An ideal eco-inovative pronciple solution for lighting bulb could be based on the integral application of the Moser's bulb and a solar panel at daylight, and LED bulbs at night (Table 6).

Table 6: *Combined specific eco-innovative solution for lighting*

Technical contradiction (TC)	Principles (1-40)	Generic solution	Specific Solution
27x20	23; 36	36: Phase Transitions	Moser's light
22x27	10; 11; 35	35: Transformation of the physical/ chemical states	Solar-powered Panel
18x20	32; 35; 1; 15	32: Changing of the color	Colorful LED Light
35x27	35; 13; 8; 24	24: Mediator	Sensor, transistor, batteries

Conclusion

The ideal eco-innovative ES should have all the advantages of the ES and EcS. Therefore, biomimetics and eco-engineering can be considered as two parts of a unique eco-inventology strategy. Eco-inventology applies the rules derived from the r- and K-strategy of survival of organisms in EcS, the basic principles of inventology and the use of modified TRIZ tools. The methodology of the quantitative estimation of the idealities of certain ES parameters is explained. On this basis, the worst starting point of the ES is taken to be repaired. It is renamed in one of the 39 parameters of TRIZ, and then in the further analysis the Eco-innovative Matrix of Contradiction is used. In it, the main mechanism is based on the discovery of the TC that exists between ES and EcS and finding the idea for solving the problem using the proposed TRIZ principles. At the same time, the matrix considers simultaneously the application of 39 ES parameters according to TRIZ, 7 elements of eco-efficiency according to WBCSD and 6 types of resources according to TRIZ.

The example of a case study demonstrates the successful practical applicability of eco-inventology.

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ECO-INNOVATIVE MATRIX BASED ON TRIZ STANDARDS

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Abstract

Compatibility between technological and biological evolution is only 12%. This means that technology (economics) and ecology are mutually contradictory in most cases. Contradiction is the basis of the problem. Ecological crisis is one of the main problems facing contemporary humanity. The Theory of Inventive Problem Solving (TRIZ, Rus.abbr.) is one of the most successful methodologies for problem solving. While the TRIZ principles with the Matrix of Contradiction indicate a general path and a fairly wide area within which problems can be solved, TRIZ Standards recommend concrete actions to be taken to solve the problem. The paper presents the original Eco-Innovative Matrix based on TRIZ Standards. It combines in one place 7 basic ecological requirements, all 6 environmental resources, 39 parameters used to describe any technical and technological system and over 70 standards that are recommended for solving the contradictions that exist between technology and ecology.

Keywords: *ecology, economics, innovation, matrix, TRIZ, standards.*
JEL Classification System: **O10**

Introduction

In ecological innovation (eco-innovation) it is necessary to overcome numerous technical contradictions (TCs) which arise when technology comes into contact with ecology. These contradictions are at the root of various problems such as environmental contamination, endangerment of life and human health, etc. Eco-inventology was created with the aim of offering a methodology that will be able to "reconcile" the incompatible fields of technology, economics and ecology. It encompasses three equal eco-innovative approaches. The first one is based on biomimetics, the other on eco-engineering, and the third on the application of the basic laws of the evolution of ecological systems (EcS) and engineering system

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(ES). Within eco-inventology, it is necessary to build reliable eco-innovative tools that will interpret and transmit data from EcS to ES, but also vice versa, in a way that seeks to achieve the idealities of these systems. One of these tools is the Eco-Innovative Matrix of Contradictions. With it, the main mechanism is based on the discovery of TC that exists between ES and EcS and finding the idea for solving the problem using the proposed TRIZ principles. At the same time, Matrix considers the application of 39 parameters, 40 principles and 6 types of resources to TRIZ, as well as 7 elements of eco-efficiency according to the World Business Council of Sustainable Development (WBCSD). Matrix is very efficient in finding solutions for various eco-innovative problems. However, the Principles for removing the TC indicate only a general path and a fairly wide area within which solutions can be reached, while Standards recommend specific actions necessary to restore the working ability of the existing system or for the synthesis of the new one (Rajić, 2017). This qualitatively enhances the possibility of obtaining an efficient problem solution. Therefore, in this paper, the Eco-Innovative Matrix based on TRIZ Standards is developed as a new eco-inventology tool. The aim of the paper is to explain its structure and mechanism of use.

Biomimetic design based on TRIZ

Nature has been inspiring inventors since the times of the Ancient Greece (Altov, 1965). A long time after Altshuller's preliminary work, several authors have proposed TRIZ-based or TRIZ-related biomimetic design approaches (Altshuler, 2000). A modern TRIZ approach is to apply Function-Oriented Search (FOS) (Litvin, 2004; Litvin, 2005) and consider Nature as a possible function-leading area. FOS is a tool in modern TRIZ that allows navigating between different industries, and consequently selecting the best available technologies to perform the desired function. One general recommendation suggested by FOS is to look at how the required function is performed in nature (Savelli & Abramov, 2017). However, no specific recommendation is given on how to identify function-leading areas within nature. Attempts were made to expand the Altshuller matrix into the so-called Matrix 2003 and later into Matrix 2010, so as to integrate modern technology findings (Mann, 2009). Initially it was aimed at building a new contradiction matrix based on identified biological solutions. However, this project was later abandoned when it turned out that the 48 parameters of Matrix 2003 were sufficient

to describe biological strategies, and that 95% of the solutions developed by nature matched the inventive principles suggested by the cells of Matrix 2003 (Mann, 2011).

Other authors proposed a new 6x6 matrix (the 6 considered parameters are: substance, structure, time, space, energy/field and information/regulation) based on biological solutions, but this new matrix kept the 40 inventive principles unchanged. This so-called PRIZM matrix shows a correlation factor between the respective biological and technological solutions to contradictions of only 12%. Nevertheless, from a practical point of view this matrix suffers the same disadvantages as the Altshuller matrix, including its general and abstract aspects.Later, Bogatyrev & Bogatyreva (2014) proposed new biology-inspired trends for developing current technologies with the aim of making those technologies eco-friendly. This interesting approach still needs a detailed description backed-up by biological and technological examples to make it fully instrumental.A comparison between the Altshuller matrix and biomimetic design has been made by Currie et al. (2009)based on a specific technological challenge, i.e. the design of a proton exchange membrane fuel cell. Although the authors considered only one example, they concluded that biomimetic design and TRIZ seem to yield comparable results. Another work defines a network of relationships between bio-inspired geometrical structures and principles (symmetry, spirals, undulations, ramifications…), functions, eco-principles, and the Altshuller matrix parameters and inventive principles from TRIZ. Nevertheless, it is questionable whether this approach provides more benefit than the Altshuller matrix. Weaver et al. (2012) propose to illustrate both principles for the resolution of physical contradictions and inventive principles with biological examples, in addition to technological examples. In order to reduce the identification of biological strategies for a given technological challenge, Vandevenne et al. (2013) have proposed an automatised biomimetic design process. Their process determines product features based on a patent database, and then matches those with organism features determined from a biological database, finally delivering biological solutions. The main drawback to this approach is that the product features do not necessarily relate to the key problems that have to be solved. The most accomplished study so far, by Bogatyrev & Bogatyreva (2012), recognises and explains the complex and empirical nature of biomimetic design; introduces four TRIZ-derived axioms (simplification, interpretation, ideal result and contradictions), and,

finally, proposes a 6-stage biomimetic algorithm which attempts to overcome the issues mentioned in the introduction. This algorithm can help when no engineering prototype exists. It is well-structured and uses sound concepts, such as main function, environment, time and size scales. Some aspects of the algorithm, however, remain unclear and too many TRIZ tools must be used, including contradictions, 9-windows tool and the inventive principles, which may make it very complex to apply. In the most recent approach by Vincent (2016), a database of biological examples has been built where the identified principles that solve any pair of engineering contradictions are sub-classes of the 40 inventive principles. Interestingly, this database can also be filled with biomimetic case studies. This biomimetic design approach gives the designer a wide set of biological strategies. So, the instrumentality of this approach is higher than that of many others, but yet it is limited by the representative character of the examples studied. In conclusion, most of the TRIZ-based or TRIZ-related biomimetic design approaches rely either on the Altshuller matrix and/or inventive principles, or on its simplified or refined versions. Also, biology inspired technological trends by Bogatyrev &Bogatyreva (2014) might have potential, but they are not yet instrumental.

None of the above-mentioned authors, or anyone else, have developed the Eco-Innovative Matrix based on TRIZ Standards.

TRIZ standards

TRIZ standards for solving inventive tasks are the rules of transformation of ES, which directly derive from the law of their development (Rajić et al., 2015; Rajic & Cabarkapa, 2016). Therefore, many examples illustrating the effect of the law of evolution of ES can be used as examples of the realisation of the standard. There are 76 standards, which are divided into 5 large classes and 18 groups (Livotov & Petrov, 2013; Rajić et al., 2016). In order to solve the problem, it is first necessary to find out which class of standards it belongs to, and then to which group. Special attention should be given to the fifth class of standards. It is applied when complications arise in search of substances or fields that are missing. This class increases the degree of idealism of ES on which it is working, because it is focused on the maximum use of resources that exist in the given system. The main disadvantage of the classic implementation of the TRIZ standard is that they generally offer general recommendations

for their use, while not considering the ecological aspects of innovation at all. However, using the Eco-Innovative Matrix based on TRIZ Standards, the innovator is making it easier to use this powerful tool and it can be more effective to come up with a solution to the eco-innovative problem which TCs are hiding.

Methodology

Eco-inventology is a systematic methodology based on the concept of eco-innovative design that takes into account elements of eco-efficiency recommended by WBCSD, the laws of evolution of ES and EcS, as well as basic principles of inventory (Rajić, 2016; Rajić, 2017). It starts from the law of idealism, which is one of the most important laws of ES evolution towards TRIZ. Improving any system means improving one or more of its main parameters. Displaying the absolute value of parameter P cannot show whether the selection of this parameter is good or bad, whether it's too much or too little, etc. Therefore, the parameter P for an interval should be normalised (Lyubomirskiy, 2015):

$$Pn = \frac{P - Pmin}{Pmax - Pmin} \qquad (1)$$

Where P_n – normalised parameter for the interval P_{min}, P_{max}; P_{min}, P_{max} – minimum allowed and maximum necessary parameter values.

P_{min} and P_{max} have a real physical meaning. Their values are oftentimes established by suitable standards, product quality regulations (PQR), or tactical and technical requirements (TTR) and in that case they are legally binding. P_{min} is the minimum allowed value of a parameter, below which the user will not accept an ES asset under any circumstances. For example, if users are continuously exposed to highly toxic materials (HTM), it offers one-time filtration disposable clothing, which can protect the user for several hours; most probably nobody will buy it regardless of its advantages (low price, comfort, availability, etc.). If protective clothing is good enough for all-day and multiple protection, it is most likely to be purchased. Therefore, somewhere between these two values there is minimal protection time, under which no one will consider purchasing such clothing, and above it there will be thinking about possible purchase. Similarly, P_{max} is the maximum necessary parameter value so that its further overrun will not be essential to the user, so this

increase will not necessarily be considered an improvement. For example, if the standard stipulates the protection time of the 60-minute for the Filtering Protective Suit (FPS), which guarantees absolute protection to the user, and the test shows that it is realistically equals 80 minutes, it is unlikely that the user will be delighted with it. Therefore, there is always a certain limit beyond which further improvements are meaningless. Since the quality of ES resources is determined by several parameters of different meaning for the user, it is necessary to introduce ponder. Then the more important parameter will look like this (Lyubomirskiy, 2015):

$$Pn = \left(\frac{P-Pmin}{Pmax-Pmin}\right)^{K} \qquad (2)$$

Where K - ponder, $0 < K < 1$.

As it has been already mentioned, when assessing the ideality of the ES system, not so much of the value of the parameters achieved is taken into account, but more the user's response to their improvement, i.e. ponder K. This answer also depends on another factor (L) called the degree of saturation of the market or the degree of availability of this parameter on the market. On the market with low competition (L leaning towards 0), even small improvements will be interesting, while the user on the highly saturated market (L leaning towards 1) could be disinterested even if he was offered a significant improvement in the parameter of the ES. Therefore, for one parameter (in FPS it is comfort) the formula should look like the following (Lyubomirskiy, 2015):

$$S = \left(\frac{P-Pmin}{Pmax-Pmin}\right)^{KL/1-L} \qquad (3)$$

Where S – user's satisfaction with the achieved parameter value P; L - market saturation coefficient, $0 < L < 1$.

If the measuring units are such that the improvement of the ES implies a decrease in the parameter value (for example, in the case of FPS, the increase in the average cardiac frequency, surface mass and prices are undesirable effects), the formula changes according to the following (Lyubomirskiy, 2015):

$$S = \left(\frac{Pmax-P}{Pmax-Pmin}\right)^{KL/1-L} \qquad (4)$$

At this point, total characteristics of the ES can be calculated, and they can be referred to as IFS (Lyubomirskiy, 2015):

$$IFS = (\prod_{i=1}^{n} Si)^{1/n} = (S1S2 \dots Sn)^{1/n} \quad (5)$$

Where IFS– practical value of the ideal final solution;
Si – user's satisfaction with the value of parameter Pi;
n – parameter number.

In addition, the relative harmful regime Ri can be calculated as a "negative contribution" of each parameter of the ES value (Lyubomirskiy, 2015):

$$Ri = \frac{1 - Si}{\sum_{i=1}^{n}(1 - Si)} \quad (6)$$

Formula (6) represents a limiting case in which all Si = 1 => IFS = 1. This means that all functional parameters reached their top values, and the costs decreased to the level of insignificance. A system like this perfectly matches an "ideal system". It functions only where necessary, when needed and in a desired manner.

The road to ES ideality is full of barriers that consist of TC and physical contradiction (PC). TC is created between certain sub-systems of ES, which can be described by some of the 39 basic parameters. Explanation of the 39 Features of the Contradiction Matrix is given in the paper (Domb et al., 1998). If one of the parameters of ES improves by known methods, then others inevitably worsen. In such a situation, optimisation is usually carried out using the classic matrix of contradiction. However, eco-inventology requires an ideal final solution (IFS) of the problem, which means that it goes to the level of PC resolution. Each TC contains at least one or more PCs, where appropriate resources are used to remove them. They can be divided into six groups: substance, energy, space, time, information and structure (Rajić, 2017). Since each of the 39 ES parameters has characteristics of a kind of resource, this correlation is given in Table 1.

Table 1: *The relationship between resources and parameters of ES according to TRIZ*

Kind of resource	Mark	TRIZ parameter (1-39)
Substance		1, 2, 23, 26, 14
Space		3, 4, 5, 6, 7, 8, 12
Time		9, 15, 16, 25, 39
Energy/ Field		10, 11, 17, 18, 19, 20, 21, 22
Structure		13, 29, 32, 36
Information/ Regulation		24, 27, 28, 30, 31, 33, 34, 35, 37, 38

Evaluation of ecological efficiency of a product, as suggested by WBCSD, comes down to an analysis of presence of the 7 elements of eco-efficiency. These elements can be linked with the 39 parameters of ES according to TRIZ (Table 2).

Table 2: *The eco-friendly elements of WBCSD and TRIZ engineering parameters of ES*

Eco-friendly elements of WBCSD	TRIZ parameters (1-39)
A-Material reduction	1-8;12;14;23; 26; 32; 39
B-Energy reduction	1; 3; 5; 7; 17-22; 33; 39
C-Toxicity reduction	13; 23; 26; 28; 31
D-Increase recyclability	9-11; 28; 29; 32; 36; 38
E-Resource sustainability	14; 30;34
F-Product durability	13-16; 27; 30; 33-37
G-Product service	9; 15; 16; 24; 25; 27; 35; 39

Source: *Chen & Liu, 2001*

Eco-innovation contradiction matrix based on TRIZ standards

In the paper of Domb et al. (1999) the link is shown between 76 TRIZ standards and 40 TRIZ principles, which was used as a starting idea for the creation of the Eco-Innovative Matrix based on TRIZ Standards. Working with the Eco-Innovative Matrix based on TRIZ Standards starts by selecting one of the 39 ES parameters that is to be improved from the ecological aspect in the horizontal line (Table 3).

Table 3: *Eco-innovation Contradiction Matrix based on TRIZ Standards (initial segment)*

PARAMETERS (1-39)			**Worsening**			
			1A, B	**2A**	**3A,B**	**4A …**
Improving	**1A, B**	Weight of moving object			2.2.4, 2.4.8, 2.4.3, 5.1.1.1, 5.1.4, 5.1.3	
	2A	Weight of stationary object				5.1.2, 2.2.2, 2.2.4, 3.2.1, 2.4.3, 5.1.1.1, 5.1.4, 5.3.1, 1.1.2.-1.1.5, 2.4.12
	3A, B	Length of moving object	2.2.4, 2.4.8, 2.4.3, 5.1.4, 5.1.3			
	4A …	Length of stationary object…		5.3.1, 1.1.2.-1.1.5, 2.4.12, 2.2.1, 2.4, 2.4.11, 4.2, 5.1.1.2, 5.1.1.1, 2.4.3, 5.1.1.1, 5.1.4		

The type of environmental improvement is listed next to the parameter, by A-G. The Matrix user in the thought process needs to conclude which

parameter of the 39 possible ones in the horizontal line of the Matrix will worsen as a consequence of the previous, desired environmental improvement. They are analysed in order of the proposed standards in the Matrix cell resulting from crossing the parameter from the column and the line. In the end, the TRIZ Standards that are most promising in finding the solution to TC problems are being selected.

A Case Study

The Filtering Protective Suit (FPS) (Figure 1) is a filtering means that protects user's body from HTM (Karkalic, 2006). Comparative tests of basic physical-mechanical characteristics FPS-M00 (manufacturer "Mile Dragić production", Zrenjanin, Serbia) and FPS-M2 (manufacturer "Trayal Corporation", Kruševac, Serbia) have been conducted. Thispaperdealswithexperimentsthatwereconductedtotestthebasicphysicala ndmechanicalcharacteristicsofPFS-M00 andPFS-M2 as two representative models which, due to their best characteristics approved by tests, were shortlisted for the final incorporation into the weapons and military equipment (WME) of the Serbian Army (Rajic et al., 2018). FPS was tested for the raw materials, surface mass, thickness, breaking forces, intermittent elongation and splitting/ripping forces. Air permeability and water vapor tests were also performed to test the basic functional characteristics of the FPS. The protective power of FPS against HTM was tested using a sophisticated dynamic gas chromatographic method, and the protection time for the effect of HTM drops was determined using S-iperite in dynamic working conditions (Karkalić, 2006).

The testing of the heat transfer process through various materials embedded in the FPS was carried out in laboratory and field conditions. The appropriate anthropometric and ergometric indicators and measured thermoregulation characteristics were tested as well (Karkalić, 2006). This made it possible to compare the materials according to all the relevant thermoregulation parameters of the body.

Results have shown that protective suits FPS-M2 and FPS-M00represent a significant improvement compared to domestic FPS of previous generations. Both FPSmodels are on the level of modern means of personal percutane protection when all the examined characteristics are taken into account (Karkalić, 2006). Testing of the protective properties of FPSagainst the effects of HTMwas conducted by the total process of

penetration of para S-iperitathrough their materials. During hours of examination, in both models of FPS, output contamination density didn't reach the value of 4 μg/cm^2, which fulfilled the set request from TTR and standards(Karkalić, 2006).

Figure 1: *Different camouflage types FPS-M2 and FPS-M00*

Source: *Rajic et al., 2018*

Comparing FPS-M2 andFPS-M00, when it comes to surface mass of outer and inner layer, it can be concluded that FPS-M00 has 30g/m^{2}greater surface mass and 80g/m^{2}of the inner layer. This means that the total surface mass of FPS-M2 is smaller by ≈ 110g/m^{2}compared toFPS-M00. Considering that for production of a set of FPSit is needed 5m^{2}do 6m^{2}of material, FPS-M2 is of a smaller mass than FPS-M00 by 550 to 600g. Differenceinmassof FPS canrepresent an important factor for choosing FPS model to equip the army with.

However, from a practical value point of view, it is necessary to determine values of key parameters that are important for calculating the FPS. Duetothis, Table4comprisesmainparametersof FPSwhich are important for evaluation of ideality: average heart frequency, surface mass, comfort and price on the market. Multi-criteria ranking of characteristics of physiological suitability and functional characteristics determined suitable ponder relative to their importance for the final user. The highest ponder belongs to the heart frequency as the most important physiological parameter which directly impacts the safety (life) of the user, followed by surface mass, wearing comfort and price. Parameters

that go the maximum ponder value were taken for the calculation of ideality.

FPS-M2 model reached ideality of 76.8%, and model FPS-M00 68.2% (Table 4). This result is surprising in a way considering that FPS-M00 average heart frequency, comfort and Price were better compared to FPS-M2. Applying the methods of optimization of the listed parameters according to the paper (Karkalić, 2006), FPS-M00 was chosen as a completely better means. However, applying the formula (5) for calculating ideality showed that the difference in mass, as an unwanted parameter, was so much better for the FPS-M2 that this parameter was the prevailing factor in deciding the greater total ideality of this means.

Table 4: *The achieved ideality degree (IFS) in the construction of FPS-M2 and M00*

FPS	Average heart frequency (bpm)	Mass (g)	Comfort, points (1-5)	Price, Euro x100	IFS, %
P (M2)	124.93	485	4.42	2.75	
P (M00)	120.92	595	4.85	2.19	
Pmin-Pmax	89-132	400-600	1-5	2-5	
K	1.0	1.0	1.0	1.0	
L	0.3	0.2	0.3	0.2	
S/% (M2)	46	87	93.5	93	76.8
S/% (M00)	56	40	98.3	98.5	68.2
R/% (M2)	67.1	16.1	8.1	8.7	
R/% (M00)	41	56	1.6	1.4	

Source: *Rajic et al., 2018*

Increasing ideality of both FPS models can be achieved by increasing their individual parameters. In the case of FPS-M2 the work is needed on constructional changes which would contribute to the lower value of heart frequency (R=67.1%), and in case of FPS-M00 the work should be done on fixing the parameter of surface mass i.e. total mass (R=56%). It is called technical improvement or innovation of a lower inventiveness level. However, one of the possible ways for achieving the greatest possible ideality of FPS could be choosing the self-decontaminating

material of the outer layer impregnated with nano-particles TiO_2 (Senic et al., 2013) or some other nano-material, which would represent a totally different conceptual approach to the development of this WME means. This approach would represent a FPS innovation of a higher level of inventiveness.

This means that the key parameter to be corrected is no. 2A (mass of the stationary object). If the mass of the stationary object decreases, the parameters no. 23A, C (loss of matter), parameter no. 36D, F (device complexity) and parameter no. 37F (control complexity) all worsen (Table 5). Thus there are three different contradictions: TC1 (2Ax23A, C), TC2 (2Ax36D, F) and TC3 (2Ax37F) (Table 6). To overcome TC1, the use of several standards is suggested, whereby standard 1.1.2 is selected: the introduction of a new substance in the ES; 1.1.4: use of the external environment and 3.1.4: translating a bi-sistem into a mono-system. In this case, the introduction into the existing FPS system of the new refrigeration system is considered, as discussed in the paper (Karkalic et al., 2015).

The second, more promising solution is to eliminate the inner protective layer from the existing FPS system which is impregnated with spherical particles of activated carbon, and instead introduce a new TiO_2 compound. This substance is able to decontaminate HTM in the presence of sunlight (Bauk et al., 2011; Bauk et al., 2012). The choice of self-contamination material of the external layer impregnated with nanoparticles of TiO_2 (Senic et al., 2013), or some other nanomaterial, presents a completely different conceptual approach to the development of FPS.

Table 5: *A segment of theeco-innovation Matrix based on TRIZ Standards used for the case analysis*

PARAMETERS (1-39)			**Worsening**		
			23A,C	**36D,F**	**37F**
Improving	**2A**	Weight of stationary object	1.1.2-1.1.5; 3.1.4; 2.4.6; 2.2.6	5.1.2; 2.2.2; 2.2.4; 3.2.1; 4.1.2; 1.1.3; 1.1.5	5.4.1; 2.4.8; 2.2.1; 2.4: 2.4.11; 4.2; 1.1.2; 2.2.4

The eco-innovative principle of the FPS could be based on one of the two possible solutions: using a cooling system, using a temperature sensor or

impregnating the outer layer of the FPS fabric with TiO_2 (Table 6). Of course, the application of TiO_2 is closer to the concept of ideality. Namely, in view of the previous preliminary investigations carried out (Bauk et al., 2011; Bauk et al., 2012; Senic et al., 2013), it has been found that textile substrates are being created by modification of the standard military textile with TiO_2nano-particles, and that those substrates have a propery of self-decontamination under certain experimental conditions.

Table 6: *Principally specific eco-innovative solution of the FPS design*

Technical contradiction (TC)	**Standards (1-76)**	**Generic solution**	**Specific Solution**
2Ax23A,C	1.1.2-1.1.5; 3.1.4; 2.4.6; 2.2.6	1.1.2: Introduction of a new substance in ES; 1.1.4: Use of the outer environment; 3.1.4: Translation of bi-system into a mono-system	TiO_2 or introduce a cooling system; Sun; Impregnation of only one outer layer of FPS with the use of TiO_2
2Ax36D,F	5.1.2; 2.2.2; 2.2.4; 3.2.1; 4.1.2; 1.1.3; 1.1.5	2.2.2: Increase of dispersity degree (mulching)	Cooling fluid distributed among the cells
2Ax37F	5.4.1; 2.4.8; 2.2.1; 2.4: 2.4.11; 4.2; 1.1.2; 2.2.4	2.2.1: Increase managing possibilities	Temperature sensors

Conclusion

While in the Classic TRIZ Matrix of Contradictions, a man has adjusted nature to himself, in the Eco-Innovative Matrix there was an adjustment of a man to nature. In eco-inventology, two types of matrices have been developed. The first uses the TRIZ principles for the resolution of TCs that occur between EcS and ES. The second, as explained in this paper, applies TRIZ Standards for this purpose. Based on the calculation of the idealities of the individual ES parameters, the worst initial characteristic of ES is chosen to be corrected. It is renamed in one of the 39 parameters of TRIZ, and then the Eco-Innovative Matrix based on TRIZ Standards is used. With it, the main mechanism is based on the discovery of the TC that exists between the ES and EcS, and finding the idea for solving the

problem using the proposed TRIZ Standards. The Matrix also examines the application of the 39 ES parameters, 6 types of resources and 76 standards according to TRIZ, and 7 eco-efficiency elements according to WBCSD.

The example of a case study of FPS demonstrates the successful practical application of this eco-inventology tool.

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MODIFIED ARTIFICIAL BEE COLONY ALGORITHM APPLIED TO INTEGER PROGRAMMING PROBLEMS

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Abstract

Artificial bee colony (ABC) algorithm is one of the widely studied swarm intelligence techniques. However, there is a drawback in the ABC algorithm regarding its solution search equation, which is more of an exploration than exploitation operator. This paper presents a modified artificial bee colony (MABC) algorithm for solving integer programming problems. The proposed approach usestwo different modified ABC search operatorsin employed and onlooker bee phases, with the intention to improve the exploitation ability of the algorithm. Experiments are performed on nine well-known benchmark functions. Experimental results show that the MABC is able to enhance the performance of the ABC algorithm adjusted for integer programming problems in terms of the robustness and convergence speed. In addition, it obtains competitive results compared with other state-of-the-artalgorithms.

Keywords: *artificial bee colony, swarm intelligence, integer programming, nature-inspired metaheuristics*
JEL classification: **C61**

Introduction

An integer programming problem is a discrete optimization problem where all of the variables are restricted to integer values. A general integer programming problem can be stated as:

$$\text{minimize} \quad f(x), \quad x \in S \subseteq Z^n, \quad (1)$$

where Z is the set of integers, and S is the feasible region. A problem where some variables are constrained to integers and some are not is a

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mixed integer programming problem. Special instance of integer programming problem is that in which the variables are restricted to be either 0 or 1. This case is called 0-1 programming problem or binary integer programming problem.

A wide range of problems from different areas of applied mathematical programming can be expressed as integer programming problems (Bradley et al., 1977). A standard capital-budgeting problem deals with the selection of a number of potential investments. The investment decision might be to pick a configuration of capital equipment or to select between possible plant locations. This problem becomes a binary integer programming problem since usually there is no sense to consider partial investments in these activities. Warehouse location problem refers to the trade-offs among transportation costs and operational costs of distribution centers. Scheduling, sequencing and routing represent class of problems which are essentially integer programming problems.

Since integer programming is known to be NP-hard, solving these problems is considered to be a challenging task. The computational cost of deterministic algorithms rapidly increases as problem size grows (Karaboga & Akay, 2009). The main limitation of deterministic approaches is that they can not be modeled to a given problem (Gandomi et al., 2011). Therefore, the problem has to be tuned in a way that the deterministic algorithm can solve it. On the other hand, metaheuristic optimization algorithms give a high quality solutions in an acceptable amount of time. These techniques do not make any presumptions about the problem. Hence they can be efficiently used to solve challenging optimization problems encountered in real-world logistics, transportation, production, healthcare, telecommunication, etc. Also, metaheuristic algorithms, apart from different variants of multi-criteria decision-making methods (Ghorabaee et al., 2017; Maksimović et al., 2017; Karabasevic et al., 2017), can be extended to efficiently solve various stochastic problems (Juan et al., 2017). However, the lack of all metaheuristics is that they have the algorithm-dependent parameters whose settings has significant impact on the performance of an algorithm.

Majority of metaheuristic algorithms have been developed by drawing inspiration from nature (Yang, 2010). One of the most notable classes of these techniques are swarm intelligence algorithms. These techniques are based on mimicking the so-called swarm intelligence features of

biological agents such as birds, bees, ants and others. Some of the most popular swarm intelligence algorithms are particle swarm optimization (PSO) (Kennedy & Eberhart 1995), artificial bee colony (ABC) (Karaboga, 2005), firefly algorithm (FA) (Yang, 2009) and cuckoo search (CS) (Yang & Deb 2009). Several prominent metaheuristics which do not use the swarming behavior directly include genetic algorithm (GA), differential evolution (DE) and more recently proposed biogeography-based optimization (BBO) (Simon, 2008). These algorithms usually start with a population of initial solutions and then they mutate and recombine solutions, selecting only the most favorable to survive each generation. After their invention, these algorithms have been studied and modified with intention to make their performances more powerful for some class of problems (Yang et al., 2016; Stojanović et al., 2017; Brajević & Ignjatović, 2018; Brajevic & Tuba, 2014).

Metaheuristic algorithms can be efficiently applied to integer programming problems by rounding or truncating the real valued solutions. The PSO was employed to solve integer programming problems in (Laskari et al., 2002). On standard test problems, the PSO outperformed the branch-and-bound method in terms of convergence speed and robustness in cases where the branch-and-bound algorithm fails. An improved variant of the PSO named quantum-behaved particle swarm optimization (QPSO) was tested to solve integer programming problems. The experiment results on benchmark functions showed that the QPSO can search out the global optima more frequently than the PSO. In (Omran & Engelbrecht, 2007) the performance of three DE variants for integer programming problems were investigated and it was concluded that the self-adaptive DE (SDE) requiring no parameter tuning is the most efficient approach. Three variants of biogeography-based optimization (BBO), named BlendBBO, BBO_DE and LBBO_LDE, were developed in (Wang & Wu, 2014) in order to solve integer programming problems. Results on standard benchmark functions showed that these methods are competitive with respect to the standard BBO, DE and SDE algorithms. The efficiency of the ABC algorithm in solving integer programming problems was investigated in (Karaboga & Akay, 2009). The experimental results obtained on nine benchmarks showed that the ABC can produce comparable or better performance with respect to PSO variants and branch-and-bound technique.

In this paper, the modified artificial bee colony (MABC) algorithm is proposed with the aim to enhance the performance of the ABC for integer programming problems. It is widely known that both exploration and exploitation are needed for a metaheuristic optimization algorithm (Črepinšek et al., 2013). These abilities should be well balanced considering the fact that they contradict each other. It was noticed that the ABC may lack at exploitation of the solutions due to the randomly selected neighborhood solution in its solution search equation (Zhu G. & Kwong S., 2010). In order to overcome this drawback, the MABC employs two different modified ABC search operators in employed and onlooker bee phases, with the intention to improve the exploitation ability of both phases. The MABC is tested on nine widely used benchmark problems. The results of the MABC algorithm are compared to those of the ABC and other state-of-the-art algorithms adjusted to solve integer programming problems.

The paper is organized as follows. A brief literature review of original ABC and its adjustment for integer programming problems are presented in section "Artificial bee colony algorithm". The proposed modified artificial bee colony (MABC) for integer programming problems is presented in section "The proposed approach: MABC". Nine test problems formulations are given in section "Benchmark problems". The experimental design, the parameter settings and the optimization results are presented in "Experiments and results" section. "Conclusion" section provides concluding remarks.

Artificial bee colony algorithm

The ABC algorithm is a swarm intelligence technique proposed by Karaboga (Karaboga, 2005) to solve unconstrained function optimization problems. It is inspired by the foraging behaviors of honey bee swarm. The employed bees, the onlookers and the scouts are included in a swarm of artificial bees. All bees that are currently exploiting a food source are known as employed bees. The onlooker bees aim to choose good food sources from those brought by the employed bees according to the probability proportional to the quality of the food source. After the selection of the food source, the onlookers further search for food around the selected food source. The scout bees are translated from a several employed bees which leave their food sources and search for new ones.

Each food source represent a possible solution for the problem. The quality of the solution is represented by the fitness value.

The framework of the ABC algorithm is given as follows:

Initialization Phase
REPEAT
Employed Phase
Onlooker Phase
Scout Phase
Memorize the best solution achieved so far
UNTIL (Cycle = Maximum Cycle Number (MCN))

The control parameters of the basic ABC algorithm are: the maximum cycle number (*MCN*), the size of the population which is equal to the sum of numbers of employed and onlooker bees (*SP*), the *limit* which represents the number of trials for releasing food source. In the initialization phase of the ABC, these parameters are set and the population of solutions is created randomly in the search space.

In the employed phase, each solution i, i =1, 2, … ,SP involves the update process, which is given by:

$$v_{ij}=x_{ij}+\varphi_i\left(x_{ij}-x_{kj}\right) \quad (2)$$

where x_{ij}denotes the *j*th parameter of x_i, j is a random index, φ_i is a uniform random number in range (-1,1), x_k represents the other solution selected randomly from the population. The update process is finished when the boundary constraint handling mechanism is applied to the novel solution v_i and greedy selection is applied between x_i and v_i.
The update process in the onlooker bee phase is the same as in the employed bees phase. But, in the onlooker stage, the solutions are selected according to the probability that is given by:

$$P_i=0.1+0.9\left(fit_i/\max fit\right) \quad (3)$$

where *maxfit* is the best fitness value of the population and fit_i is the fitness value of the *i*th solution in the population.

In the scout bee phase, a solution that does not change over a certain number of trials is again randomly generated in the search space. These three steps are repeated the predefined number of times until a condition is satisfied.

The basic ABC was originally proposed for solving continuous numerical problems, but a lot of different variants of the ABC have been developed and applied to solve discrete and combinatorial types of problems (Karaboga et al., 2014). Some of these versions were applied to solve capacitated vehicle routing problem, the reliability redundancy allocation problem, different versions of scheduling problem, economic load dispatch problem and knapsack problem. In general, application areas of the ABC algorithm include neural networks, image processing, data mining, industrial, mechanical, electrical, electronics, control, civil and software engineering.

Specially, Akay and Karaboga modified the ABC algorithm in order to solve integer programming problems (Karaboga & Akay, 2009). In this variant of the ABC a new control parameter called modification rate (*MR*) is introduced in the search equation of the basic ABC. In order to increase the convergence rate of the ABC algorithm, the solution search equation is modified as follows:

$$v_{ij} = \begin{cases} x_{ij} + \varphi_{ij}\left(x_{ij} - x_{kj}\right), & \text{if } R_j \le MR \\ x_{ij}, & \text{otherwise} \end{cases} \qquad (4)$$

where φ_{ij} is a uniform random number in range (-1, 1), $x_k$represents the other solution selected randomly from the population, R_{ij} is a randomly chosen real number in range (0,1), and $j = 1,2...D$ (D is the number of optimization parameters). The introduced control parameter *MR* controls possible modifications of optimization parameters and it can take value between 0 and 1.

The proposed approach: MABC

The main components of each metaheuristic technique are exploitation and exploration (Črepinšek et al., 2013). The exploration refers to the ability to focus the search on different unknown areas in the solution space. The exploitation refers to the ability to to apply the knowledge of

the previously visited good solutions to discover better solutions. These abilities are fundamentally conflicting activities and a good ratio between them is of main significance for the success of a metaheuristic algorithm. Particularly, performance of the ABC algorithm adjusted for integer programming problems depends on its search equation described by Eq. (4) and the selection mechanism. Therefore the exploration and exploitation are interleaved in the employer and onlooker phases. Scout bee phase performs only exploration by randomly producing a new solution in the search space.

The search equation used in the ABC is a mutation operator. This operator is mostly seen as an exploration operator, since it modifies individuals with a given probability, and thus increases the structural diversity of a population. According to the solution search equation of ABC algorithm described by Eq. (4), the new potential solution is created by moving the old solution towards or away from other solution selected randomly from the population. The probability that the randomly selected solution is a quality solution is the same as that the randomly selected solution is not a promising one. There is no warranty that the new created solution will be a better solution than the previous one. Therefore the search equation described by Eq. (4) has good exploration ability, but it is not promising at exploitation. In order to improve the efficiency the ABC algorithm adjusted for integer programming problems, the MABC algorithm uses two different search equations with improved exploitation ability in the employed and bee phases.

In the employed phase, in order to generate a new candidate solution v_i by using the solution *xj*in the employed phase, the MABC uses different implementation of the Eq. (5) which is given as follows:

$$v_{ij} = \begin{cases} x_{ij} + \varphi_i \left(x_{ij} - x_{kj} \right), & \text{if } R_j \le MR \\ x_{ij}, & \text{otherwise} \end{cases} \qquad (5)$$

where $\varphi_i$is a uniform random number in range (-1, 1), $x_k$represents the other solution selected randomly from the population, R_{ij} is a randomly chosen real number in range (0,1), and $j = 1,2...D$.

From the Eq. (5) it can be noticed that the same random number is used for all dimensions. Comparing the Eq. (4) and Eq. (5), Eq. (5) has a

smaller search space due to the same random number being employed for all dimensions. The usage of the Eq. (5) has effective implications on the ABC performance. More precisely, differences among individuals of the population are reduced as a consequence of reducing the space where the newly created solution can be. Therefore this modification prevents the algorithm to provide too much exploration, and consequently increases exploration ability in the employed phase. This different implementation of the ABC search equation is previously successfully used in the employed bee phase with the intention improve its performance for constrained optimization problems (Brajevic, 2015).

In the onlooker phase, inspired by the variant of the ABC proposed to solve numerical optimization, gbest-guided artificial bee colony (GABC) algorithm (Zhu & Kwong, 2010), we modify the search equation described by Eq. (4) as follows:

$$v_{ij} = \begin{cases} x_{ij} + \varphi_{ij}\left(x_{ij} - x_{kj}\right) + \omega_{ij}\left(y_j - x_{kj}\right), & \text{if } R_j \le MR \\ x_{ij}, & \text{otherwise} \end{cases} \qquad (6)$$

where $\varphi_{ij}$is a uniform random number in range (-1, 1), $w_{ij}$is auniform random numbers in range (0, 1.5), $x_k$represents the other solution selected randomly from the population, y_j is the jth element of the global best solution, $R_{ij}$is a randomly chosen real number in range (0,1), and j = 1,2...D. According to Eq. (5), the third term can drive the new potential solution towards the global best solution. Hence, the modified search equation described by Eq. (6) can increase the exploitation in the onlooker phase.

Pseudo-code of the proposed MABC algorithm is presented below:

1: Initialize the population of solutions x_{ij}, i = ,...,SP/2, j = 1,..., D and evaluate it
2: cycle=1
3: **REPEAT**
4: Generate new solutions v_{ij} for the employed bees by using the Eq.(5), evaluate them and apply the greedy selection process
5: Calculate the probability values P_i for the solutions by the Eq.(3)

6: Generate new solutions v_{ij} for the onlooker bees from the solutions x_{ij} selected depending on P_i by using the Eq.(6), evaluate them and apply the greedy selection process
7: Generate a new solution from the abandoned solution , if exists, and replace it with a new randomly produced solution
8: Memorize the best solution achieved so far
9: cycle = cycle + 1
10: **UNTIL (**cycle=MCN)

It is important to mention that there is no the distinction of control parameters used in the MABC and ABC algorithms for integer programming problems, considering the fact that tuning the control parameters of an algorithm might be more difficult than the problem itself (Akay B., 2013). Both methods use the *SP* and *MCN*, which are common control parameters for all nature-inspired metaheuristic approaches. From the special control parameters, both algorithms use the *MR* and limit control parameters. In order to solve the integer programming problems, the MABC rounds the parameter values to the closest integer after evaluation according to Eq.(5) and Eq.(6). The solutions were also rounded after initialization phase and scout phase of the algorithm.

Benchmark problems

To test the performance of the MABC algorithm on integer programming problems nine problems widely used in the literature are employed (Karaboga & Akay, 2009). These problems are presented below:

Test Problem 1. This problem is defined by:
$F_1(x) = |x_1| + \ldots + |x_D|$,
with $x = (x_1, x_2, \ldots, x_D)$, where D is the dimension. The solution is $x_i^* = 0$, $i=1, 2, \ldots, D$. The global minimum is $F_1(x^*) = 0$.

Test Problem 2. This problem is defined by:

$$F_2(x) = x^T x = (x_1 \ldots x_D) \begin{pmatrix} x_1 \\ \vdots \\ x_D \end{pmatrix},$$

with $x = (x_1, x_2, \ldots, x_D)$, where D is the dimension. The solution is $x_i^* = 0$, $i=1, 2, \ldots, D$. The global minimum is $F_2(x^*) = 0$.

Test Problem 3. This problem is defined by:

$$F_3(x) = -(15 \quad 27 \quad 36 \quad 18 \quad 12)x + x^T \begin{pmatrix} 35 & -20 & -10 & 32 & -10 \\ -20 & 40 & -6 & -31 & 32 \\ -10 & -6 & 11 & -6 & -10 \\ 32 & -31 & -6 & 38 & -10 \\ -10 & 32 & -10 & -20 & 31 \end{pmatrix} x.$$

The best known solutions are $x^* = (0, 11, 22, 16, 6)$ or $x^* = (0, 12, 23, 17, 6)$ and $F_3(x^*) = -737$.

Test Problem 4. This problem is defined by:

$$F_4(x) = (9x_1^2 + 2x_2^2 - 11)^2 + (3x_1^2 + 4x_2^2 - 7)^2.$$

The global minimum is $F_4(x^*) = 0$ at $x^* = (1, 1)$.

Test Problem 5. This problem is defined by:

$$F_5(x) = (x_1 + 10x_2)^2 + 5(x_3 - x_4)^2 + (x_2 - 2x_3)^4 + 10(x_1 - x_4)^4.$$

The global minimum is $F_5(x^*) = 0$ at $x^* = (0, 0, 0, 0)$.

Test Problem 6. This problem is defined by:

$$F_6(x) = 2x_1^2 + 3x_2^2 + 4x_1x_2 - 6x_1 - 3x_2.$$

The global minimum is $F_6(x^*) = -6$ at $x^* = (2, -1)$.

Test Problem 7. This problem is defined by:

$$F_7(x) = 3803.84 \quad 138.08x_1 - 232.92x_2 + 123.08x_1^2 + 203.64x_2^2 + 182.25x_1x_2.$$

The global minimum is $F_7(x^*) = -3833.12$ at $x^* = (0, 1)$.

Test Problem 8. This problem is defined by:

$$F_8(x) = \left(x_1^2 + x_2 - 11\right)^2 + \left(x_1 + x_2^2 - 7\right)^2.$$

The global minimum is $F_8(x^*) = 0$ at $x^* = (3, 2)$.

Test Problem 9. This problem is defined by:

$$F_9(x) = 100\left(x_2 - x_1^2\right)^2 + (1 - x_1)^2.$$

The global minimum is $F_8(x^*) = 0$ at $x^* = (1, 1)$.

For each test problem the solutions were constrained in $[-100, 100]^D$, where D is the dimension of the corresponding problem.

Experiments and results

The evaluation of the proposed MABC is presented in this section. Two types of comparisons were investigated in the experiments. First type of comparison is a direct comparison, where the ABC adjusted for integer programming problems and the MABC were implemented and their corresponding performances are examined. Both algorithms were implemented in Java programming language on a PC with Intel(R) Core(TM) i5-4460 3.2GHz processor with 16GB of RAM and Windows 10 x64 Pro operating system. Second type of comparison is an indirect comparison, where the results of other metaheuristic algorithms were taken from the specialized literature and compared with those reached by the MABC.

Two metrics are employed to evaluate the performances of the MABC and other metaheuristic approaches. The metric AVEN is used to compare the convergence speed of each algorithm (Liang et al., 2017). AVEN represents the average number of function evaluations needed to obtain the optimal value. If the value of AVEN is smaller, the convergence speed is faster. The metric success rate (SR) is employed to compare the robustness or reliability of each algorithm. This rate denotes the ratio of successful runs in the total number of independent runs. In this paper it is assumed that a successful run means the algorithm reaches a solution whose objective function value is equal to the optimal value. The algorithm is more robust if the value of SR is greater.

In a direct comparison of the ABC and MABC, in all experiments for both algorithms the SP of 50 and the same MCN of 1000 is used. Therefore, for each test problem, the maximal number of function evaluations (MaxNFEs) used is 50000. The ABC algorithm uses the same specific parameter settings as those suggested in (Karaboga & Akay, 2009). These values are the following: *MR* parameter is 0.8 and *limit* parameter is *2.5 * SP * D*. The specific parameter values used by the MABC algorithm are the following: *MR* is 0.8 and *limit* is 50. Each of the experiments was repeated for 50 runs and the algorithms are terminated when optimal solution is reached. The SR and AVEN results of the ABC and MABC for the benchmark problems P1-P9 are given in Table 1. Best results are indicated in bold.

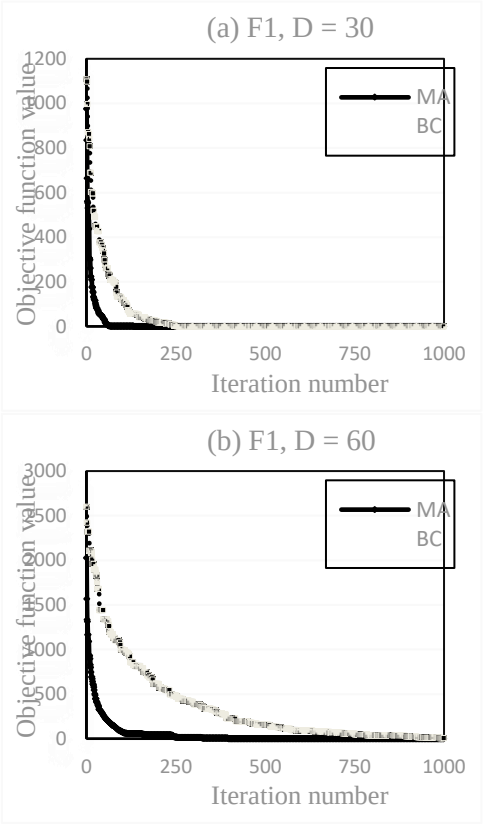
Table 1: *The SR and AVEN of the ABC and MABC algorithms for nine benchmark problems, NA: not available*

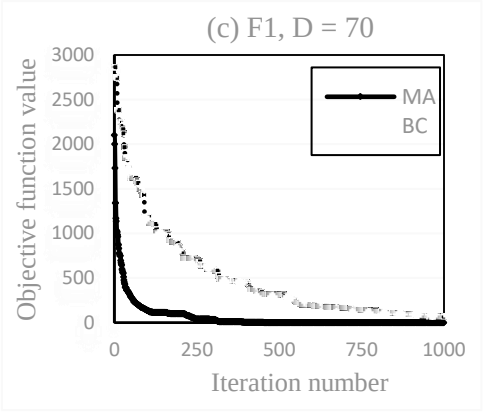
		ABC		MABC	
Prob.	D	SR	AVEN	SR	AVEN
F1	5	**100%**	1256	**100%**	**713**
	10	**100%**	2950	**100%**	**1374**
	20	**100%**	7072	**100%**	**3561**
	30	**100%**	13245	**100%**	**6956**
	40	**100%**	21879	**100%**	**11334**
	50	**100%**	34818	**100%**	**16276**
	60	12%	49241.5	**100%**	**20562**
	70	0%	NA	**100%**	**24349**
F2	5	**100%**	1612	**100%**	**787**
	10	**100%**	3971	**100%**	**1639**
	20	**100%**	10447	**100%**	**5116**
	30	**100%**	21169	**100%**	**9821**
	40	**100%**	37854	**100%**	**13505**
	50	0%	NA	**100%**	**19338**
	60	0%	NA	**100%**	**24914**
	70	0%	NA	**100%**	**31020**
F3	5	**100%**	15555	**100%**	**3368**
F4	2	**100%**	375	**100%**	**190**
F5	4	**100%**	6039	**100%**	**1433**
F6	2	**100%**	339	**100%**	**232**
F7	2	**100%**	431	**100%**	**308**
F8	2	**100%**	648	**100%**	**498**
F9	2	**100%**	1121	**100%**	**831**

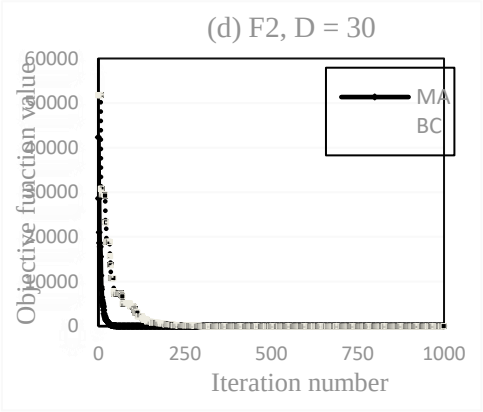
The SR results show that the MABC is more reliable with a 100% success rate on all benchmark problems. Specially, for higher dimensions of the F1 and P2 problems, the MABC algorithm obtains much better results than ABC algorithm. In the case of the benchmark F1 with D = 60 and D = 70, the success rate of the MABC was 100%, while the SR results of the ABC were only 12% and 0% respectively. Also, in the case of the problem F2 with D = 50 and higher, the ABC algorithm was not able to find the optimal solution in allowed maximum number of function evaluations in none of the runs. On the other hand, in these test cases the SR results of the MABC were 100%. From the AVEN results it can be

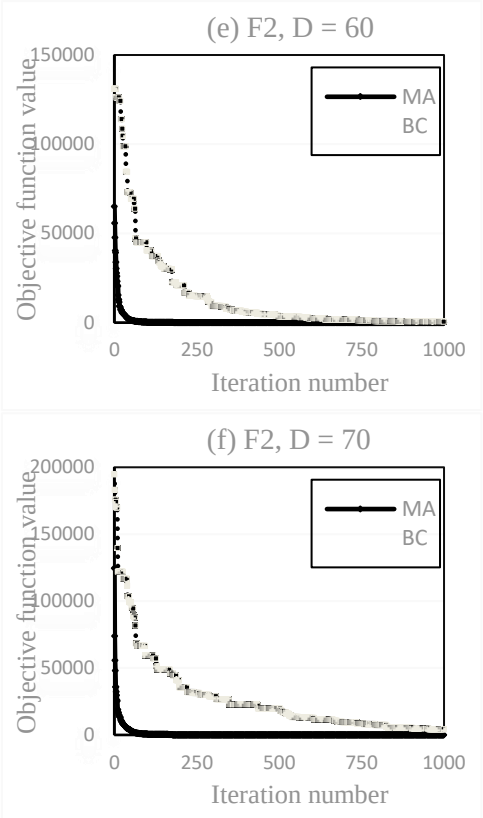
seen that the MABC shows faster convergence speed than the ABC in all test problems.

Figure 1: *The convergence graphs of the mean results obtained by the MABC and ABC algorithms for benchmark problems F1 and F2 in 30, 60 and 70 dimensions.*




(c) F1, D = 70
Objective function value
3000
2500
2000
1500
1000
500
0
0
250
500
750
1000
Iteration number
MA
BC


(d) F2, D = 30
Objective function value
0
Iteration number
MA
BC



The convergence graphs of the mean results obtained by the MABC and ABC algorithms for problems F1 and F2 with D = 30, 60 and 70 are presented in Figure 1. As it can be seen in Figure 1, the convergence speed in the MABC is much faster than the ABC algorithm. Also, by the increase in dimension, the performance of the ABC significantly deteriorates, whilethe MABC preserves its reliability. Hence, it can be concluded that the MABC is able to significantly improve robustness and convergence speed with respect to the ABC.

In order to further show the superiority of the proposed approach, an indirect comparison between the MABC algorithm and six other metaheuristic algorithms is provided. The approaches included in comparison with the MABC are: DE, BBO, self-adaptive DE (SDE) and three relatively new BBO-based methods, named BlendBBO, BBO DE, and LBBO LDE. The results obtained by these six algorithms were taken from (Wang & Wu, 2014). Since in (Wang & Wu, 2014) only the first seven benchmark problems were solved by these approaches, the

comparison will only be made on such test functions. Each of the compared metaheuristic algorithms used the size of population 50 to solve these benchmarks. The specific parameter settings of the DE, BBO, SDE, BlendBBO, BBO DE, and LBBO algorithms can be found in (Wang & Wu, 2014).

The SR and AVEN of these algorithms for the first seven test problems (F1 in 10 and 30 dimensions, F2 in 5 dimensions and F3- F7) are presented in Tables 2, 3, 4 and 5. Best results are indicated in bold.

From the SR results presented in Tables 2, 3, 4 and 5 it can be noticed that the MABC obtained the same or better results with respect to each algorithm on all test problems.

Table 2: *The SR and AVEN of the algorithms on F1 in 10 and 30 dimensions, NA: not available*

	F1 (D=10)		F1 (D=30)	
Method	SR	AVEN	SR	AVEN
BBO	0%	NA	0%	NA
BlendBBO	20%	2080.50	0%	NA
DE	**100%**	3777.50	0%	NA
SDE	**100%**	3762.40	85%	9301.00
BBO_DE	**100%**	3674.80	90%	8204.25
LBBO _LDE	**100%**	2493.75	**100%**	**6471.60**
MABC	**100%**	**1374**	100%	6956

Table 3**:** *The SR and AVEN of the algorithms on F2 in 5 dimensions and F3, NA: not available*

	F2 (D=5)		F3	
Method	SR	AVEN	SR	AVEN
BBO	10%	4415.50	0%	NA
BlendBBO	55%	1363.36	0%	NA
DE	95%	1797.37	**100%**	2490.00
SDE	100%	2022.35	**100%**	3260.00
BBO_DE	100%	2336.65	**10%**	5028.00
LBBO _LDE	100%	1451.20	**100%**	2958.85
MABC	100%	**787**	**100%**	**3368**

Table 4: *The SR and AVEN of the algorithms on F4 and F5, NA: not available*

	F4		F5	
Method	SR	AVEN	SR	AVEN
BBO	75%	1726.87	0%	NA
BlendBBO	**100%**	424.50	25%	1842
DE	**100%**	420.00	**100%**	1445.00
SDE	**100%**	520.00	**100%**	1550.50
BBO_DE	10%	632.30	**100%**	3681.25
LBBO _LDE	**100%**	400.60	**100%**	1532.35
MABC	**100%**	**190**	**100%**	**1433**

Table 5: *The SR and AVEN of the algorithms on F6 and F7*

	F6		F7	
Method	SR	AVEN	SR	AVEN
BBO	45%	1150.22	60%	1714.75
BlendBBO	80%	455.81	70%	459.50
DE	**100%**	392.50	**100%**	480.00
SDE	**100%**	405.20	**100%**	451.00
BBO_DE	**100%**	708.50	**100%**	978.40
LBBO _LDE	**100%**	410.05	**100%**	389.45
MABC	**100%**	**232**	**100%**	**308**

When comparing the AVEN results obtained by the MABC with respect to the same of the remaining six algorithms, from the Table 2 it can be seen that the MABC outperformed each algorithm on the problem F1 with D = 10 and D = 30. The only exception is the problem F1 with D = 30 where the MABC obtained slightly worse AVEN result in comparison with the LBBO_LDE. If we compare the AVEN results achieved by the MABC with respect to the same of the remaining six algorithms, from Tables 3, 4 and 5 it can be seen that the MABC outperformed each algorithm on the remaining six benchmark problems. Hence it can be concluded that the MABC shows the same or better robustness with faster convergence speed with respect to the BBO, BlendBBO, DE, SDE, BBO_DE and LBBO_LDE on majority of benchmark problems.

Conclusion

In this paper, a modified artificial bee colony (MABC) algorithm for solving integer programming problems is presented. In order to enhance the exploitation ability of the ABC algorithms two modified search operators are used in employed and onlooker phases. The performance of the proposed algorithm was investigated on the set of nine integer programming problems frequently used in the literature. The MABC obtained a better performance than the ABC adjusted for integer programming problems and six other state-of-the-art algorithms with respect to the convergence speed and robustness. Considering the fact that most combinatorial problems can be converted to integer programming problems, this research indicates that the MABC can be adapted to effectively solve other kinds of combinatorial optimization problems, such as production planning and scheduling problems.

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DEVELOPING AN INNOVATION CULTURE

Nebojša Pavlović[1]

Abstract

Innovations are paramount for the economy inasmuch as the company is worth as much as its ability to be innovative.The aim of this paper is to analyze the transformation of the organizational culture into the innovation culture. By analyzing the available sources, the author sheds light on some of the ways a company's culture can adjust to its needs for innovations.Furthermore, the results show that this will happen when the management changes the existing organizational culture and, thus, enables the development of the innovation culture. However, it should be noted that this is a long and arduous process. It is of paramount importance that the managers are skilled as they need to notice and support innovative demands in their environment.Lastly, a lot of attention will be devoted to enhancing and maintaining innovation culture in the future. This means that the researchers will need to go great lengths in order to shed light on this field.

Key words:*innovations, innovative culture, changes of organizational culture*
JEL classification:*O3, M14*

Introduction

Some of the characteristics of the traditional way of conducting business are the long periods of stability and short periods of changes in a company. A company needs to respond to this in a timely manner and without substantial investments. Today's changes are produced rapidly and abruptly. Apart from that, they require constant investments. That being said, the main reason for these investments is to gain and maintain advantage. Because of this, the aim of all managers is to form a stable company which, although resisting them, is able to create the changes on its own. The ultimate goal is to generate profit and ensure success in the business world.

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A company ensures its stability and survival by investing in its progress and development. Even though the managers play a crucial role as they direct the development of a company, it goes without saying that the employees provide excellent foundation. By building a stable basis, i.e. foundation of a company, the importance is placed on the advancement of the employees.

A company will feel positive effects if its employees are willing to constantly learn, improve and progress. If the management adopts this then the traditional, organizational culture will be replaced with the modern, innovation culture in a company (Pavlovic, 2012).

Organizational culture

There is a myriad of definitions and ways of inferring the term "culture". Therefore, because of this, there are numerous types of culture. The culture is commonly associated with nations, religion, industries (e.g. agriculture), and with a company. It serves as an important connection between the members of a particular community inasmuch as that group of people is assigned with significant characteristics (Ružičić, 2012).

Although there are numerous definitions of culture, it is not possible to provide a general one because its definition depends on understanding or criteria set for evaluating activities of a particular group of people. However, we can highlight one of the oldest definitions of this term given by Edward Tylor Burnett. According to him, culture is a complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man (Burnett, 1871).

The last few decades are unique because of the growth in the number of companies and the emergence of multinational organizations. This has brought about the development of the term organizational culture.

Organizational culture is an extremely important means for understanding the behavior of employees because it is made up of psychology, management, anthropology, and sociology.
The skillfulness and employees' understanding of their job, interpersonal relations, and business, all depend on how much the organizational culture is present and important in a company. Therefore, a company's

business has its basis in the organizational culture which presents the experience of that company. In other words, organizational culture is a social phenomenon because it is based on the social interactions. This is why it is unique for every organization (company). Also, it provides a feeling of order and security to the employees because it makes sense of every action and event in a company (Janićijević, 2012).

One of the definitions of the organizational culture adopted by many authors is the one given by Edgar Schein. According to him, organizational culture is a pattern of shared basic assumptions that the employees learned as they solved their problems of external and internal nature, that has worked well enough to be considered valid and, therefore, binding to all the employees as the correct way to perceive, think, and feel in relation to those problems (Schein, 2010).

Organizational culture is a key part of every company. It has a two-way relationship with all the "hard" and "soft" components of an organization. Thus, together they exert influence on the organizational performances. The term culture in a company has been connected to the structure of an organization in recent papers. The term "structure" is derived from a Latin word *structura* which can be roughly translated as building, putting together, and assembling. Based on this, the organizational structure is the process of putting the organizational elements together by following company's rules. This is the basic and the most important task of the management (Ružičić, 2012). In other words, the organizational culture has a two-way relation of mutual influence with the organizational structure.

As previously mentioned, the organizational culture and structure exert influence on each other. The organizational culture has a significant impact on the choice and implementation of organizational structure. Also, the implementation of a new organizational structure can exert impact on the organizational culture which means that it will either be changed or strengthened.

Aside from the organizational structure, the "hard" component of the organization is strategy. Strategy is defined as a mutual decision that establishes the goal of a company and sets out the rules which will enable those goals to be achieved. It plays a key role as it helps in determining

the way in which a company should gain advantage. Furthermore, it provides resources and establishes the area of activity.

The organizational culture has a big impact on the strategy and vice versa. The culture impacts the choice of the strategy during its formulation, implementation, and realization.

Therefore, the organizational culture represents the employees' behavior and modus operandi in an organization. They need to be in accordance with the norms and rules. It consists of (Schein, 2010; Janićijević, 2012, Stevanović, 2017) cognitive elements including assumptions (they refer to the employees' knowledge and experience in regards to the way a company functions, operates and develops interpersonal relations), values (they refer to a state in which the employees want their company to be), and beliefs (a set of beliefs the employees have in regards to the way their company operates). They are difficult to change because the employees are not aware of them and they accept them as an integral part of their personality.

- Symbolic elements refer to all the elements in a company that are of some importance to its employees. They can be material or non-material in nature. We have here: fixed behavior, language's uniqueness, company's logo, appearance of the official documentation, interior and exterior of a company, employee's dress code, etc. These elements are easy to change.

The principle of the organizational culture builds up a considerable pressure and creates a negative work environment where the employees are exposed to stress, fear, and are not willing to risk (Rou, 2008). The employees are not willing to risk and voice their new ideas because of the belief that this will exert a negative influence on their career and interpersonal relations.

Innovation culture

The term "innovation" was introduced by J. Schumpeter who defined it as being a primary factor in technological progress and economic growth. In other words, innovation is the implementation of an idea, invention or discovery. It consists of theoretical concept, technical invention, and commercial exploitation with a view to transforming an idea into practice (Schumpeter, 2000).

In etymology, the term "innovation" is derived form a Latin word *innovare* which can be translated as "making something new". It can refer to a product, service, or the process of coming up with an idea and then executing it (Stevenson, 2010).

There is a vast number of definitions of the term innovation. However, they are largely based on Schumpeter's definition. Apart from that, Peter Ducker stated that innovation is a key element of entrepreneurship (Drucker, 1985). However, according to Porter and Stern, a company gains advantage on the market due to the innovations (Porter & Stern, 2001).

OECD standard (Oslo Manual) (Development, 1997) concludes that innovation is a successful invention, i.e. the use of a new or significantly improved product, service, marketing method or new organizational method in business, work, or relations.

Also, innovation can be defined as an intentional introduction or implementation of ideas, processes and procedures which are relevant and important for the wellbeing of the individuals, groups, organizations, or society in general (West & Altink, 1996).
According to Rothwell, there are two types of innovations (Rothwell, 1992):

- Radical innovations – major developments according to the current state of technology
- Incremental innovations – small technological changes based on the model *know-how*.

Innovations can be divided according to the degree of development (Panuwatwanich et al., 2008):

1. Inventiveness– a company wants innovative leadership;
2. Adaptability– a company enables others to lead, however, it quickly adapts or changes a product;
3. Economic – the products (or the same product that another company is making) are produced with low costs;
4. Innovative application– a company uses the existing technology in new ways.

The most important innovations for every company are those of a product, service, or process, while innovations in management refer to the process of creating new business and reorganizing the industry (Schumpeter, 2010).

According to OECD and Eurostat in the book Oslo Manual (Development, 1997), there are five types of innovations:

1. Product innovations – they refer to the implementation of a product and/or service that is completely new or significantly improved. In this case, two different types of innovations are brought to the attention: essential product innovations (new technology or a combination of new technologies with an eye to creating a new product and/or service) and incremental product innovations (a product or service which has better characteristics). The new innovations are introduced because of the competition and their advantages (enhancing or changing the company's direction, improving the reputation of both the company and its product, a good impact on the employees). Depending on the type of the innovative product or service there are new products (new on the market and in the company), new production lines (the product is new for a company, but not on the market). Apart from that, the advantages are the increase in existing lines, improvement of products, the decrease in costs, and repositioning (a new use for an existing product).
2. Service innovations are specific because of their unique, changing, unpredictable nature. This is known as coherence between the creation and use of services. The creation of this type of innovations depends on the employees' knowledge and skills. One of the disadvantages is the weak protection of the intellectual property and, because of this, a lot of company decides to provide "back-office" service.
3. Process innovations means that the existing processes are changed and improved or that the new ones are implemented. The following changes belong here: changes in technology, equipment, software, and work in order to create a new product or better the quality of the existing one. The goal of this innovation is to increase efficiency and effectiveness of the production process. Every process innovation goes through four stages (Abernathy & Utterback, 1978):

- Fluid phase (also knows as the flexible phase because the marker is not set, the production process is not determined which leads to flexibility. In this phase, the attention is dedicated to product innovation),
- Transitional phase (the process of moving from the product innovation to process innovation),
- Speficif phase (process innovations are of paramount importance here),
- Mature phase (here one must be careful when optimizing the process in regards to its cost. Also, it is important to enhance its efficiency while keeping the same or increasing the product quality).

4. Organizational innovations introduce new organizational methods in business practice which will include the internal and external relations. The goal of this implementation is to achieve good business practices by introducing new methods for workplace organization. Also, the implementation puts the emphasis on the external companies and improves the relations with clients and business partners in order to improve the company's reputation.
5. Marketing innovations introduce new marketing methods in order to generate a bigger profit. These innovations consist of methods which refer to market research (e.g. implementation of new methods and channels of sale). When it comes to the methods which refer to the product, it is important to mention the change in product design (e.g. a bottle is changed, however, all the characteristics remain), product promotion and pricing.

Apart from the above mentioned types of innovations, the term eco-innovations emerged in the late 90s. This term was defined by Fussler and James who said that eco-innovation is the process of developing new products, processes or services which provide customer and business value, but significantly decrease environmental impact (Fussler & James, 2004). The European Commission has broadened the definition. Namely, the European Commission says that eco-innovation is any innovation resulting in significant progress towards the goal of sustainable development, by reducing the impacts of our production modes on the environment, enhancing nature's resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources (Commision).

Also, product packaging can be in accordance with the ecological norms which means that a package is biodegradable or that its production does not exert negative influence on the environment. This packaging is called green (eco) design, while the product is deemed “green (bio) product”.

The types of ecological innovations are (Commission):

1. Ecologically motivated innovations which are formed with a view to improving the environment;
2. Ecological gain of the innovation is directed towards creating new products and services while taking ecology into account.

Like the other innovations, the eco-innovations have their goal, mechanism and impact. The goal is reflected in its desired conclusion which may or may not be technological in nature, whereas the mechanism refers to the introduction of this type of innovation according to the rules of ecology. The impact of the ecological innovations includes the innovation effect visible in the environment, i.e. the interaction between the innovation and all factors of the environment.

There is a large number of definitions of the innovation culture. Gandotra (Gandotra, 2010) has given a general definition which can be used in everyday life and, thus, innovation culture creates innovations in our lives. Innovation culture consists of innovation mechanisms. These mechanisms are composed of the processes of defining and developing new products and promoting them on the market with a view to creating changes (Bordia et al., 2005).

According to Langdon (2011), innovation culture in an organization emerges when, thanks to their activities, the employees are deemed as being: creative geniuses, innovation leaders, and innovation champions.
Innovation genius applies the know-how method on his ideas. With the help of his knowledge and skills he successfully creates acceptable and lucrative innovations. On the other hand, innovation champion gives depth to the business practice which enables innovation genius to bring his innovations to life. In this way, he will eliminate all the threats and bad ideas which can exert a negative influence on that innovation. Because of this, there is a clear path for the creation and development of innovation culture. Similarly, innovation leader oversees and leads the development of innovation culture and implementation of the innovation

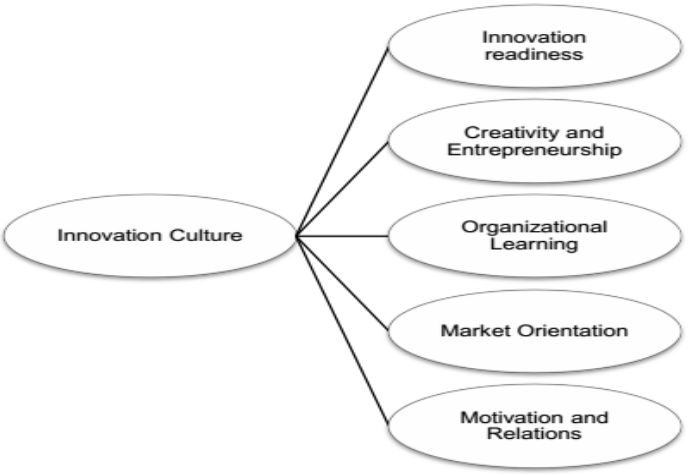
while defining the rules. His task is to notice and remove all the obstacles (Morris, 2007).

Innovation culture consists of five basic parts (Kasper & Clohesy, 2008):

- The strategy needed in order to support innovations;
- The process of identifying the problems and opportunities which are ought to be improved or changed;
- The overview of all innovations, i.e. of all ideas which are necessary in order to overcome the existing issues;
- The explanation of the innovations and assessment of their validity;
- The divison of the innovations.

A vast number of issues lead the companies to accept and face the changes if they want to keep their business. This encourages them to implement innovations not only internally, but externally as well (Alm & Jönsson, 2014). The company needs to select the model of innovation culture (Table 1) and develop and enhance it. Apart from that, the company needs to use it in accordance with its business practice (Gassmann & Enkel, 2004).

Figure 1: *The model of innovation culture*



Source: *Ismail, W. K. W., Abdmajid, R (2007). Framework of the culture of innovation: A revisit. Jurnal Kemanusiaan*

One of the models of innovation culture can be seen on Table 1. Its basic parts are (Ismail & Abdmajid, 2007):

- Innovation readiness – it points to the degree of company's development, i.e. its willingness to accept innovations and introduce them. It is reflected in the propensity of the employees for innovations as they want to achieve goals and missions, solve tasks and issues, etc. Also, the implementation of innovations is paramount as it refers to the way different innovations are implemented. Apart from this, an important characteristic of an organization is its flexibility during the implementation process (Dobni, 2008).
- Creativity and entrepreneurship – These are the two important parts of innovation culture. There is a different between the terms creativity and innovation, inasmuch as innovation can be defined as a successful implementation of creativity, i.e. creative ideas in a company (Amabile, 1988). There are two types of creativity – individual and organizational. Individual arises as a consequence of the ability, motivation and skills of an individual and they need to be congruent with self-discipline, independence and persistence (Alm & Jönsson, 2014). Creativity at the organizational level depends on the skills of management, organizational motivation and financial resources. If this creativity pervades a company, then a positive work environment is created where freedom of thought, trust and openness is established between the employees.

  According to Schumpeter (2010), an entrepreneur is a person who has abilities, knowledge and skills to transform an idea into innovation. However, according to Amabile (1988), entrepreneurship is defined as a successful implementation of a creative idea in order to form new business or improve the existing one.
- Organizational learning is paramount not only for the managers but for their employees. This means that a manager is expected to support his employees while they are going through the process of learning and improving. The professional development ought to teach the employees how to implement the knowledge, develop new innovations and strategies of innovation culture.
- Market orientation refers to the process of devoting ones attention to new ideas and motivations. Also, it can refer to the readiness to accept changes imposed by the employees, market, clients or business partners. This part of innovation culture is closely connected with research and development whose main goal is to

find new ideas, analyze them, check their profitability, and suggest their implementation.

- Motivation and relations is an important characteristic of an organization which draws heavily on motivation, communication, and collaboration of employees in a company. It differs from the rest in that in determines the way a company conducts its business. Also, it establishes interpersonal relations between employees and business partners (Alm & Jönsson, 2014).

The characteristics which make up the innovation culture of an organization are (Losane, 2013):

- Values – freedom of speech, taking risks, trust and openness between employees and business partners, creativity, flexibility, constant development, advancement and learning.
- Strategy – The aim of a strategy is connected with the employee and manager's innovation. The employees ought to have a good relationship with their clients. The employees want to improve the business, achieve goals, and provide stability.
- Structure – team work with a view to establishing good communication and interaction. Structure needs to be founded on autonomy, transparency and flexibility.
- Behavior and communication – good working environment where employees are supporting each other. This support is built on tolerance, trust, openness for new ideas. It is also built on the ability of the employees to accept new innovations and implement them.
- Leadership – it is an important characteristic of both an organization and individual who is capable of taking risks, accepting changes, managing teams and leading them during the process of implementing innovations.

If a company or organization has this model, i.e. approach to innovation culture, then it will try to be innovative and set its goals, visions, and missions. It is important for a company to be flexible when it comes to changes and innovations, and have an infrastructure which can support this. This type of culture is possible only if creativity of the employees is nurtured. Also, by constantly teaching and improving the employees, it is possible to create innovation culture where a manager's support plays a key role. Aside from this, the important task of a manager is to understand the needs of the market, his business partners, and clients. It is paramount

for him to encourage his employees to accept his suggestions. And, most importantly, he needs to constantly motivate his employees as this will lead to the increase in valuable innovations and it will bring about positive working environment.

The transformation of organizational culture into innovation culture

The changes in an organization mean that a new environment will be established in which everyone will aspire to innovation and creativity (Stevanović, 2017). Organizational culture is created by using the experience of the employees, thus, it is not easy to change it.

The key behind the successful business lies in its introduction of innovation culture which enables flexibility, knowledge, creativity and innovation. Also, if a company wants to be successful, it needs to gain advantage on the market. By gaining advantage, a company needs to remove hierarchy and bureaucracy and pay closer attention to its employees. The management needs to consider the employees' ideas, hire skilled workers and invest in their training. Also, the development of creativity and innovation means that a company needs to secure rewards for the employees. The desire to learn, improve and dedicate themselves to their work is brought about when the employees believe in their job and position.

An organization needs to develop innovation culture which defines the present as the time for changes and challenges. Those challenges need to be perceived as chances not threats (Watkins et al., 2015).

Learning is necessary in every company. The development of the employees' potential is conditioned by the constant process of learning. Therefore, there are numerous ways of learning; however, it is crucial to know how to manage the knowledge. This means that one needs to gather the necessary knowledge and distribute it accordingly.

"The modern organization requires the learning culture. In this culture, the constant development and learning become an obligation. The development needs to be dynamic and constant, whereas learning needs to be perceived as a lifelong process" (Bahtijarević-Šiber, 1999).

A new organization ought to learn how to live with changes. Therefore, it needs to invest in knowledge and education of its employees through various programs, trainings, and courses which will allow them to gain and improve their skills and knowledge. Not only is this important for management but also for every employee. A successful management has a group of skilled employees who are willing to improve themselves. There are many instances in which employees undergo certain courses so that they can increase their productivity (Premovic, 2010).

The key difference between the traditional, organizational and modern, innovation culture is the way they solve problems and tasks. The traditional culture directs its employees towards an effective way of solving the tasks and issues. However, the principle of solving issues and tasks by creating new ideas is unique for innovation culture. This means that the employees are expected to express their views and voice their opinions. Furthermore, in innovation culture, the issues are solved by implementing scientific methods, learning from your own experience, and transferring knowledge between employees (Premovic, 2010).

The change from organizational to innovation culture is important if one wants to gain advantage on the market. It goes without saying that it takes time for a person to gain knowledge and skills in order to perform a job. A company gains advantage due to the knowledge of its employees. Human capital (experience, ability, creativity, know-how) owned by a company becomes its intellectual property (projects, programs, data, innovations, processes, and good practice). This will lead to new products, patents, and services (Premovic, 2010).

Furthermore, Krstić and Sekulić state that an effective strategy can create knowledge which can be transformed into profitable market value. The only way to gain advantage is to constantly come up with new ideas and implement innovations. The innovations have become crucial for organizational performances (Krstić & Sekulić, 2007).

Moreover, according to Levi-Jakšić et al. “the management needs to be able to create a favorable environment for the development of innovations. Apart from that, the management needs to value and reward its employees. This will create a suitable innovation culture and climate. Innovation culture is characterized by the belief in innovations and ideas,

market orientation, teamwork, loyalty, readiness to take risks and the feeling of responsibility“ (Levi-Jakšić et al., 2005, 245).

Innovation and creativity are developed by having the below (Levi-Jakšić et al., 2005):

- Free time for creativity,
- Cross-functional teams,
- Creative centers,
- Efficient anarchy,
- Trainings,
- Open communication.

By developing innovation culture, a company encourages its employees to adopt an adventurous spirit and share their ideas freely. This means that the services provided to the clients will be improved. Also, a company will generate a bigger profit by selling the products and services. By creating a positive working environment where the employees' opinions are valued and by rewarding them for their ideas, the turnover will be decreased.

The transformation from organizational into innovation culture needs to encompass every sector of the company. This means that a company is required to reduce the fear of changes, increase the employee's acceptance and willingness to take risks. It should be emphasized that not all employees need to be innovative. However, it is paramount for them to realize the importance of innovations and participate in them. The management plays a key role here – they need to encourage the employees to improve and accept their suggestions. It is important to implement model of innovation and organizational structure.

This model consists of (Ružičić, 2012):

- Operational part where executive jobs are carried out and products are advertised. It is a main source of profit.
- Innovation part which finishes the tasks relating to innovation and this is the source of costs and it is important to invest in its activity.

The innovation culture increases interaction, discussion and debates among the employees. Everything is based on trust, cooperation and security. The managers are positive; they pay attention to their employees

and are open for their ideas. By establishing this type of working environment, a company can respond to external changes, challenges and demands while their employees will not be exposed to negative pressure. They will have a positive attitude towards changes and innovations (Stevanović, 2017).

The mere existence of a company on the market depends on the clients and their demands, products and their endurance. It also depends on technology. In order for the company to meet the set criteria and continue to conduct its business, it is paramount to form a department which will pay attention to the processes of innovation (Pavlovic, 2017). They should also have innovation management. The department would devote its time to research and development, production and marketing. Aside from this, creative individuals also impact the process and development of innovation. They, using their knowledge and creativity, suggest their own ideas and work hard to implement them.

Conclusion

The modern way of conducting business brings about numerous changes which the employees need to accept. The management is aware that, if they want to gain advantage, they need to introduce radical changes. In other words, it is important to implement innovation culture which makes it possible for a company to respond to all the demands and changes.

The transformation from organizational culture to innovation needs to include all sectors which means that a company is required to encourage the employees not to be afraid of the changes, but to accept them and take risks.

Innovation culture brings about flexibility, knowledge, creativity and innovation which means that a company will be deemed a worthy competitor. This culture will remove hierarchy and bureaucracy while a manager will show interest in the employees' ideas. The increase in the degree of creativity which is achieved by using material and non-material rewards will lead to the creation of innovation culture. Thus, because of this, a company will prosper.

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THE IMPORTANCE OF THE ORGANIZATIONAL LEARNING'S DIMENSIONS ON THE ABILITY OF INNOVATION IN THE ORGANIZATION

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Abstract

Today's organizations operate in an extremely dynamic and turbulent environment. Accordingly, adapting to various changes and constant efforts on improving performance is something that is implied and is the basic condition for survival and development of the organization. Therefore, organizational learning becomes an important factor that has an impact on innovation and innovation capability in the organization. The aim of the paper is to define the importance of the dimensions of organizational learning on the ability to innovate in the organization. To determine the importance of the dimensions of organizational learning on innovation in the IT industry, the newly developed Pivot Pairwise Relative Criteria Importance Assessment Method (PIPRECIA) method was used.

Keywords*: Organizational learning, dimensions, MCDM, PIPRECIA, IT industry*
JEL classification: *D81, D83, O30*

Introduction

Organizations are increasingly confronted with the question of how to respond to changes caused by the globalization process. Therefore, modern organizations main focus is on the development of a strong culture of organizational learning in order to achieve competitive advantages.

The global business environment is changing rapidly. A strategic response to these challenges caused by changes in the global business

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environment can only be the development of an economy based on innovation, knowledge and educated people (Frynas & Mellahi, 2015). Innovation is generally accepted as a key factor in the competitiveness of nations and organizations. Importance of innovation is even more pronounced thanks to modern processes such as: increased global competitiveness, shortening of product life cycle, increasing technological capability, and increasingly changing customers' demands.

Different authors differently approach the definition of the term of innovation, so that Cvetanović and Novaković (2014) state that "Innovation represents the improvement of products or processes, which significantly influence the improvement of the quality of the economic performance of the company". Drucker (1984) has defined innovation as "the useful information that offers the employees who work at a firm together and have different knowledge and capability with an opportunity for the first time to make them productive". Pasher & Ronen (2011) expresses the view that Innovations are focused on shortening the time of realization of the production process, accelerating the development of new products and creating new organizational structures.

Pullen et al. (2009) distinguish the basic types of innovation as incremental and radical. In doing so, organizational, resource and technological prerequisites for the creation of one and the other are completely different. Incremental innovations imply continuous improvement of existing products and processes, while radical innovation implies the replacement of the same with completely new forms.

It is also important to note that organizations that are dedicated to the organizational learning have a much higher chance of developing innovation capacity in relation to the competition (Damanpour, 1991). Therefore, organizational learning is closely related to the innovation capacity of an organization. Some of the most innovative organizations have effective systems of organizational learning (Kiziloglu, 2015; Tushman & Nadler, 1986).

Therefore, the aim of the paper is to define the importance of the dimensions of organizational learning on the ability to innovate in the organization. To determine the importance of the dimensions of organizational learning on innovation in the IT industry, the newly developed Pivot Pairwise Relative Criteria Importance Assessment

Method (PIPRECIA) method was used. Accordingly, paper is structured as follows: In section 1 introductory considerations are presented; Literature review with the theoretical background of organizational learning and multiple-criteria decision-making methods is presented in Section 2; computational procedure of the PIPRECIA method is presented in Section 3 whereas Section 4 presents the numerical example. Finally, at the end of the manuscript conclusions are given.

Literature review

Theoretical background of organizational learning

Organizational learning is a relatively new concept, and as such is often placed within the framework of existing theories and considered as part of the strategic management, sociology of organization and psychology of the organization. However, none of the existing disciplines has fully managed to explain organizational learning. Also, it is noticeable that there is no single definition of the concept of organizational learning, which conditioned the existence of numerous different perceptions about the very concept of organizational learning.

Janićijević (2006) states that a part of the authors and theoreticians argues that organizational knowledge can not exist because there is no knowledge beyond individuals and their minds. However, others argue that the processes in the organization, structures, systems and work technologies that exist in organizations, independent of its employees, are a direct evidence of the existence of organizational learning, that is, i.e. that there is a learning organization that is learning and developing. These authors claim that this knowledge is exclusively organizational and not individual and is the most important resource of the organization and is a source of competence and a condition for achieving the organization's competitiveness.

The active application of such knowledge is a characteristic of the learning organization. There are various theories about the organizations that learn. Some of them will be presented below.

Senge (1990) certainly contributed most to the popularization of learning organizations. According to him, learning organizations are places where people are constantly expanding their capacities to produce the results

they really want, where new and expansive ways of thinking are fostered, where collective aspiration is freed and where people are continually learning to see the whole (out of the box). Organizations are the product of the way people think and act in them. The results of organizational learning of individuals who participate in activities that follow new ways of thinking and acting and interacting, lead to greater and lasting organizational ability for change. Therefore, it is essential that employees constantly expand, develop and improve their knowledge in order to create opportunities for achieving results.

Nonaka (1991) companies that create knowledge sees as places where the invention of new knowledge is not a specialized activity, but is a mode of behavior, a way of being in which everyone is a worker of knowledge.

Garvin (1993) sees completely different organizations that learn in relation to Senge and Nonaka views. For the recommendations of Senge and Nonaka, Garvin says that they really sound idyllic and desirable, but they are also too abstract and leave many questions without answers like: "How will managers know if their company will become a learning organization?" and "What concrete changes in behavior are needed?". Garvin, therefore, sees the learning organization as an organization that is skilled in creating, adopting and further transferring knowledge. It is also necessary for the organization to approach certain changes in its behavior in order to further reflect the new knowledge and culture of the organization.

According to Honey & Mumford (1982) organizational learning involves the creation of an environment in which the behavior and practices who lead to continuous development are constantly and actively supported. Thurbin (1994) states that by studying learning processes in organizations, he concluded that the learning organization is the one who easily demonstrates his knowledge by understanding himself in the environment over time and making use of the learning of his members. Sveiby (1994), however, believes that the learning organization attracts professional staff and users, and connects, that is, it fits the abilities and effects of "attractive forces" between professional staff and users.

Janićijević (2006) notes that organizational learning should be explained from the perspective of organizational change theory, because is closely related and mutually dependent that is why, every organizational learning

involves organizational changes. The purpose of organizational learning is that organizations and employees work together to develop new skills and knowledge in order to achieve and maintain competitive advantage on the market.

As emphasized, the purpose of organizational learning is the development of employee and organization competencies, which involves replacing existing behavior in organization with new and constant improvement through learning, with the aim of achieving and retaining competitive advantage. In this way, there is an organization that learns, that is why, we can say that an organization that learns is the consequence and condition of the process of organizing learning. Most authors accept that the organization that learns is the prerequisite for organizational learning, because it is an organization that has created the conditions and atmosphere that supports organizational learning. On the other hand, the ultimate form of learning organization depends on the organizational learning process that takes place within it. Therefore, the manager's goal is to improve and direct employees through organizational learning to increase the efficiency and effectiveness of the organization through their behavior.

In the process of organizational learning, some authors point out its formal-technical side, i.e. processes of collecting, processing, storing and applying data, while others emphasize its social character, i.e. the importance of social interaction as a result of which organizational learning leads to the creation of knowledge that can not be found in an individual member of the organization, but is a part of the collective.

Schulz (2002) lists some key sources for acquiring knowledge in organizational learning, such as learning from one's own experiences, experiences from the past, other experiences, thinking, recombining existing knowledge and experimentation.

There are different types, i.e. levels of organizational learning. The division into two general levels in the category of cognitive development was carried out by Fiol & Lyles (1985): a) lower level of learning that occurs in the given organizational structure and given set of rules; and b) a higher level of learning aimed at adapting the overall rules and norms rather than specific activities and behaviors.

The classical division of organizational learning is given by Argyris & Schön (1978) and Chiva et al. (2010):

- Adaptive learning (learning in one circle) - Adaptive learning involves improvement or development through the process of self-organization and represents the basic form of learning, based on the previously established assumptions that are exempt from questioning;
- Generative Learning (Learning in a Double Circle) - Generative learning is developed individually, through intuition, attention and dialogue of research. Generative learning creates new knowledge that does not apply to existing standards, but aims at completely changing and establishing new routines based on new assumptions.

Dierkes et al. (2003) classify types of organizational learning as well as the process of its creation. The stages of the learning process are described in four basic steps that do not necessarily have to be sequential:

1) Identification of information that is significant from the angle of learning with the creation of new knowledge;
2) Exchange and diffusion of knowledge, from an individual to a collective level or only on a collective level;
3) Integration of knowledge into existing systems of knowledge, at individual, collective or at both levels;
4) Transformation of new knowledge at work and application of knowledge for organizational routines in order to achieve the effect on organizational behavior.

Grossan et al. (1999) propose a framework for organizational learning 4I, which consists of four sub processes: intuitive, interpretive, integrating and institutionalizing. These sub processes occur through individual, group and organizational levels.

Janićijević (2006) especially distinguishes the concept of Nonaka's organizational learning as one of the most original. Nonaka et al. (2003) has classified the types of organizational knowledge and the process of its creation. According to him, organizational learning is the process through which an organization acquires, manipulates and uses knowledge. Organizational knowledge includes everything that an individual or group knows to do (human and social knowledge), along with knowledge of social norms, processes and procedures, resources, and routines

(structured knowledge). Knowledge has two forms, i.e. it can be objective, open, tangible or explicit and subjective, hidden, intangible or implicit. Organizational knowledge is generated by the conversion of one form of knowledge into another through the process of organizational learning.

Petković et al. (2006) suggest four ways to create organizational knowledge, such as socialization, externalization, combined method and internalization. Socialization is the exchange of knowledge through the exchange of experiences, i.e. through observation and imitation that takes place in the organization itself. Externalization is essentially a translation of subjective knowledge, i.e. knowledge of an individual in objectively applied knowledge that contributes to the organization. The combined method is the systematization of objective knowledge into the knowledge system through analysis and categorization, and the applied knowledge of the individual is studied in detail to make it clearer and more accessible to other employees. Internalization represents the transformation of explicit knowledge into implicit through employee training.

The ways of learning and acquiring information are important for the organization. The basic forms of learning are learning before acting and learning during acting. Learning before acting is the expansion of knowledge based on the collection and analysis of professional literature, or through various trainings, seminars, etc. Learning during acting is a "more expensive" type of learning because it is based on one's own experience, i.e. on mistakes.

The learning organization is, therefore, always ready for continuous change, adaptation and innovation with the creation of an organizational atmosphere and an organizational culture that fosters new ways of thinking and supports learning.

Theoretical background of the multiple-criteria decision-making

Decisions are made today on a daily basis and represent one of the most important elements of managerial activities. With globalization and with increasing business dynamics, there have been changes in the decision-making process, so that the decision-making has become much more demanding and complex. High-quality decision-making and making sustainable decisions involve extensive preparation.

In the real world, often when deciding and making decisions, the decision makers are guided by their own experience and intuition. Multiple-criteria decision-making as a substantial part of operations research and helps in decision-making process and significantly reduces the possibility of subjectivism and intuition during that process.

In the simplest sense, multiple-criteria decision-making (MCDM) is the process of selecting one alternative from the set of available alternatives, or in some cases, ranking alternatives based on a predefined set of particular criteria that most often have different significance. Justification for the application of the MCDM methods is relevant approach to making decisions and the adoption of sustainable solutions (Stanujkić et al. 2013; Karabašević et al. 2017; 2018).

In numerous papers published so far, different authors have identified different phases, as well as different number of phases, in the process of multi-criteria decision-making. In the simplest case of decomposition of the multiple-criteria decision-making process, the following steps can be identified (Stanujkić et al. 2013):

- Identification and formulation of the problem;
- Forming a MCDM model;
- Normalization phase;
- The aggregation phase; and
- Selection phase.

Multiple-criteria decision-making (MCDM) has so far been used to solve various problems from different areas, and as a result of that is proposed the application of a number of well-known MCDM methods, such as: SAW (Churchman & Ackoff, 1954; Fishburn, 1967), TOPSIS (Hwang & Yoon, 1981), PROMETHEE (Brans &Vincke, 1985), ELECTRE (Roy, 1991), VIKOR (Opricovic, 1998), AHP (Saaty, 1980) and so on.

In order to solve a number of complex decision-making problems, numerous MCDM methods have undergone some modifications, primarily with the aim of applying them in cases of uncertainty and inaccuracy, as well as their application in a group environment. In addition to the aforementioned MCDM methods, new MCDM methods can also be identified, such as: MOORA (Brauers, 2004; Brauers & Zavadskas, 2006), MULTIMOORA (Brauers & Zavadskas, 2010), ARAS

(Zavadskas & Turskis, 2010), SWARA (Keršulienė et al., 2010), WASPAS (Zavadskas et al., 2012), KEMIRA (Krylovas et al., 2014), EDAS (Ghorabaee et al., 2015) etc.

Over time, MCDM methods have been applied to solve a variety of problems, such as: personnel selection (Urošević et al. 2018; Stanujkić et al. 2017a; Karabašević et al. 2015; 2016; 2017; 2018); tourism industry (Urošević et al. 2017; Maksimović et al. 2016) as well as various other problems in the field of management, finance and economy. A comprehensive overview of the some of the afore mentioned methods is given by: Kahraman et al. (2015) and Mardani et al. (2015a, b, c).

Procedure of the PIPRECIA method

The Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA) method for determining the weights of criteria was proposed by Stanujkic et al. (2017a), as one of the extensions of SWARA method.

Although it is a relatively new method, until now, the PIPRECIA method is applied for solving problems of personnel selection (Urošević et al. 2018) and website selection (Stanujkić et al. 2018).

The computational procedure of the PIPRECIA method can be shown through the following steps (Stanujkic et al. 2017a):

***Step* 1**. Determine the set of the relevant evaluation criteria and sort them in descending order, based on their expected significances.

***Step* 2**. Starting from the second criterion, determine the relative importance s_j of the criterion j in relation to the previous (j-1) criterion, and do so for each particular criterion as follows:

$$s_j = \begin{cases} >1 & \textit{when significance of } C_j \succ C_{j-1} \\ 1 & \textit{when significanse of } C_j = C_{j-1} \\ <1 & \textit{when significance of } C_j \prec C_{j-1} \end{cases}. \qquad (1)$$

***Step* 3**. Calculate coefficient k_j as follows:

$$k_j = \begin{cases} 1 & j=1 \\ 2-s_j & j>1. \end{cases} \qquad (2)$$

***Step* 4**. Calculate the recalculated weight q_j as follows:

$$q_j = \begin{cases} 1 & j = 1 \\ \dfrac{q_{j-1}}{k_j} & j > 1. \end{cases} \quad (3)$$

***Step* 5**. Calculate the relative weights of the evaluation criteria as follows:

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k}. \quad (4)$$

where$w_j$denotes the relative weight of the criterion j.

Numerical example

This section will present a numerical example of determining the significance of the dimensions of organizational learning that have an impact on the ability to innovate in an organization. Accordingly, three decision makers in the IT industry will assign importance to each dimension (criterion) of organizational learning. A total of 6 dimensions were selected for the evaluation. The first four dimensions (Commitment to Learn – C_1; Shared Vision – C_2; Open-mindedness – C_3; Intraorganizational Knowledge Sharing – C_4) are discussed in more detail in the papers: Kiziloglu (2015) and Calantone et al. (2002), the other two dimensions (Empowerment – C_5; Continuous learning – C_6) are discussed in more detail in the paper Ismail (2005).

Responses and assigned weights of the evaluated dimensions (criteria) obtained from the three DMs by applying PIPRECIA method is shown in Table 1, Table 2 and Table 3.

Table 1: *The responses regarding evaluated dimensions obtained from the first of the three DMs and the weights of the criteria*

	Criteria	s_j	k_j	q_j	w_j
C_1	Commitment to Learn		1	1	0.20
C_2	Shared Vision	0.95	1.05	0.95	0.19
C_3	Open-mindedness	0.95	1.05	0.91	0.18
C_4	Intraorganizational Knowledge Sharing	0.85	1.15	0.79	0.15
C_5	empowerment	1	1	0.79	0.15
C_6	continuous learning	0.79	1.21	0.65	0.13
				5.09	1.00

Source: *Author's calculations*

Table 2: *The responses regarding evaluated dimensions obtained from the second of the three DMs and the weights of the criteria*

	Criteria	s_j	k_j	q_j	w_j
C_1	Commitment to Learn		1	1	0.20
C_2	Shared Vision	0.9	1.1	0.91	0.18
C_3	Open-mindedness	0.9	1.1	0.83	0.16
C_4	Intraorganizational Knowledge Sharing	1	1	0.83	0.16
C_5	empowerment	0.9	1.1	0.75	0.15
C_6	continuous learning	1	1	0.75	0.15
				5.06	1.00

Source: *Author's calculations*

Table 3: *The responses regarding evaluated dimensions obtained from the third of the three DMs and the weights of the criteria*

	Criteria	s_j	k_j	q_j	w_j
C_1	Commitment to Learn		1	1	0.21
C_2	Shared Vision	0.8	1.2	0.83	0.17
C_3	Open-mindedness	0.5	1.5	0.56	0.11
C_4	Intraorganizational Knowledge Sharing	1.1	0.9	0.62	0.13
C_5	empowerment	1.3	0.7	0.88	0.18
C_6	continuous learning	1.1	0.9	0.98	0.20
				4.87	1.00

Source: *Author's calculations*

Finally, the significance (weights) of the evaluated dimensions (criteria) of organizational learning that have impact of the innovation obtained from the stances of the three DMs are shown in Ta

Table 4: *The weights of the criteria obtained from the three DMs*

	Criteria	w_j^1	w_j^2	w_j^3	w_j^*	w_j
C_1	Commitment to Learn	0.197	0.197	0.205	0.200	**0.201**
C_2	Shared Vision	0.187	0.179	0.171	0.179	**0.180**
C_3	Open-mindedness	0.178	0.163	0.114	0.149	**0.150**
C_4	Intraorganizational Knowledge Sharing	0.155	0.163	0.127	0.147	**0.149**
C_5	empowerment	0.155	0.148	0.181	0.161	**0.162**
C_6	continuous learning	0.128	0.148	0.201	0.156	**0.158**
					0.993	**1.000**

Source: *Author's calculations*

Conclusion

Organizational learning is important for the organization. Organizations that have a commitment for organizational learning have far more opportunities to develop capacity in terms of innovation in the organization. Organizational learning is extremely close to the organization's innovative capacity. Innovation is also essential for achieving and retaining competitive advantage. Market struggle is taking place today between organizations and in terms of innovation and new approaches, because today the organization survives only if it is innovative enough. The paper presents the importance of the dimensions of organizational learning that have an impact on the organization's innovativeness in the IT industry. A newly developed PIPRECIA method was applied to determine the importance of organizational learning dimensions. The PIPRECIA method was extremely suitable for solving the research problem. After succesfully conducted numerical example and based on the stances of the three decision makers, the greatest importance is assigned to the dimension "Commitment to Learn" designated as C_1, followed by dimensions: Shared Vision – C_2; Empowerment – C_5; continuous learning – C_6; Open-mindedness – C_3 andIntraorganizational Knowledge Sharing – C_4.As a possibility for future research, other methods can be used to solve a similar problem, and other dimensions that were not included in this work can also be selected.

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RISK MANAGEMENT AS A PART OF MANAGEMENT PUBLIC INVESTMENT PROJECTS

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Abstract

Improving governance and business decision-making in the implementation of public investment projects, requires clearly established procedures for a comprehensive risk assessment. The subject of research of this paper is an analysis of organizational solutions and procedures that can establish basic principles and efficient methods of assessment and risk reduction in project implementation. Awareness of the conditions of uncertainty in which projects are carried out impose a need for risk assessment to all participants in the project. Due to the great diversity and relatively short duration of each project, we can conclude that it is not easy to establish a universal system of monitoring, analysis and risk control. With this work we just wanted to prove that there are methods that can, on the basis of insufficiently structured information, give risk appraisal on projects, or that with appropriate risk management policies can improve business processes, reduce risks in individual projects, and raise awareness about them.

Key words: *risk management, public investment projects, good governance, risk strategies*
JEL classification:***L38, O22, P43***

Introduction

In all business processes, and especially when it comes to large infrastructure projects, due to uncertainty and risk, there is a danger of occurrence of unwanted, unforeseen events, which can not be absolutely excluded, which can cause material damage, threaten the continuated of the project, cause moral damage the contractor or the contractor, or even endanger the lives and health of people.

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By continuous studying and analyzing possible risks, we can learn about the measures and actions that we can take to reduce the risks and uncertainties of the project. Risk assessment, taking into account global trends, is included in each project.

The project consists of three basic interdependent elements: a project task, resources and the necessary time. Changing any of these three elements causes changes in the other two, and all together, it reflects the cost and value of the project. For these reasons, the investor and project team are tasked to carry out the project in the given circumstances and achieve the set goal with a small cost as possible, shorter deadlines and reducing the risks caused by the project to such an extent that they can not endanger the project's goal nor cause harm to the environment (Stamatović et al., 2005). From all of the foregoing, it is suggested that risk management planning should be integrated into project planning.

Precisely the development of financial management requires the development of risk management, creating such an environment in which the risk analysis will be part of everyday business. The extent to which risk management has been developed, so many controlling activities have been developed. It is a continuous cycle, which involves risk assessment, probability and impact assessment of a particular type of risk, risk monitoring. In this paper we dealt with the impact of risky events on the implementation and realization of project activities (Maksimović et al., 2018) Sources of risk were identified on the costs, deadlines and quality of the project.

In this paper, we intend to explore the basic methods of process management in public investment projects, as well as to propose methods and procedures for a comprehensive risk assessment, as well as measures to reduce risk on projects. Namely, the analysis of priority risks in the area of public investment projects provides an opportunity for improvement of techniques and methods of risk management. We hope that the work will contribute to the overview of the overall picture and problems, and that the defined risk models will indicate the possibilities of reducing and eliminating negative impacts, as well as opening some new issues and topics for future research.

The notion of risk and the purpose of risk management

The risk can be defined as the possibility of occurrence of events which may adversely affect the achievement of the set goals, or as a threat to the successful achievement of goals ("Official Gazette of the Republic of Serbia,"82/2007). Risks can occur in various forms, such as financial risks, project risks, risks related to services provided by the public sector to the users, risks related to certain stakeholders, risks of missed opportunities, or non-fulfillment of public policies, reputational risks, security risks, etc. There is no final list of all risks that can affect the achievement of the goals of public investment projects, so all business processes are carefully planned with the use of experience, engineering methods, decision-making methods and other relevant information that can be collected. has its own specificities that depend on goals, organization, resources, locations, environments, etc.

Traditional beleives have been based on the belief that the most effective way of increasing security and reducing risk is by improving organizational processes by raising awareness of the situation in the environment by using risk analyzes, in order to timely change the strategy on relation to changes in conditions, either internally or in the environment (Lutovac et al., 2016) There are a whole range of standardized procedures and software packages for organizational and business process improvement. In particular, this is done by applying modern methods of project management, using network planning techniques and other procedures, including continuous improvement of information technologies. By increasing the efficiency and reliability of business processes and the quality of products and services, security is significantly increased and risk decreases, given that the size of risk and risk management correlate with these methods.

Observing trends that are defined as a segment of best practice in the field of business, it is very important that public sector entities establish an effective risk management system, otherwise they may find themselves in a situation where they spend huge amounts of money to eliminate the consequences of negative events. In essence, the goal of an effective risk management system when talking about public investment projects is that the goals set out are achieved (Maksimović & Draganić, 2009). It is important to point out that in business processes, the risk can not be avoided, because it is a factor of business,.but it must be managed with

them. The risk management process is a set of activities that should function as parts of an integrated, strategic system that permeates all management activities and requires specific human, time and financial resources. Once the risk management process is established and the development of a risk management culture is developed and documented the most significant risks, project managers adopt a risk management strategy ("Official Gazette of RS" 99/2011). Risk management, among other things, is a tool that helps managers to anticipate and change the circumstances. It is important to emphasize that risk management is a particularly systematized activity, which, as an additional integrated upgrade, improves business processes and, through special measures, further reduces the uncertainty and possibility of occurrence of harmful events on projects.

Speaking about a formal risk management process, we can conclude that highly developed countries are very aware of the importance of risk assessment and risk management and to developing ever-better methods. A number of respectable institutions have conducted research on risk management, such as COSO 2010 report on ERM (COSO 2010), Enterprise Risk Benchmark Survey 2011 (RIMS 2011), Global Survey on Risk Management and Internal Control (IFAC 2011). Special attention should be paid to the view that a system of risk management is established, is a procedure for identifying, assessing, monitoring and controlling possible circumstances that may adversely affect the achievement of the identified objectives of the project (Directorate for Central Harmonization, 2012). It implies the introduction of effective prior controls in order to reduce the risks to an acceptable (reasonable) level. In the adequate establishment of the risk management process of public investment projects, internal acts (book procedures) are important, describing all significant business processes and activities that are carried out in organizational units that include documentation on the flow of financial and other transactions, audit reports, persons responsible for the implementation, manner and deadlines for the implementation of certain activities.

For the needs of this paper's research, with qualitative risks analysis, probability matrix and impact on individual project objectives, we have estimeted priorities of the identified risks in order to obtain a clear description of the individual risk and rang the risks for a specific project, and on the basis of that, we had planed and implemented responses to

each of these, the most influential risks. The research was carried out in the area of 8 municipalities of Western Serbia in the period from May to June 2016, in the organization the research center of the Institute of Economics and Finance, IEF Beograd. Eight possible sources of risk were identified on the costs, deadlines and quality of the project (poor coordination of all participants, lack of quality professional workers, slowness of local and state structures, documentation, unresolved property-legal relations, inefficient project management team, frequent changes in regulations, adverse climatic conditions). Respondents evaluated their own risk sources. For each risk, evaluated its occurrence as well as the potential effects on the project's objectives (deadlines, costs, quality) are assessed in case of occurrence of a particular risk. The result of a qualitative risk analysis is the priority list of the most significant risks for a specific project. They can identify risks that require an urgent response, the risks that need to be further analyzed, the risks that need to be re-controlled, so as not to outgrow risks that are dangerous to achieving project goals. The Respondents rated the "Inefficient Project Management Team" as the most critical factor in increasing the cost of the project, also they believes that the costs greatly affected by the defects in the project documentation.As a critical success factor, they see poor coordination among the participants, so we can conclude that the planned approach to managing public projects is very important (Stević et al., 2011). Next on the list is the problem of the lack of quality professional workers, the same priority is given to frequent changes in regulations, which once again confirms the unsustainability of the previous approach to the development of local communities. In a similar way, a list of the most critical sources, that is, the risk factors of exceeding deadlines and the risk of quality reduction, has been obtained. According to the assessment of the respondents, the deadline for exceeding the deadlines is mostly influenced by the "Slowness of Local and State Structures". In Serbia, one of the main problems is the slowness of administration, that is, bureaucratic apparatus at all levels, from local to state administration bodies (Stamatović et al., 2016). As the main risk factor for reducing the quality of the project the respondents consider "Lack of quality professional workers."

The results of the survey also identify critical factors for the success of public projects in order to plan the response to the emergence of critical risk factors and to monitor the implementation of the risk response, reduce their negative impact, or increase the opportunities for the success

of the project. However, from the results of these surveys, there is no visible connection between the application of the Capital Investment Plan (for municipalities that have declared that the Capital Investment Plan has been adopted) and the achievement of project success. The fact that municipalities in Serbia have had received training in project cycle management it does not mean that it successfully applied at all levels in the implementation of the projects they implement.

Methods for identifying risks

Projects in their structure encompass a series of different, mutually dependent activities, which are carried out within certain timeframes. The characteristics of the project are defined goal, one-time and limited duration (Maksimović & Stamatović, 2018) .Each project is different from the previous project and has its own sequence of activities, beginning and ending within the dynamic activity plan, as well as the defined financial resources, ie calculation. The project's assessment is more the predictive or giving opinions. No prediction can go without problems. The risk represents the possibility of a bad outcome, or a high probability of a bad outcome. Estimating this probability is usually based on limited knowledge. For example, due to data constraints, based on the prediction of water consumption, prediction is subject to errors. One of the explanations of engineers, it may be, that the data for the performance of the equipment is approximately accurate. It is also possible to doubt the accuracy of some parameters, of vital importance for calculating the return on investment (wages in shadowing). It is also necessary to distinguish between risk and uncertainty. At the beginning there is always uncertainty, which can be turned into a risk by assessing the probability of whether the project parameters will be realized within the set limit values. Therefore, it is necessary to carry out risk analysis and measurement in order to manage it (Vujnović, 2009). A risk event, if it occurs, can have cost, planning or technical consequences (Gates et al., 2009). The quantitative risk represents a change in numerical indicators: net present value, internal yields and investment returns.

In the PMI standard (Kerzner, 2003) also according to ISO 17799 - The Information Security Standard (www.security-risk analysis.com/introduction.htm) the risk analysis is broken down into qualitative and quantitative.

Qualitative analysis is the most widespread approach to risk analysis. Qualitative risk analysis does not require data on the likelihood of risk events, but an estimate of the possibility of loss (damage) is used. Qualitative risk analysis assesses the priorities among the identified risks for further activities in order to successfully manage risk. For each risk, the likelihood of its occurrence as well as the potential effects on the project's objectives (deadlines, costs, quality) are assessed in case of occurrence of a particular risk. For each risk, the probability of its occurrence as well as the potential effects on the project's objectives (deadlines, costs, quality) are assessed in case of occurrence of a particular risk (Maksimović, 2016) For this purpose, matrices of probability and impact are made, analyzes the quality of collected data on individual risks, categorizes the risks to the source of risk, the area in the project to which they can work, the phases of the project, and the assessments of the urgency of risk management are being carried out. In the process of qualitative analysis, a series of mutually dependent elements is used:

- Threats, these are the dangers that can be attacked by the system (fire, or scam)
- Sensitivity, which assumes that if the system is more exposed to danger, the probability of the influence of the suspected threat is more likely (if the presence of flammable materials is higher, the greater the possibility of a fire)
- Control, there are four types of controls that reduce the risk of sensitivity:
    - Control as a means of abandoning the project
    - Preventive control
    - Corrective control that diminishes the effect if a risky event occurs
    - Detective control, which detects the danger and activates preventive and corrective controls.

Quantitative risk analysis assesses the risk based on the likelihood of occurrence of the event and the likely amount of loss, or damage if the event occurs. The main problem with this method is the unreliability of data on the likelihood of an event occurring. In addition, the possible events that are analyzed are often interdependent, and there is corelation among them. Quantitative risk analysis refers to the analysis of the impact of those risk events identified by the previous qualitative analysis as

potentially most influential in achieving the objectives of the project. In quantitative analysis, appropriate techniques and tools are used: sensitivity analysis, estimation of expected costs (for negative risk), as well as quantitative decision-making methods, modeling and simulation techniques (Project Management Institute, 2006). The result of this analysis is a supplemented risk register that contains:

- Probabilistic analysis of the project (estimation of possible costs, deadlines, most often in the form of cumulative distributions),
- Probability of achieving individual project objectives in relation to risks,
- Rank list of critical risks,
- Trends of occurrence and risk impact.

Risk models

The most common definitions of the term "model" relate to a simplified presentation of reality, with the purpose of better understanding a problem, before making key decisions for its solution (Smith & Merrit, 2002). The model must have three most important features:

1. validity - good presentation of critical aspects of the situation;
2. usability - possibility of use for intended purpose;
3. value for the user - acceptable difference between the received and invested.

Mathematical modeling is a process of mathematical presentation of a problem with the aim of its better understanding. The purpose of risk management in public projects is to reduce the probability of occurrence of negative events, in order to achieve the project's objectives (Wideman, 1999). In the public sector, factors that influence the life cycle of projects can be divided into:

- Internal factors - organizational structure, quality of project management team, existing knowledge, project management plan, management procedures, etc.,
- External factors - political, macroeconomic, legal, sociological and others.

The risk analysis involves probability testing, whether the project will achieve satisfactory indicators that are required from a given project (PMBOK, 2006). The probability, or risk, should be expressed by an index, which can have the following values:

- The value is equal to 1 (= 1), signifies the high probability that predictions will be achieved;
- The value is equal to 0 (= 0), indicates a high probability that predictions will not be achieved;
- The value greater than 0 and less than 1 (> 0 and <1), represents all the situations between the boundaries.

By qualitative risk analysis we get a number of uncertainties that arise on the project, reasons for their creation and the risk of the project. Special logical maps and questions for risk identification are also assisted here. The risk is classified by relevance and possible losses. The most important risks are subject to quantitative analysis.

Quantitative analysis can be done using the following methods:
- Impact analysis of individual factors (sensitivity analysis)
- Analysis of the impact of a group of factors (scenario analysis)
- Imitation modeling (Monte Carlo method)

Sensitivity analysis enables the definition of key project assumptions. The analysis is carried out by changing the value of one assumption and measuring the effects on the change in the values of NPV and IRR. The general rule is that the

1. identification of all assumptions
2. elimination of assumptions, which are causally connected (change of one sensitivity of assumptions should be analyzed, whose change in value by 1% leads to a change in the baseline value of NPV not less than 1%. The sensitivity analysis includes the following phases:parameter leads to a change in the value of another parameter)
3. analysis of the sensitivity of the project profitability indicator to the parameter value shift
4. choice of key assumptions.

Sensitivity analysis is a limited project evaluation tool. It deals with the individual analysis of each assumption, provided that the other assumptions are constant.

Analysis of the scenario, unlike the sensitivity analysis, which examines the sensitivity of the financial and economic rationality of the project to change one assumption, examines the sensitivity of the project's profitability indicators to the change in the value of a group of key

variables (PMBOK, 2006) In order to define a realistic scenario under the same assumption, it is useful to combine the optimistic and pessimistic values of the group of variables. In order to define an optimistic and pessimistic scenario for each key variable, the boundary values, i.e. minimum and maximum. After that, for each scenario, the calculation of the profitability indicator of the project is performed.

Schedule of probability of key variables

The next step in the analysis is to determine the layout and the probability of occurrence of possible values of key assumptions about the best value, used in the base case. This enables the calculation of the expected values, indicators of the financial and economic viability of the project. The schedule of probability of key assumptions can be determined on the basis of different sources of data: historical data, published data for similar projects, consultations of experts, etc. If the probability distribution is unrealistic, then the risk analysis will be unreliable. If the layout of the probability is simple, then the risk analysis will be reliable (Stamatović et al., 2013). In any case, the simplest display of the values of the variables is extremely important for understanding the good and bad sides of the project compared to the baseline.

Once the key assumptions have been identified, for carrying out a risk analysis, it is necessary, for each of them, to determine the layout and probability of occurring possible values around the best value used in the base case. After defining the layout of the values of the key variables, it is possible to determine the schedule of possible values of the NPV and IRR project. When evaluating the obtained result, an important aspect of the analysis is to reach a compromise between: the option of a project with a high risk and high social benefits. Sometimes there are reasons for selecting a low-risk project option. In some situations, the evaluator and proposer may deviate from risk neutralization and choose an option with a lower or higher risk in order to achieve the expected profit. Such a choice must be clearly explained.

Reaction to risk

In order to encourage positive success factors and minimize the negative impacts on the success of the project, special efforts should be invested in risk management in the project management process. Project risk

management includes processes for risk management planning, risk identification, risk analysis, risk responses, and project monitoring and control. The purpose of risk management is to increase the likelihood of positive impacts, and reduce the likelihood of occurrence of events that may have a negative impact on the project.

The risk management process how it seen by Smith and Merritt (Smith; Merrit, 2002) consists of five basic steps:

Step 1 - identify risks, in order to face their consequences;
Step 2 - analyze risks to determine the causes of their emergence, the magnitude of their impact, and the likelihood of occurrence of each of them;
Step 3 - Identify priority risks in order to address the most important risks;
Step 4 - Plan activities to combat negative consequences of risks.
Step 5 - Monitor the processes of the risk management plan, monitor the status of the risks and eventual emergence of new ones.

For the management of risks in public projects, significant additional efforts are needed for the purpose successful realization of project goals, which includes:

- Establishing a framework for risk management,
- Support of senior management, project leader and political experts
- Clear communication and submission of reports to all participants in the project
- Constant application of the risk management process in all business processes

Authors dealing with risk management agree that a planned approach to risk management improves project performance in terms of costs, planned deadlines and achievement of business objectives. Risk management planning is a decision-making process on how to approach risk management and implement the necessary activities throughout the life cycle of a project. (Wideman, 1999). This process is essential in order to ensure an optimal way of managing risks in relation to the type of risk and importance of the project for the organization. Risk management planning needs to be done as early as possible, but in the phase of project planning. (Kerzner, 2003)

On the Internet, information, articles and many other sources of risk analysis and risk data, or new forms of research in this field, are particularly relevant for project management, risk mitigation, simulation methods, and the like. For example, the following softwars for analysis and risk assessment are offer on the Internet:

- Risk for Project and Risk + use Monte Carlo simulation method (www.palisade-europe.com).
- Risk + (www.cssi.com)
- Cobra (www.riskworld.net)
- Method123 (www.method123.net)
- Software for Building Process Management: Spitfire Software for Construction (www.spitfireconstruction.com)
- Training and Training Programs: Quality Management Int (www.aworldofquality.com)

Risk for Project is an add-on for Microsoft Project. It takes into account the fact that the duration of the activity behaves stochastic in a function of a distibution, so it is not definitively defined completion of either the activity or the whole process covered by the network plan. By choosing a distribution for each activity and using the Monte Carlo simulation method, you get the expected completion time of the process, costs, and other parameters. The COBRA version involves the application of a database, or a questionnaire for risks and other parts of the process, which builds a system of estimates for a given situation. There are also a number of other standardized methods and software packages for organizational improvement, in particular the process. By increasing the efficiency and reliability of the business system, security is significantly increased and risk is considered, because the size of risk and risk management is in great correlation with these methods. However, we can never solve all risks, especially external risks, arising from uncertainties in the environment.As a rule, the process of implementing modern risk management methods in the short term will show the need for introducing modern management methods in all elements of the business and organizational system. Risk management involves specific methods and techniques (Kerzner, 2003), to address known risks, identifying responsibilities for a risky problem, and evaluating costs and time needed to address risks. According to PMBOK (Project Management Institute, 2006), risk response planning is the process in which options are developed and the activities for risk acceptance and the reduction of threats to achieve project objectives are determined. Possible risk response is possible - planned activities that will

be carried out only in cases where the risk really comes in, and elaborated strategies for managing negative (threats) or positive (opportunity) risks.

Strategies for negative risks or threats

There are three basic strategies for responding to the emergence of a negative risk event (Project Management Institute, 2004):

- Risk avoidance - the project management plan is changed to avoid adverse risks (eg, more precise requirements are defined, communication is improved, experts included, etc.), the project objectives are removed from the risk impacts, or the disadvantaged objectives are mitigated (eg extending the deadline or reducing project scope).
- Transaction risk - the negative impact of risk is transferred to a third party, making it responsible for managing that risk, for which it receives a certain premium (eg, guarantees, insurance, construction contracting of turnkey works) ;
- Mitigate the risk - the likelihood and / or impact of a risky event is reduced to an acceptable threshold of activity at the earliest stage of the project (for example, the application of a less complex process, taking a number of trial samples, choosing a more reliable supplier, etc. to reduce probability,such as an additional aggregate plant in the event of a power failure).

Strategies for Positive Risks or Threats

- Use the opportunity - conditions are created for the opportunity to happen (for example, increasing resources, ensuring better quality than planned, etc.)
- Share a chance - positive impacts are shared with a third person who is most capable of taking advantage of existing opportunities (eg partnerships, joint ventures, etc.)
- Increase the chance - increase probability and / or positive impact.

Strategies for both types of risk, positive and negative

- Accept the risk - when none of the previous strategies corresponds to risk, it is accepted: passive acceptance means not undertaking any activities until the risk actually arises, and active acceptance involves

the creation of a certain reserve in money, resources, or time in order to solve and exploit known, and sometimes unknown, risks.

After this phase of the risk management process, the risk register has been supplemented with data on accepted risk management strategies, description of activities for implementation of the chosen strategy, necessary funds and time for their realization, risk holders (responsible person for managing a certain risk) and their responsibilities, reserve plans, residual and secondary risks, after certain activities were undertaken to respond to primary risk (The Green Book, 2003). In addition to the risk register, it is necessary to update the risk management plan and to conclude the relevant contracts related to risk management (property and people insurance agreement, service contract, etc.). The problem is how to choose the optimal response to a particular critical risk. In practice, the selection is generally made according to the degree of risk and tolerance of the project manager towards that risk (Kerzner, 2003). However, there are other important elements that influence the selection of risk responses: the quality and availability of required resources, and the policies and procedures for managing projects that more or less allow the project leader to freedom of decision making. When risks can have very serious consequences for a project to make it completely unacceptable, they resort to measures to avoid these risks. Risk mitigation measures are undertaken to increase the probability of project implementation, but at the same time mean an increase in the basic budget for the costs required to undertake risk mitigation activities. Risk transfer to another person is a decision to be taken with a prior understanding the nature of such a risk, and properly selected the person who will best manage this risk. Risk acceptance is also one of the risk management options, but does not mean such risk management activities.

Conclusion

This paper starts with a hypothesis about the uncertainty and unpredictability of events in the environment and within the project, due to which in business processes the possibility of occurrence of unwanted events, which can not be excluded, can affect the safety and health of people, or cause material damage to the company or project. The Large investment projects, as the most common one-off complex ventures, under conditions of insecurity and due to the complexity of the work, but also time-bound and available resources carry an increased risk.The

investor, the project manager and the project team have a difficult task that in given circumstances carry out the project and achieve the intended goal with a small costs as possible, with a shorter deadline and with the reduction of risk to such a measure that the goals of the project can not be compromised, or damage to the environment.

Models of risk management in public projects, as presented in this paper, synergistically link modeling, project management and defining a risk management process. Connection takes place through the phases of the project life cycle, planning methods, multi-criteria decision-making methods and decision-making methods under uncertainty conditions. The model is at the same time a response that eliminates critical risk factors, recognized as an "ineffective, or non-existent risk management system." The consistent application of the risk model can reduce the impacts of many other risky events, including those that were conducted in a high-ranking survey priority risks, which gives hope that with the use of modern organizational solutions, procedures and techniques, will be achieved significant improvements which are a guarantee for success and risk reduction in public investment projects.

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INTEGRATED MANAGEMENT SYSTEM INNOVATION AS COMPANY DEVELOPMENT DRIVER

Boško Vojnović[1]; *Svetlana Vukotić*[2]

Abstract

In addition to the economic, political and social factors that significantly affect the viability of a business, an important place belongs to technological factors and the introduction of innovation in business processes of enterprises, especially with integrated information systems. Information systems provide incentives to intellectual work, provide operational support, as well as significant support to management in decision making. This paper explores the importance of the integration of information systems to improve business performance through innovation and increased security when the management is making business decisions, with special reference to Serbian companies. A questionnaire method was used on a sample of about 70 companies of all sizes and various activities that exist in the Serbian economy. The results indicate that the introduction and integration of information systems significantly improve the performance of enterprises in all segments.

Keywords:*information systems, management, innovation, management support, Serbian companies*
JEL Classification: O32, O31, M15

Introduction

Innovations are everywhere. They are the reality as well as inevitability. On the other hand, science recognizes that the world consists of multiple complex system interactions. This means that it is necessary to deal with both system and innovation. However, integrity management system innovation also represents a company development driver. This multiple interaction gets the attention form many researchers, (Samy et al., 2015;

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Tidd et al., 2005; Olaru et al., 2014),which is also logical when the final outcome is the matter.

According to Urošević et al. (2018,77), the main vector creating and shaping all the changes occuring in the modern world is the technological progress. The imperative of harmonization with the present time flows imposes the need for the information system connection as well. Modern organizations are transorganizational systems because they do not represent the traditional final products exchange, but information and knowledge exchange, reciprocating functions and duties in the partner companies included (Vukotić & Vojnović, 2016). According to Lawson & Samson (2001)excellent companies invest and nurture this capability, from which they execute effective innovation processes, leading to innovations in new product, services and processes, and superior business performance results.

This paper is organized in the following manner. Following the introduction, in the first section we speak of the systematic approach to organization, how to determine this concept as well as its structural elements and how to divide the systematic approach to organization. The following sections consider business improvement through information technology support in certain parts of organization, as well as the international standards and their comparative characteristics. The next chapters within the theoretical part of the paper include the analysis: the advantages of management system integration, IMS integration within the basic MS of the organization and computer-aided quality assurance (CAQ). The second conceptual entity refers to the practical research of integrated business system influence on the business viability of the companies in Serbia. The final part of the paper is the conclusion, where we present the research findings.

The aim of this paper is to show this interdependence between the advanced integrated management system innovations and their influence on the company development. The research in this paper is intended for both the direct actors in company management and a wide academic community interested in these issues.

Systematic approach to the organization

The systematic approach starts from the fact that organizations can be improved only if all the variables as characteristics of the complete system environment are taken into account. According to this approach, all elements are the integral parts of the system and they all have their own roles in it. The integration of common effects should be greater than the sum of the individual elements in the system.

The system is made of a group or sum of several elements representing parts of the system and they are called subsystems. The characteristics of an organizational system are: complexity, dynamism, undeterminatedness and openness.

The important structural elements of the organizational system are: input subsystem, operation subsystem, output subsystem, adaptive subsystem, management subsystem and control subsystem.

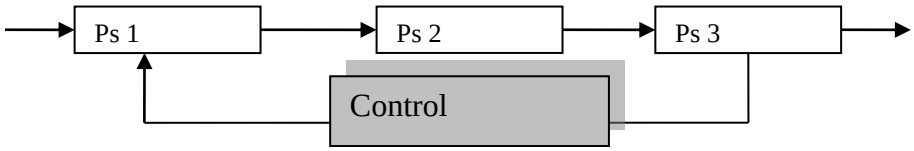
Input subsystem is the first stage in the organizational system working process. This subsystem should be in the interactive relation with the production subsystem.Production subsystem is in charge of converting input elements into output, which proves beyond any doubt the connection between these subsystems. The output subsystem is the result of the production subsystem operation.

An adaptive subsystem is organized for the above mentioned reason. The very nature of the input and output subsystem function is in the direct contact with the environment, and therefore forced to feel the changes within it. These border subsystems are in charge of the contact with the environment and they adjust it through certain measures or they are adjusted to the environment.

Management subsystem is one of the most important subsystems. Itssignificance is that the organizational system, with all its attributes, is still unpredictible and uncertain. The directions to follow are planned in their nature, and they can be defined with difficulties.

Control can be considered in two ways, as a technical control or as a control which is a component of the management subsystem (Figure 1).

Figure 1: *Control through feedback*



Source: *Bober (1970). Stroj, čovek, društvo, Naprijed, Zagreb.*

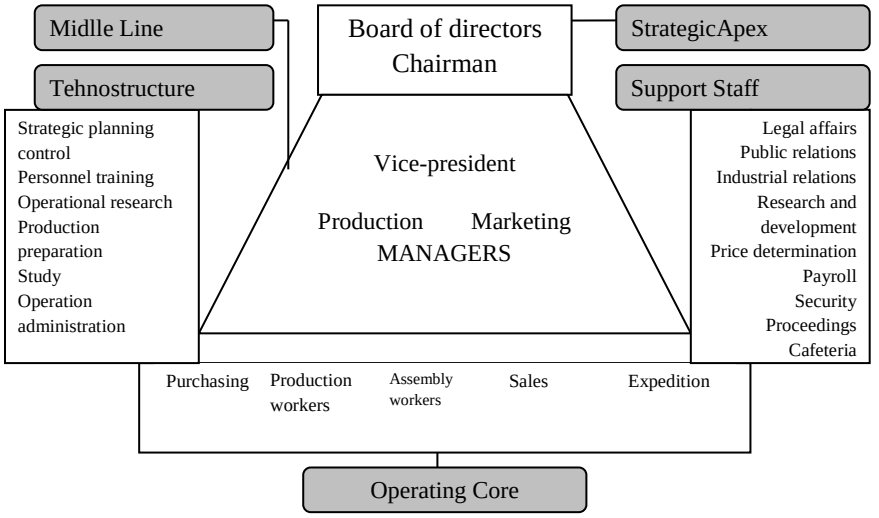
The organizational systems are active and dynamic, and therefore their subsystems are in constant mutual interaction. The subsystems are transformed into a system of a higher order through the interaction itself.

Business improvement through information technologies support for certain parts of the organization

Dynamic form of demands for information and complex organizational relations impose the need for information system development. The role of information technologies in a company enables the business system to react to environment influences quickly and appropriately. For instance, the impact of technological progress can be observed in all aspects of marketing process. Also, Internet has led to information boom, which gives users an opportunity to purchase products from cheap suppliers all over the world (Mihailović & Brzaković, 2018, pp. 71-72). A company with good information technologies can react efficiently and timely change its attitude towards the environment, when there is a good reason (Cvijanović et al., 2016). When we observe Mintzberg's organizational structure defined at the end of the 1980s, we can reach the conclusion that the organizational structure set in such a way can also be generally acceptable even nowadays with a good information technology support.

If we analyze the activities in almost each of the business functions, we can notice that 90% of all the activities of most business actions come down to gathering, processing and analysis of certain data (Figure 2).

Figure 2: *Basic parts in an organization*

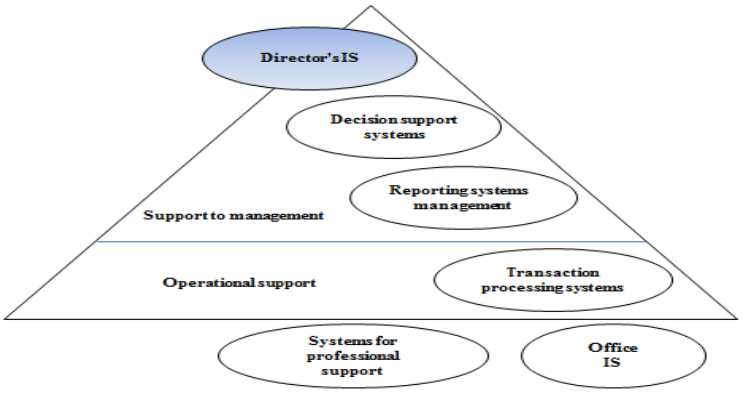


Source: *Minzberg (1979). The Structuring of Organizations, Pearson, UK, pp. 20-23.*

The basic information system (IS) categories in companies can be divided into three categories, as we can see in figure 3:

1. IS for intellectual work support
2. IS for operative support
3. IS for management support

Figure 3: *IS classes*



Source: *Jokanović (2001). Poslovni informacioni sistemi, Megatrend, Beograd, p. 6.*

IS for professional support is mainly related to the office information systems and professional support systems (lawyers, office work and similar jobs*). Operative support IS* are mostly used for operative support in transactions processing. Information technologies have a significant application in the following areas: information systems for financial management, information systems for operating processes management in a company (for example, production), the Internet and intranet technology, various digital technology application in business organization and company management by the managers. *Management support* implies information system help in reporting and decision making.

Information systems for business and other organizational systems needs can be introduced through its own development or through the purchase of the appropriate software. Both of these have their own advantages or disadvantages. When we speak of its own development, the advantage is that the generated program can be commercialized through the sale to other companies besides being used in its own company, but its main disadvantage is in wasting the time necessary for IS development. The purchase enables the company to apply the necessary software in a short time, but it also has its price.

IS application leads to improvements in: profits, increased revenue, market share increase, quality and other business performance. In addition to all these points, an adaptive subsystem is also necessary with the aim of removing the unpredictable errors.

Multidimensional business information system and its harmonization with the increasingly complex business system is necessary in order to sustain and possibly accelerate progress and production technology exploitation. In fact, material world general progress or the increasingly higher level of the total material and non-material processes are the main and essential drivers of all human and scientific activities development, and therefore the business information system and organization science development drivers as well.

International standards and their comparative characteristics

Management integrated systems are based on the integrated application of several standards form the area of management, and they are a good way for efficient business.

ISO 9000 standard is applicable in overall economy as well as all types of organizations.

ISO 14000 is a series of standards from 1996. It was revised in 2004 and defined as 14001 standard. It represents a global model for environment management. The application of this standard is a proof of responsible environmental behavior.

OHSAS 18001 is a standard for system management and it is focused on occupational health and safety. The aim of this standard is to create a safe workplace environment. Its demands concern planning, risk management, danger identification, management and dealing with extraordinary circumstances. Its application increases occupational safety, health protection in the workplace, reduces treatment costs and eventually increases prevention.

SA 8000 is the first international standard for social accountability in workplaces. It requires the employer to guarantee the basic labor rights for the employees, safe working conditions, the right to organize trade unions. The standard forbids discrimination on religious, racial or national basis, as well as the possibility of promotion at work.

ISO 26000consists ofguidelines for social responsibility. Social responsibility is the responsibility of an organization for the influence its decisions and activities have for the environment through sustainable development, health and welfare of the society included, the organization that takes care of the expectations of the interested parties and which complies with the laws and international rules of behavior.

Table 1: *Common concepts for ISO 9001, ISO 14001 and OHSAS 18001 standards*

CONCEPT	**ISO 9001**	**ISO 14001**	**OHSAS 18001**
Management area	Quality	Environment	Professional health and safety
Main goals	User satisfaction achievement	Environment parameters improvement	Health and safety parameters achievement
Main interested parties (stakeholders)	Customers Laws	Laws Interested parties for the environment	Employees Laws
Critical aspects	Quality characteristics (products and processes)	Environment aspects (related to activities, products and services)	Risks (related to activities and operations within the organization)
Requests related to the critical aspects	Users' requests Requests related to the intended usage Legal requirements Requests determined within the organization	Legal requirements requests/needs of the interested parties requests arising from risk analysis in environmental aspects	Requests/needs of the interested parties (employees) requests arising from risk assessment in aspects of danger
Management activity focus	Processes critical for product quality characteristics fulfillment and organization performances related to quality	Operations and activities significant for the environment	Operations and activities significant for health and safety risks and dangers
Lack of management consequences	Poor organization and product performances causing customer dissatisfaction	Harmful influence for the environment	Damage for health and welfare of the employees
Risks for the organization	Organization cannot fulfill users' requests and legal requirements; consequences: users' dissatisfaction. Responsibility to population, legal violations, market reduction and financial loss	Environment performances opposite to legal requirements or interested party needs; consequences: legal violations, responsibility to population, bad image and financial loss	Health and safety performances, risk control level which do not meet legal requirements and employees' needs

Source: *Milekić & Bobrek (2015). Integrated Management Systems, 9th Research/Expert Conference with International Participation "Quality 2015", Neum, B&H, 10th – 13th June 2015, p. 539.*

The benefits of management system integrations

The conflicts in organization competence are often caused by partial management system application in certain areas, and they are almost always opposed. In order to overcome this situation, also confirmed by experience, integrated management systems are necessary, the ones that will enable more productive and more efficient system.

The conditions for the employees to tend to achieve a total management system are created not only through the functions, but through communication improvement among various organizational units, information technology application, cooperation and process work (Heleta, www.educta.co.rs). The benefits that arise from management system integration can be multiple. The integration procedure itself top management is involved in the process, and therefore the positive outcome is more certain. Business results achieved in the future are better because of more efficient and cheaper particular management system application. The savings in the policy, document and records numbers through their integration lead to resource and effort rationalization. System application and maintenance through integrated testing, verification, re-examination and valorization is time and money saving. The process of system upgrade can be improved through a unique process, which is cheaper and more efficient than the improvement of several separated processes. It also enables a higher level of control. Priority conflict is avoided through an integrated priority in relation to partial priority requirements and focuses. The goals of all interested parties are satisfied, which makes an integrated system better accepted by the employees. And finally, the integrated program eliminates confusions within the system.

IMS integration within the basic MS organization

Systems –standards should completely cover the basic system of an organization: strategic, system of earnings, financial system and all others. Anyway, it is important to integrate particular systems, which implies IMS integration within everyday management practice.

For these reasons, it is important that certain individual standards/systems are integrated among themselves, but it is even more important for them to be successfully integrated within the basic

organization management system. IMS integration within the basic management system in the organization implies: IMS integration within the organization business strategy and IMS integration within management everyday practice.

Typical organization characteristics are presented in the table below, depending on the quality integration level within the organization business strategy and practice.

Table 2: *Quality, business strategy and practice integration level in the organization*

Organizational characteristics	**Level 1 Annual budgeting**	**Level 2 Long-term planning**	**Level 3 Externally oriented planning**	**Level 4 Strategic planning for quality**	**Level 5 Strategic management of quality**
Integration level between quality strategy and business	No improvement strategy for 7 qualities. No strategy and quality integration.	User satisfaction relates to the chosen goals. Little integration between goal quality strategy.	Goal collections, user needs analyses and competition benchmarking are used. Quality goals are integrated within the business goals of the organization.	Quality as a strategic tool. Quality strategy related to the performances.	.Quality integrated with the business strategy. Improvements completely focused on achieved results performances.
System of strategic values	Survival is the goal. Budget fulfillment	Anticipation of the future	From anticipation of the future to startegic thinking	Strategic thinking	Creation of the future
Highest management style	Improvization „oral presentations“	Function delegation	System orientation	Leadership and participation	Leadership and innovativity
Quality system	Quality values and long-term goals are not specified.	Reliable products or services and „zero defects“.	System-quality focus in all business processes.	Quality implementa ti-on in business structure.	Quality as an excellence in all realizations.
Management and measurement system purpose.	Trade documents ownership. Quality checks.	Quality management system	Management(decision-making) quality improvement.	Prompt response and proactive pleasure.	Balance in the satisafction of all the interested parties – users in the organization.

Source: *Heleta (2004). TQM – Modelizvrsnosti, Educta, Beograd.*

Computer aided quality assurance (CAQ)

New tools of quality help with analysis, error prediction and removal in some of the processes related to companies, srevices or product. The help is significant,

but also often very slow, creating the issue of unsuitable timing. The problem created in this way is solved by information system and automation introduction. Thus, CAQ (Computer aided Quality) is planning and implementation of the processes concerning the quality system in the company, assisted by information technologies, as presented in figure 4.

Figure 4: *CAQ system and its relation to the other elements of the organization and the market*

Source: *Burchardt (2001). Dasgrosse Handbuch Producktion", VerlagModeme Industrie, München.*

Information system is a system where the relations between the objects and system links with the environment are realized through information exchange. Information systems are an integrated parts of management, that is, they maintain the desired activity in a system, and from that point of view the adjective"managing" can be added to them.

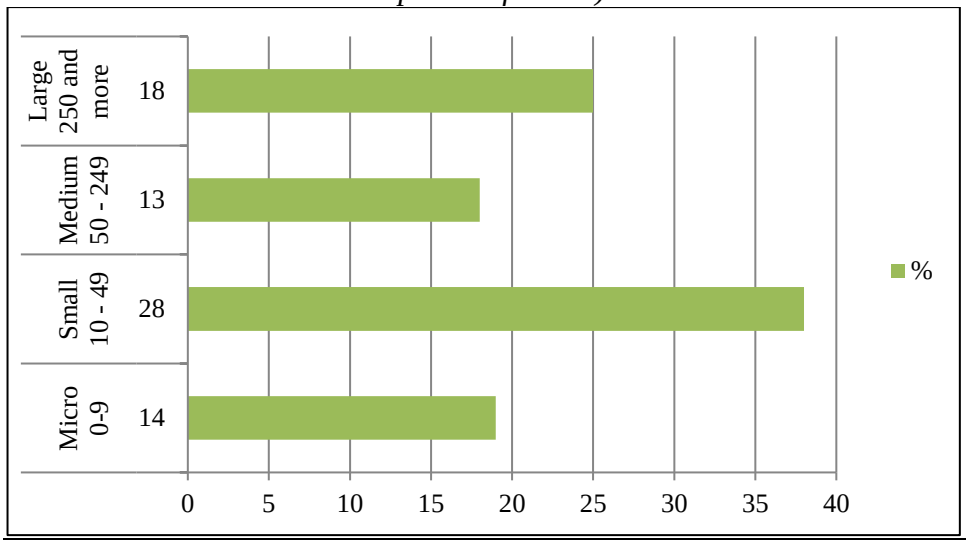
The basic function of the information system is data storage and transfer about the facts from the system and its environment, their processing into the information requested by the user.

As far as system approach, an information system can be defined as"an arranged set of methods, processes and operations for data gathering, storage, processing, transfer and distribution within the organization, including the equipment used for such a purpose, people dealing with these activities."

Practical research of integrated business systems influence on business capacity of the companies in Serbia

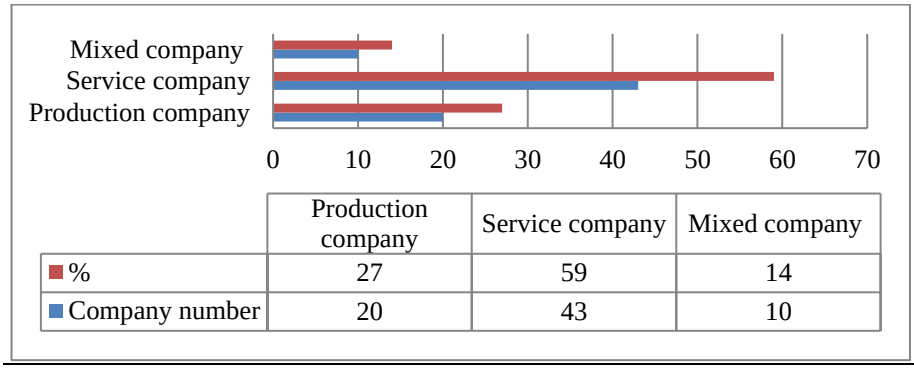
This research uses the data from the questionnaire on information system application and their influence on companies' operations in Serbia. Around 100 companies took part in the survey, but only 73results from these business subjects were taken into account because the survey was conducted in a valid way. The survey was conducted by the Agricultural High School lecturers and associates, with the students' help, within Strategic Business Planning subject realized in the second year of management undergraduate studies.

Graph 1: *Classification of the surveyed enterprises according to size (division of the enterprises according to the Statistical Office of the Republic ofSerbia)*



Source: *the survey*

Graph 2: *The number of the surveyed enterprisesaccording to industry*



	Production company	Service company	Mixed company
%	27	59	14
Company number	20	43	10

Source: *the survey*

Table 3: *IS possession*

Does the company possess an information system?		
Yes	73	100
No	-	-

Source: *the survey*

Table 4: *IS introduction time period*

When did you introduce the information system in the company?		
During the previous year	12	16
Over the last 2-3 years	16	22
Earlier	45	62

Source: *the survey*

Table 5:*The manner of ISintroduction*

How did you introduce IS?		
Independently	21	29
With the help of a company specialized for IS introduction	52	71

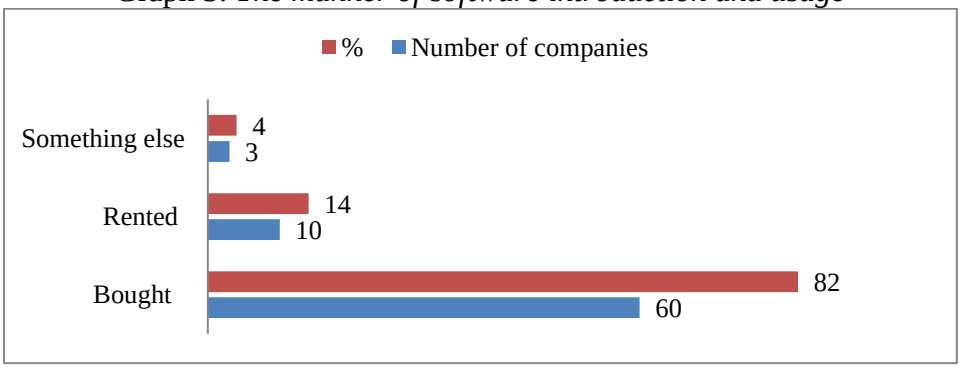
Source: *the survey*

Table 6: *IS introduction duration*

How long was the introduction period?		
1- 6 months	50	69
6 – 12 months	12	16
Over 12 months	11	15

Source: *the survey*

Graph 3: *The manner of software introduction and usage*



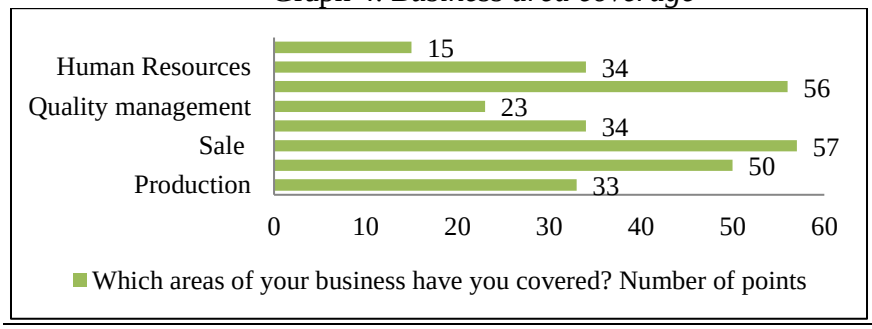
Source: *the survey*

Table 7: *IS usage training organization*

Did you have organized training of your employees for new computer equipment and program usage?			
	Number of months	**Number of enterprises**	**Total number of enterprises**
Yes, with the help of specialized companies	1 2 3 6	14 9 13 4	**40**
Yes, from our own resources	1 2 3 6	9 2 3 1	**15**
No			**18**

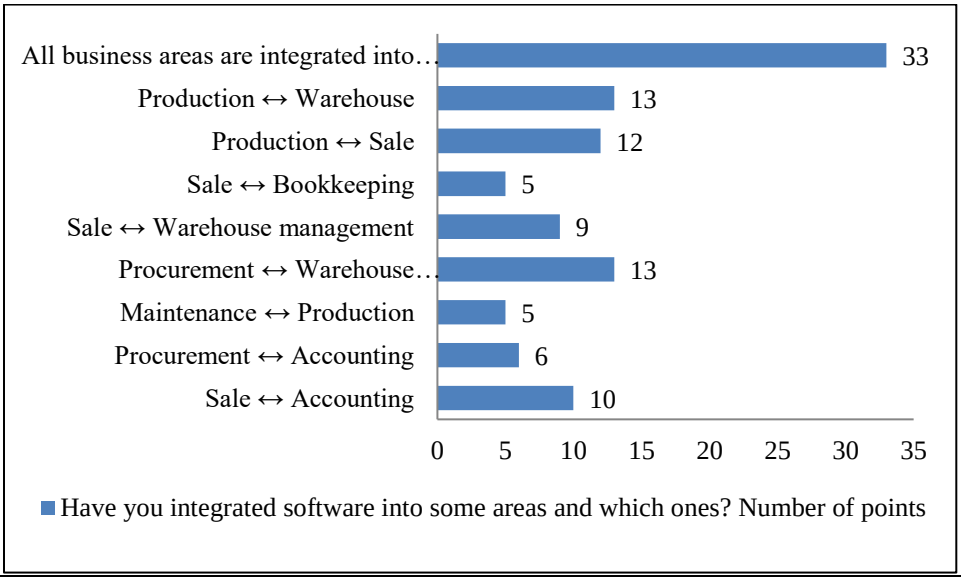
Source: *the survey*

Graph 4: *Business area coverage*



Note: due to the inability of enterprises to answer several questions – the data in the tables are expressed in points
Source: the survey

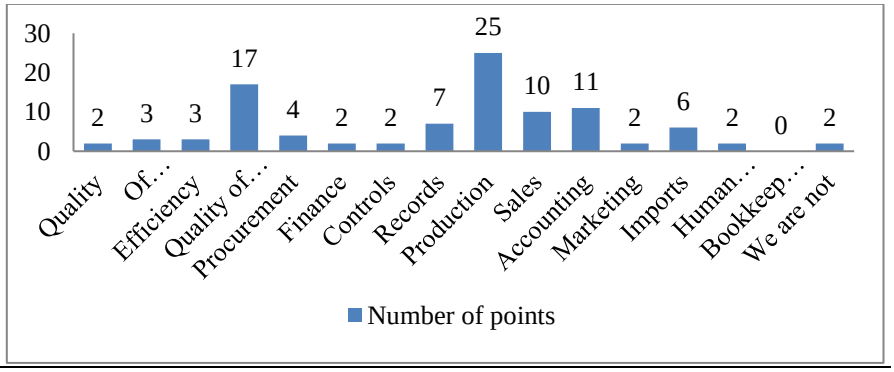
Graph 5: *Software connection to the area of business*



Source: *the survey*

The following answers were given to the question 'did you achieve any improvements in business because of IS introduction?' They are presented in graph 6.

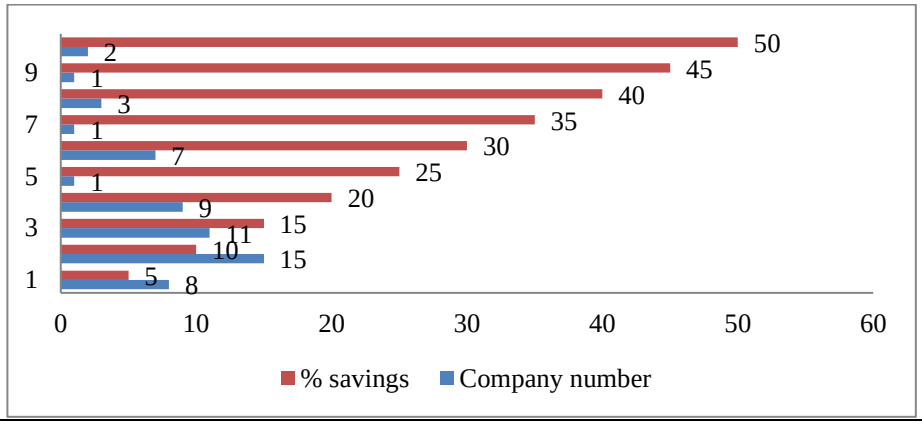
Graph 6: *Savings from IS application*



Source: *the survey*

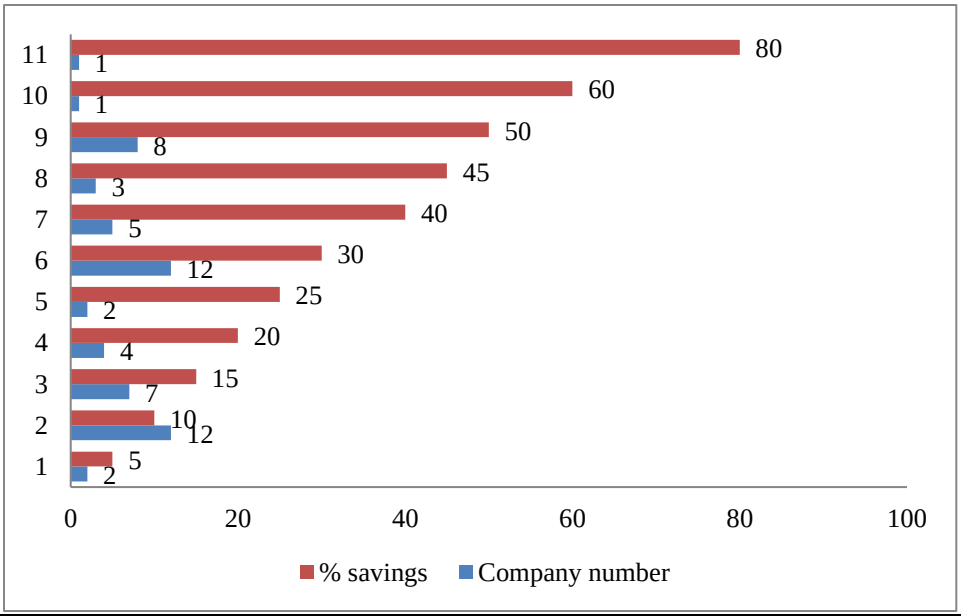
For the question – How much did you save for the following resources (percentages) – the following answers were given (Graphs 7, 8 and 9):

Graph 7: *Work force savings in percentages*



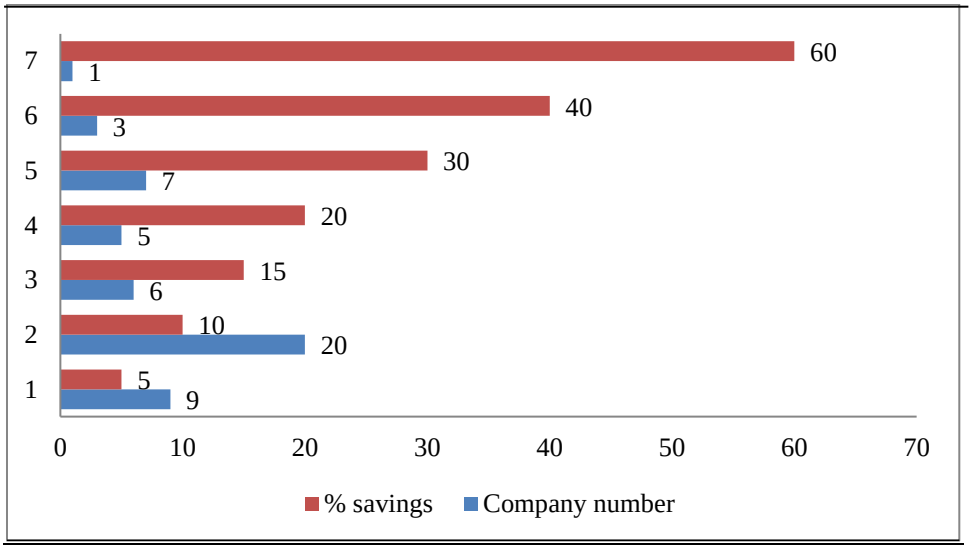
Source: *the survey*

Graph 8: *Time savings in percentages*



Source: *the survey*

Graph 9: *Money savings in percentages*



Source: *the survey*

Conclusion

Based on the analysis of the research results in local companies, in relation to the information system application, we can reach the following conclusion: the access to company sample tells us that most of the companies that took part in the survey were small enterprises 38% and large 25%. According to the structure of the industry they predominantly deal with, 59% were service companies, followed by manufacturing enterprises with the share of 27%.

The survey data tell us that all the enterprises have information system available and most of the enterprises introduced the information system previously, in the period longer than three years.

Over two thirds of the subjects introduced information system with the help of specialized companies, and approximately the same number stated that the time period of IS introduction was shorter than six months. The most popular software solution for the half of the companies was Microsoft Business Solutions, while the other half used other programs. According to the expectations, 82% of the companies bought the software, while only 14% rented it.

Fifty-five companies provided organized training for the employees in new program and equipment usage, 40 of them with the help of specialized companies and 15 on their own. The best covered areas of business were: accounting, sales and procurement, with production only in the sixth place, which sounds logical considering that most of the companies in the survey dealt with services. The best integrated areas in terms of software were: procurement and warehouse management, production and warehouse, production and sales, sales and accounting. Still, most of them integrated all areas of business in one single system, indicating, beyond doubt, IS positive influence on all the elements of the organizational structure. IS introduction enabled the largest savings in sales and procurement sectors, followed by marketing and accounting. These savings in business refer to workforce, time and money resources. Depending on the company and its size, workforce savings percentage ranges from 5 – 50%. The research results in time savings are even more significant. They range from 5% to the incredible 80%. It indicates that IS application is becoming an unavoidable factor in business, especially in large business systems. Money savings as a result of IS application ranges from 5 – 60%, which also seems logical if we consider the former results about workforce and time change.

We can assume that further studies, analyses and deliberations will contribute to mutual enrichment of these innovative integrated management system relations in the function of company development.

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CORPORATE SOCIAL RESPONSIBILITY – POST OF SERBIA CASE STUDY

Radica Bojičić[1]; Marko Pavlović[2]

The aim of this paper is to examine the attitudes of the individual users of the Post of Serbia regarding the quality of services provided and socially responsible business. The obtained results can serve the management of the Post of Serbia in further development of relations with the users. The survey was conducted on the basis of a questionnaire consisting of two parts regarding the examination of attitudes: the quality of services and CSR. The research was conducted on the territory of Republic of Serbia.

Keywords: *socially responsible business, Post of Serbia, environmental analysis and business quality.*
JEL classification: M13, M14, P4, Z1

Introduction

Business ethics represents moral norms, that is, the rules that apply in business relations, encompassing principles and standards, spontaneously created or set, based on moral virtue and professional good, regulating the behavior of persons employed in the Company, and one of the most significant ethical principles is professional performance business activities, compliance with laws and regulations. The ethics must relate to each and every employee in the company, everywhere and continuously. Bearing in mind the fact that management is an interdisciplinary process, ethics has the function of establishing standards in relation to what is good and what is bad in decision making and implementing them. Therefore, the adequate education of employees / managers of business ethics and compliance are of great importance. According to researches conducted in recent years, companies operating in Serbia still do not have a developed culture of ethical behavior, despite the fact that the majority of them have already introduced the Code of Conduct. Recent researches

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in this area show that ethical issues affect not only the public and private business world, but also the non-profit sector as well as the media (Carroll & Buchholtz, 2008). Ethical behavior of companies in Serbia in 2013 (as in all Southeast European countries) is below the global average and significantly below New Zealand as the best ranked country in that year (Tipurić, 2015). The basis of every modern successful business involves respecting the basic human values: honesty, trust and fair dealing (Abramov & Johnson, 2004). It is possible to identify community problems and to provide a timely reaction by developing ethical awareness in business. Strengthening of the company's identity depends on the behavior of management and employees, giving true data, adequate and fair access to competition and other stakeholders, and strategic orientation towards sustainable development and socially responsible business (Vujić et al., 2012).Corporate social responsibility is often used in modern business practice, since companies are responsible for events and activities of a broader social significance to a large extent. The term corporate social responsibility relates to author Harold (Bowen, 2002), who defines it as an obligation of entrepreneurs to implement those business policies, make those business decisions, or follow business activities that are desirable from the point of view of the goals and values of the company in which they operate. Social responsibility is an ethical framework and indicates that the entity, whether an organization or an individual, has an obligation to act in the interests of society as a whole. Milton Fridman, the economist (2012) states that corporate social responsibility is known for its analytical relaxation and lack of rigor. Friedman believes that only individuals can have a sense of social responsibility. Social responsibility has become a part of the latest management strategies where companies are trying to create a positive impact on society while at the same time boosting brand image and doing a good job. It drives organizations to discover and satisfy consumer needs in a way that also ensures social well-being. Today, many of the ethical issues arising from health and safety issues regardingconsumers have led to practices that prevent or reduce the frequency of unethical behavior in businesses. Organizations are expected to have a code of conduct or set of ethical policies that help employees, partners and suppliers in a safe, legal and fair business practice. Although organizations establish ethical and corporate policies to facilitate the recovery process in the event of an ethical scandal, they also serve to promote ethical standards throughout the organization. Numerous studies in the Business-to-Consumer context have established a positive link between the corporate social

responsibility of a company and the significant outcomes of consumers (http://www.msi.org/reports/customer-outcomes-of-corporate-social-responsibility-in-supplier-customer-r).Corporate Social Responsibility (CSR) is a form of corporate self-regulation integrated into a business model. CSR policy functions as its own regulatory mechanism, whereby business monitors ensure its active compliance in the spirit of the law, with ethical standards and national and international standards. CSR strategies encourage the company to make a positive impact on the environment and stakeholders, including consumers, employees, investors, communities and others. Oppewal (2006) found that not all CSR activities are attractive to consumers. He recommends that traders should focus on one activity. According to Becker Olsen (2006), if a company's social initiative is not in line with other goals, the company will have a negative impact.

Research

This research is a continuation of the author's research (Pavlović et al., 2018) „Customer satisfaction with postal services in Serbia".

The results of the research carried out by the authors (Pavlović et al., 2018) regarding the quality of postal services indicate that users on the scales of expected and perceived attribute of postal services expect Reliability (1.30), Safety (1.25) and Empathy (1.22).Also, in the research of the author (Stojanović-Višić, 2016, page 610), the obtained results indicate that there is a difference in the sample, i.e., 60 percent of the respondents think that the Post of Serbia is socially responsible. In the research of the authors (Pavlović et al., 2018), as a recommendation for further research in the postal sector, the need for modification of existing questionnaires, i.e. instruments for measuring the quality and needs for a new instrument for measuring the quality of services is imposed, but also more frequent and detailed analysis. For this reason, the authors decided to further examine the quality of postal services as well as CSR of the Post of Serbia based on the opinions of individual users. It should be noted that in the survey in the age range of 25-35, 84% said that Post is not modern (Pavlović & Bojičić, 2016). The importance of mail is reflected in its availability, and this is also important for foreigners. In the paper (Pavlović & Bojičić, 2017), we can see the number of tourists in Serbia.The subject of this paper is to study the socially responsible business of the Post of Serbia in order to determine whether the Post of

Serbia operates socially responsible and what kind of opinion the service users have. The following methodology of analysis methods, synthesis method, description method, survey method, quantitative analysis and comparative method were used. The data on the attitudes of the users of the Post of Serbia services were collected by the survey method, so the analysis with help of theSPSS statistical program and statistical methods was performed.The initial hypothesis reads as follows:

- H_0Post of Serbia applies the CSR concept.Auxiliary hypotheses:
- H_1The respondents know the meaning and role of the concept of socially responsible business.
- H_2 Respondents believe that the Post of Serbia applies the CSR concept.
- H_3 Respondents believe that the Post of Serbia is socially responsible company.
- H_4 Respondents believe that the Post of Serbia applies the CSR concept in services tailored to individuals and legal entities.
- H_5Respondents consider that the application of CSR plays an important role in the selection of the postal operator.

The total sample of research consists of 100 respondents. The research was conducted in the period from the beginning of April to the middle of May 2018, in such a way that respondents received an invitation to participate in the research via e-mail. In addition to the invitation, respondents were given the explanation that the research is completely anonymous and that the obtained results will be used exclusively for the purpose of developing this scientific paper. When it comes to the structure of the sample compared to the genders, slightly more than half of the overall sample was female respondents (58.0 percent), and slightly less than half of the sample was male respondents (42.0 percent). It can be said that the sample is approximately equal when it comes to the gender of the respondents. Compared to the age of the respondents, the highest percentage of the total sample of respondents is in the range of 31 to 45 years of age (39.0 percent). Respondents aged 46-65 take the second place (31.0 percent), followed immediately by respondents aged up to 30 years (30.0 percent). It can be said that the sample is approximately uniform according to the age of the respondents. When it comes to the structure of the sample according to the level of education of the respondents, the highest number of respondents has university degree (39.0 percent). After that, we have respondents holding a MastersDegree / Magister (20.0 percent), followed by PhD holders (19.0 percent).

Respondents with a completed secondary school (12.0 percent) and a college /associate degree (10.0 percent) were represented in a significantly smaller number. When it comes to the social status of the respondents, the sample is extremely uneven. Specifically, more than 90 percent of the whole sample of respondents (93.0 percent) is employed and 7.0 percent are unemployed. Other categories of social status (student, retires, etc.) are not represented. In relation to the monthly income of the respondents, almost half of the total sample does not want to disclose the amount of their monthly income (44.0 percent), and one quarter of the respondents have monthly income over RSD 55000 (25.0 percent). In the survey, respondents with income from RSD 35000 to 45000 (13.0 percent) and respondents with income from RSD 25000 to 35000 (10.0 percent) were much less represented. In addition, the least represented respondents with monthly income of RSD 45000 to 55000 (5.0 percent) and with income up to RSD 25 000 (3.0 percent). Just over two thirds of the respondents in this study are married or living together (76.0 percent). In addition, 21.0 percent of the respondents are single, and 3.0 percent of the respondents are divorced/ separated. The aim of this research is to examine the opinion of the users of the Post of Serbia services on the concept of socially responsible business. For the purpose of collecting data on the mentioned problem, two scales were used: Business Qualityscale (BQ) of the Post of Serbia and Compliance Level scale in relation to the Application of Corporate Social Responsibility (CSR) in the Post of Serbia. The BQ scale consists of 13 items with a range of respondents from 1 - Poor grade up to 5 - Excellent grade. The quality of the business is operatively defined as *the kindness and availability of employees*, *the quality of services in the office*, *the quality of the Express post*, etc. A higher average on this scale indicates a higher rating of a certain aspect of the quality of services. The scale of the level of agreement with the application of CSR consists of 11 items with a range of answers of the respondents from 1 - I generally disagree to 5 - I completely agree. The degree of agreement with the application of CSR is operatively defined as Corporate Social Responsibility and creates a positive image of Post of Serbia. Corporate Social Responsibility allows the Post of Serbia to have a competitive advantage over the competition. Social Responsibility affects the overall business results of the Post of Serbia, etc. In addition to these two scales, a number of questions were also formulated to determine whether the respondents know what the CSR is i.e. what CSR represent according to their opinion and whether they consider that Post of Serbia apply CSR and which evaluation they

would gave for the CSR of Post of Serbia. When it comes to the reliability of the scale used (Table 1), both scales showed high reliability (α> 0.80). Reliability of the scale Quality Score is α = 0,832 (N = 13), and the reliability of the degree of CSR application scale is α = 0,810 (N = 11).

Table 1: *Reliability of instruments*

Scale	Cronbach's alpha (α)	Number of items (N)
Quality Score	0,832	13
Degree of CSR application	0,810	11

Source: *Author's' calculations*

It was confirmed that there is a statistically significant deviation from the normal distribution on both scales by checking the normal distribution of results on both the scale used (Table 2).

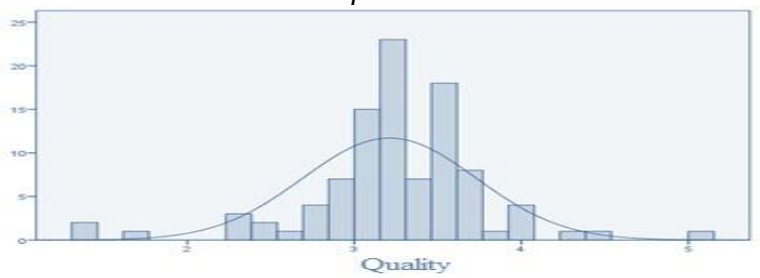
Table 2: *Checking of the normality of result distribution*

Scale	K-S test	p	Sk	Cu
Quality	0,166	0,000**	-0,684	3,911
CSR	0,128	0,000**	-0,967	3,756

*df=100; p<0,01**; Source: Author's' calculations*

The height of Kolmogorov-Smirnov statistics on the quality scale is 0.166 and the significance of the deviation of p = 0.000. On the CRS scalethe height of K-S statistics is 0.128 and the significanceof p = 0.000. These results confirm there is a statistically significant deviation from the normal distribution of results.

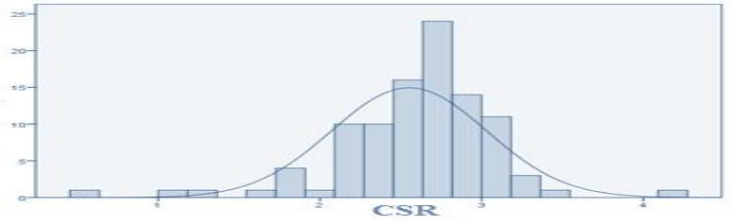
Chart 1: *Distribution of the results on the quality assessment scale of Post of Serbia*



Source: *Author's' calculations*

Chart 1 shows the distribution of respondents' answers on the Quality scale. The resulting diagram shows a deviation in relation to normal distribution curve. The resulting curve is negatively asymmetric (Sk = -0.684) and leptocurtic, i.e. elongated (Cu = 3.911).Graph 2 shows the distribution of results on the scale of the degree of agreement in relation to application of CSR in the Post of Serbia. The negative asymmetry (Sk = -0.967) is even more pronounced in this diagram and the resulting curve form is also elongated or leptokurtic (Cu = 3.756). According to the height and the significance of K-S statistics and the height of the skewness (Sk) and kurtosis (Cu) significant deviation from the normal distribution on both scales, and taking into account the use of *nonparametric methods and techniques* in the subsequent analysis. When it comes to knowing the role and significance of the CSR concept (Table 3), the vast majority of respondents know what socially responsible business (94.0 percent) is, and only 6.0 percent of respondents do not know what is the role or significance of CSR.

Graph 2: *Distribution of results on the scale of the degree of CSR application by Post of Serbia*



Source: *Author's' calculations*

Table 3: *Knowledge of the significance and role of the socially responsible business concept*

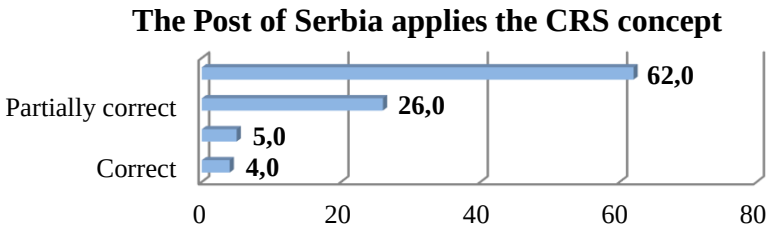
The role and significance of CSR	f	Percent
Yes	94	94,0
No	6	6,0
Total (Σ)	100	100,0

Source: *Author's' calculations*

When asked what the concept of CSR means to them, the majority of respondents chose the answer *Care of society, community and people* (82,0 percent). In addition, respondents frequently selected following responds, *Care of employees*(78,0 percent), *Care of Environment/ Natural Resources* (69,0 percent) and *Respect for the Law* (66,0 percent).When it

comes to CRS in Post of Serbia, the questionnaire on whether the Post of Serbia applies the CSR concept received the average response of the respondents from AS = 3.23, SD = 0.737 (ranging from 1 to 5). Also, on the question of whether the respondents consider the Serbian Post as a socially responsible company, the average respondent's response is AS = 3,36, SD = 0,959 (minimum is 1 and maximum is 5). The obtained scores indicate above the average expressed attitude of the respondents, both in relation to the application of CSR by the Post of Serbia, and in the opinion of the respondents that the Post of Serbia is a socially responsible company.Graph 3 shows the structure of respondents' answers to the question whether the Post of Serbia applies the concept of CSR. More than half of respondents (62.0 percent) answered "I do not have an opinion". One-fourth of the respondents' sample (26.0 percent) believes that it is partially true that the Post of Serbia applies the CSR concept in its business, and 4.0 percent of the respondents consider it to be true. Also, 5.0 percent of the respondents gave the answer *partially incorrect*, and there were no respondents who gave the answer *completely incorrect*. According to the respondents, the Post of Serbia mostly applies the concept of socially responsible business in relation to *Services tailored to individuals and legal entities* (28.0 percent) and *Improvement of business quality through services* (19.0 percent), then through *Sponsorships and donations* (10.0 percent) and *Human Resources Management* (8.0 percent). 2.0 percent of respondents chose the answer *Relations with business partners, suppliers and users, Environmental impact and natural resource management*, and *Health and safety at work*. In addition, as many as 25.0 percent of the respondents answered, *I do not know*, and 4.0 percent of respondents answered *Other*. When asked which fact is of significance for the respondents to use the services of the Post of Serbia, the majority of respondents gave the answer *Reputations and long tradition* (42.0 percent). Also, 21.0 percent of respondents picked out the answer *Accessibility and availability* of Post of Serbia and 17.0 percent stated *Price of the service* as the answer. Employee Empathy (2.0 percent) and Corporate Social Responsibility (7.0 percent) had the smallest frequency. Asked to answer whether the application of CSR has significance in their selection of the postal operator, 71.0 percent of the respondents responded *yes* and 29.0 percent responded *No*.

Chart 3: *Whether Post of Serbia apply the CRS concept*



Source: Author's' calculations

The results of the survey showed that the average Business quality rating of the Post of Serbia was AS = 3.21, SD = 0.519. The minimum score is 1 and the maximum is 5 (Table 4).

Table 4: *The rating severity on Business Quality scale*

Scale	MIN	MAX	AS	SD
Quality	1	5	3,21	0,519

Source: *Author's' calculations*

The obtained score points to the above-average expression of the Quality Score of the Post of Serbia. The respondents gave the highest ratings to *Money Transfer Security* (AS = 3.95, SD = 0.947), *Location of the Post Office Branches* (AS = 3.85, SD = 1.019), the *Express Mail Quality*(AS = 3.84, SD = 0.896) and to *Working Hours* (AS = 3.83, SD = 0.833).

The lowest percentage of respondents gave to the assertions *The possibility of free parking* (AS = 2,05, SD = 0,925), to claim *Waiting time at the office* (AS = 2,45, SD = 0,936) and to claim*Internal and external space adapted for people with disabilities* (AS = 2.47, SD = 0.926). For these three claims, the expression was below the theoretical average, while for all other claims, the severity was above the theoretical average (1 to 5).The results of the survey showed that the degree on the scale of agreement with the CRS application in the Post of Serbia was achieved score which was also considered to be above -average (AS = 3.27, SD = 0.568) and somewhat higher than the average obtained on the Quality Score scale of Post of Serbia.

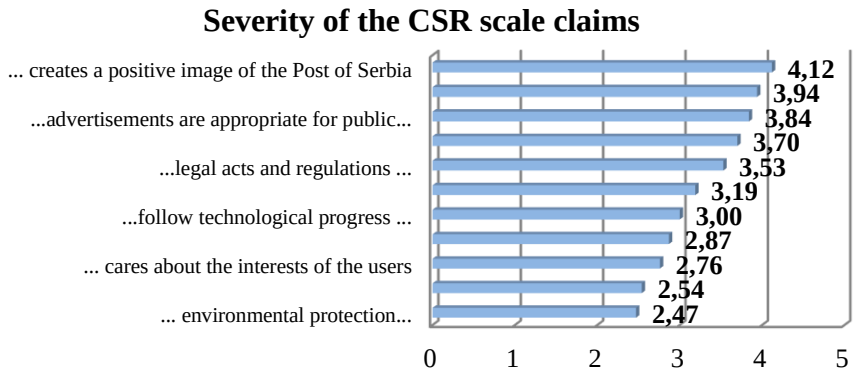
Table 5: *Severity of the degree of agreement on the CSR scale*

Scale	MIN	MAX	AS	SD
CSR	1	5	3,27	0,568

Source: *Author's' calculations*

When it comes to expressing the degree of agreement with the CSR application in the Post Office of Serbia (Graph 4), the strongest expression is obtained for the claim *Socially responsible business creates a positive image of Post* (AS = 4.12, SD = 0.946). High level of accuracy was also obtained for claims S*ocial Responsibility affects the overall business result of the Post of Serbia* (AS = 3.94, SD = 0.993). *In the Post of Serbia, advertisements are suitable for public broadcasting and are not discriminatory* (AS = 3.84, SD = 0.950) and the claim *Socially Responsible Business allows the Post of Serbia a competitive advantage over the competition* (AS = 3.70, SD = 1.059). The lowest expression on the degree of agreement with the application of CSR in the Post of Serbia was obtained for claims *The Post of Serbia promotes environmental protection and conservation of natural resources* (AS = 2.47, SD = 0.958) and this is at the same time the only claim on which the score below the theoretical average was obtained. A somewhat lower expression was obtained for the claim *that the Post of Serbia is well organized, so there are no long wait in the queues* (AS = 2.54, SD = 0.979). On all other claims of this scale, the scores above the theoretical average were obtained. When it comes to the link between the Quality Score of the Post of Serbia and the degree of compliance with the CSR application of the Post of Serbia, a high statistically significant correlation was obtained. The Pearson correlation coefficient $r = 0.744$, $p = 0.000$. The resulting correlation is significant at the level of $p<0.01$ and has a positive sign indicating that with the increase of scores on one scale, the scores on the second scale increase and vice versa.In addition to showing the correlation between the scale of the Business Quality score and the degree of agreement with the CSR application in the Post of Serbia, the research dealt with the existence of differences in relation to the knowledge of the role and significance of the CRS concept, as well as with the attitude of the respondents whether the Post of Serbia applies the concept of CSR or not.

Graph 4: *Severity of the CRS scale claims*



Source*: Author's' calculations*

Table 6: *Differences in the expression depending on the knowledge of the role and meaning of the CSR concept*

Scale	Knowledge of CSR	AS	SD	Z	p
Business quality	Yes	3,24	0,507	**-2,511**	**0,012***
	No	2,69	0,454		
CSR	Yes	3,31	0,540	**-2,475**	**0,013***
	No	2,61	0,637		

df=100; p<0,05; Source: Author's' calculations*

When it comes to knowing the role and meaning of the CSR concept (Table 6), statistically significant differences for both the used scale were obtained. The obtained difference on the scale Business quality is -Z = -2.511, p = 0.012, and on the degree of agreement with the CSR application is Z = -2.475, p = 0.013. Both derived differences are significant at the p<0.05 level and indicate that the respondents who answered *Yes* (I do know the role and meaning of the CSR concept) have significantly more scores on both used scales than the respondents who answered *No*. Of course, this result is interpreted in the light of the response structure of respondents (94 percent - Yes, 6.0 percent - No) where there is unevenness, so the obtained findings are interpreted with care and generalized with reservations.

Table 7: *Differences in severity depending on the fact whether the Post of Serbia implements the CSR concept in its business*

Scale	Post of Serbia applies CSR	AS	SD	χ^2	p
Business quality	Totally incorrect	1,92	0,742	**13,664**	**0,008****
	Partly incorrect	2,97	0,903		
	I have no opinion	3,23	0,376		
	Partially correct	3,20	0,378		
	Totally correct	4,10	0,733		
CSR	Totally incorrect	1,73	0,241	**22,123**	**0,000****
	Partly incorrect	2,78	0,751		
	I have no opinion	3,25	0,453		
	Partially correct	3,46	0,405		
	Totally correct	4,07	0657		

*df=4; p<0,01**;* Source: *Author's' calculations*

Regarding the attitude of the respondents whether the Post of Serbia applies CSR (Table 7), statistically significant differences were also obtained on both used scales. The difference in the scale of the business performance score is $\chi2$ = 13,664, p = 0,008, and on the scale of the agreement with the application of CSR is $\chi2$ = 22,123, p = 0,000. Both of these differences were high and significant at p<0.01, and a more detailed analysis and insight into the severity ofscores showed that the respondents who chose the *Completely incorrect* answer have the lowest scores on both scales, while the respondents who chose the *Absolutely correct*answer have the highest scores on both used scales. It is noticeable that the severity of the scores is accompanied by the positive attitude of the respondents when it comes to the implementation of the CSR concept by the Post of Serbia.

Table 8: *Differences in severity depending on whether Post of Serbia is a socially responsible company*

Scale	Post of Serbia applies CSR	AS	SD	χ^2	p
Business quality	Totally incorrect	2,67	0,945	4,437	0,350
	Partly inaccurate	3,15	0,675		
	I have no opinion	3,31	0,371		
	Partially correct	3,18	0,409		
	Totally correct	3,63	0,774		
CSR	Totally incorrect	2,70	1,077	4,087	0,394
	Partly inaccurate	3,15	0,650		

	I have no opinion	3,24	0,452		
	Partially correct	3,33	0,472		
	Totally correct	3,71	0,703		

df = 4;Source: *Author's' calculations*

Regarding the attitude of the respondents whether they consider the Post of Serbia as a socially responsible company (Table 8), statistically significant differences in the scores on the scales of Business quality ($\chi 2$ = 4.437, p = 0.350) and the degree of agreement with the CSR application ($\chi 2$ = 4.087, p = 0.394) were not confirmed. The highest scores on both scales were obtained from the respondents who answered*Totallycorrect*, and the lowest number was among respondents who answered*Completely incorrect*, but they were small differences that did not show any statistical significance.

Table 9: *Differences in severity depending on the score for socially responsible business of the Post of Serbia*

Scale	Rate	AS	SD	χ^2	p
Business quality	**1**	2,31	0,979	**16,400**	**0,003****
	2	3,02	0,567		
	3	3,18	0,413		
	4	3,36	0,351		
	5	4,46	0,761		
CSR	**1**	2,07	0,710	**16,445**	**0,002****
	2	3,09	0,558		
	3	3,32	0,499		
	4	3,34	0,398		
	5	4,45	0,771		

*df=4; p<0,01**;* Source: *Author's' calculations*

When it comes to the assessments that respondents gave to the socially responsible business of the Post of Serbia (Table 9), statistically significant differences on both used scale were obtained. The scale difference on *the business quality scale*is χ^2 = 16,400, p = 0.003, and on the scale of agreement with the CSR application is χ^2 = 16.445, p = 0.002. Both of these differences are high and significant at the level of p<0.01 and show that respondents who gave the lowest grade of 1 and 2 have significantly lower scores on both used scales compared to those respondents who gave higher grade of 4 and 5 for Corporate Social Responsibility of Post of Serbia that have significantly higher scores on both scales. In addition to examining the existence of differences in the

expression of scores on the scales used in relation to the knowledge of the role and significance of the CSR concept, the research also examined the existence of differences in relation to the socio-demographic characteristics of the respondents: gender, age, level of education, social status, and marital status.

Table 10: *Differences in severity in relation to gender of the respondents*

Scale	Gender	AS	SD	Z	p
Business quality	Female	3,24	0,548	-1,312	0,190
	Male	3,17	0,481		
CSR	Female	3,30	0,535	-1,142	0,254
	Male	3,23	0,614		

df=100; Source: *Author's' calculations*

In relation to the gender of the respondents (Table 10), statistically significant differences in the scores on the scale of the KP (Z = -1.312, p = 0.190) were not confirmed nor on the scale of agreement with the CSR application in the Post of Serbia (Z = -1, 142, p = 0.254). Higher scores on both scales were found within female respondents and lower among male respondents.Regarding the age of the respondents, statistically significant differences on the scale of the KP score (χ^2 = 2.638, p = 0.267) were not confirmed nor the degree of agreement with the CSR application in the Post of Serbia (χ^2 = 1.540, p = 0.463). Compared to the scores, the highest score on the KP scale was obtained from subjects aged 31 to 45, and the lowest from subjects aged up to 30 years. On the scale of stacking with the use of CSR, the same score was obtained from the 31 to 45 year olds and 46 to 65 years of age (AS = 3.30), and somewhat lower score was obtained among subjects up to 30 years of age.In relation to *the level of education* of the respondents, a statistically significant difference in the expression of the scores on the scale of the Business Quality of Post of Serbia was obtained (χ^2 = 16.592, p = 0.002). The resulting difference is high and significant at the level of $p<0.01$, and additional analysis showed that respondents with College / University diploma have significantly more scores on this scale compared to respondents, holders of Master or PhD diploma.Statistically significant differences in the severity of the scores in relation to the level of education of the respondents (χ^2 = 3.784, p = 0.436) were not confirmed on the scale of the agreement of the respondents with the CSR application in the Post of Serbia. A slightly higher score on this scale had respondents with a completed secondary school and with university diplomas, and the lowest score was obtained

from the respondents with a PhD degree. When it comes to the social status of the respondents, statistically significant differences in the scores on the scale of the BQwere not confirmed ($Z = -0.973$, $p = 0.330$), nor on the scale of agreement with the CSR application in the Post of Serbia ($Z = -0.264$, $p = 0.792$). A somewhat higher score on the BQ scale was obtained from respondents who were employed in relation to the unemployed respondents, while on the scale of agreement with the use of CSR, a somewhat higher score was obtained from respondents who are unemployed.When it comes to differences in the scores expressed in relation to the place of residence of the respondents, statistical significance was not confirmed, nor on the scale of the KP score ($\chi^2 = 7.174$, $p = 0.067$), nor on the scale of the agreement with the CSR application in Post of Serbia ($\chi^2 = 1.630$, $p = 0.653$). The difference obtained on the scale of the BQ score is near the significance limit of $p<0.05$, but it is not considered significant. Compared to the scores severity in relation to the place of residence, the highest expression was obtained from the respondents from Central and Western Serbia and the lowest with the respondents from South Serbia on both scales used.In relation to the monthly income of the respondents, statistically significant differences in the scores were not confirmed on the scale of the Business quality of Post of Serbia score ($\chi^2 = 3.634$, $p = 0.603$), so on the scale of the agreement with the CSR application in Post of Serbia ($\chi^2 = 5.108$, $p = 0.403$). The highest scores on the BQ score were obtained from respondents with income from RSD 35 to 45 000 and respondents who do not want to disclose the amount of their monthly income, and the lowest score on this scale was obtained from respondents with income up to RSD 25 000. On the scale of agreement with the CSR application in the Post of Serbia, the highest scores were obtained from the respondents with income from RSD 35 to RSD 45 000 and subjects with income up to RSD 25 000 dinars per month, while the lowest gain was obtained from respondents with monthly income of RSD 25 up to RSD 35,000.When it comes to the marital status of respondents, statistically significant differences were not confirmed on the scale of BQ ($\chi^2 = 0.774$, $p = 0.679$), nor on the scale of agreement with the CSR application in the Post of Serbia ($\chi^2 = 1.483$, $p = 0.476$). In relation to the expression of the scores on both scales used, the highest scores were obtained from subjects who were divorced / separated, and the lowest scores among the subjects who were married / single.

Conclusion and discussion of research findings

In order to carry out the research two Likert type scales were used, with scaled responses from the respondents ranging from 1 to 5. The scales used are the Business Quality (BQ) in Post of Serbia and the scale of degree of agreement with the CSR application in the Post of Serbia. In addition, in order to carry out the research, a questionnaire was also formulated aimed at examining the role and significance of the concept of socially responsible business, examining the meaning of this concept for respondents, and also examining the extent to which the CSR concept is applied according to the opinion of respondents in Post of Serbia. The questionnaire also contained a section that examined the socio-demographic characteristics of the respondents. The results of the research showed, first of all, that both scales used had high reliability ($\alpha >$ 0.80). In addition, a statistically significant deviation from normality was obtained on both scale used. The obtained results showed a negative asymmetry on both scales used and elongated shape of the distribution curve. With this in mind, nonparametric methods and techniques were used in further analysis and presentation of research results. The results of the research have shown that when it comes to knowing the concept of socially responsible business, the vast majority of respondents (> 90.0 percent) know what the role and meaning of the CSR concept is. When asked about the concept of socially responsible business, the majority of respondents chose the answer *Care of society, Community and People*. Also, respondents were frequently selected following answers, *Taking care of employees*, then *Taking care of the Environment / Natural Resources* and *Respecting for the Law*. In addition, slightly less than half of the sample was selected *Responsibility* as a response, and slightly more than one third chose *Honesty, Morality, and Education* as a response. The smallest frequency was obtained for answers such as*Something Positive* and Fair Worker's Relationship to Work. Nevertheless, the results of the research showed, when it comes to the opinion of the respondents whether the Post of Serbia applies the CSR concept, more than half of the respondents have no opinion, and one-fourth of the sample of respondents find it partially correct. When asked *whether you consider the Post of Serbia a socially responsible company*, almost half of the sample respondents said partially while one-third of respondents have no opinion. Also, when it comes to the assessment of CSR in Post of Serbia, an over-estimation was obtained. According to the respondents, the Post of Serbia mostly applies the CSR concept in relation to *Services tailored to*

individuals and legal entities and *Improving the quality of business through services*. In addition, CSR is also applied in the form of sponsorships and donations and through *Human resource management*. It is important to note that one-fourth of the respondents' sample does not know how the Post applies CSR. When it comes to fact that it is important for respondents to use the services of the Post of Serbia, the majority of respondents answered Reputations and long standing tradition. *Employee Empathy* and *Corporate Social Responsibility* had the smallest frequency. The obtained findings showed that the CRS use by the Post of Serbia is crucial in the selection of the postal operator for two-thirds of the respondents, and for one third of the respondents the implementation of this concept has no relevance in selecting the postal operator. Regarding the Business Quality of the Post of Serbia, according to the findings obtained by this research, there is a high and above average BQ rating of the Post of Serbia. Money Transfer Security, Locations of the Post Office Branches, Quality of Express Mail and Working Hours got the best ratings by the respondents. The worst ratedare *The possibility of free parking, Waiting time in the office queue* and A*dapting the interior and exterior space for people with disabilities*. The greatest agreement is obtained for the claim *Socially responsible business creates a positive image of the Post of Serbia*. High level of severity is also given for claims *Social responsibility affects the overall business results of the Post of Serbia, In the Post of Serbia, advertisements are suitable for public broadcasting and are not of discriminatory contents* and claim *Socially responsible business enables the Post of Serbia a competitive advantage over the competition*. The smallest level of agreement with the CSR application in the Post of Serbia was obtained in relation to claims *The Post of Serbia promotes environmental protection and conservation of natural resources,* and *the Post of Serbia is well organized and there is no long wait in the queue.*The results of the research have shown there is a high, statistically significant correlation between the BQ estimation in Post of Serbia and the degree of agreement with the CSR application in the Post of Serbia. The resulting correlation has a positive sign that indicates that with the increase of scores on one scale, the scores on the second scale increase and vice versa. In addition to showing descriptive indicators on the scales, the BQ score and the degree of agreement with the CSR application, the research also examined the existence of differences in the scales used in relation to the knowledge of the role and meaning of the CSR concept. The results of the research showed that the respondents who answered *Yes* (I do know the role and meaning of the

CSR concept) have statistically significantly higher rates on both scale used than the respondents who answered *No* (I do not know the role and significance of the CSR concept). Statistically significant differences in the scores on the scales used were obtained in relation to the attitude of the respondents whether the Post of Serbia applies CSR. Subsequent analysis and insight into the scores showed that respondents who chose the answer *Totally incorrect* on both scales had the lowest scores, while the respondents who chose the answer *Totally correct* have the highest score on both scales used. It is noticeable that the severity of the scores is accompanied by the positive attitude of the respondents when it comes to the implementation of the CSR concept by the Post of Serbia. In addition, a statistically significant difference was obtained for both the scale used and in relation to the assessment given by respondents to the socially responsible business of the Post of Serbia. In addition to examining the differences in scores severity on the scale of the Business Quality of the Post of Serbia and the degree of agreement with the CSR application in the Post of Serbia, the research also included testing the existence of differences in the severity of the scores in relation to the socio-demographic characteristics of the respondents. Statistically significant differences in the severity were obtained only in relation to the level of education of the respondents, while in relation to other socio-demographic characteristics of the respondents, statistically significant differences in the scores were not confirmed on the scale of the BQ assessment in Post of Serbia and on the scale of agreement with the CSR application in Post of Serbia.

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STRATEGIC ANALYSIS OF ORGANIZATION BY AHP METHOD

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Abstract

Strategic analysis of the general external factors of various models of organizations is a problem for managers which can be solved using multi-criteria decision-making (MCDM) methods. Quality strategic analysis of organizations provides the opportunity for quickly recogniztion of the risks, weaknesses, opportunities and chances of the company. This positively influences the goals of sustainable development, competitive advantage and project management, all of which contributes to meeting stakeholders' interests. Each organization's goal is to satisfy all stakeholders. The approach is based on the AHP method for analyzing global, demographic, economic, ecological, technological, political-legal and socio-cultural trends. The analysis was done using the Criteria Decision Plus software. The proposed methodology is used to determine the impact of general external factors on various sustainable models of organizations.

Keywords: *AHP analysis, strategic analysis, MCDM.*
JEL Classification: C44, D81, LM21, O21

Introduction

Strategic analysis of general external factors in different models of organizations plays an important role in business. It is the first step in strategic management (Grasseová et al., 2010). An analysis of the strategic management of the organization can positively contribute to the goals of sustainable development and building a competitive advantage (Sullivan et al., 2018). The goals of sustainable development and a

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competitive advantage play an important role in the globalization of the world market and the changing business environment today. The current modern business environment requires a strategic analysis of the trends of different models of organizations and virtual design. The analysis of a virtual organization effectively affects the efficiency of the organization's business, as virtuosity significantly influences the efficiency of teams in such organizations (Hosseini et al., 2018).

The modern operation of various models of the organization from managers requires constant monitoring of the caring and interior environment in order to identify the common interests of stakeholders.
The authors in this paper aim to make an AHP method, one of the methods of multi-criteria decision making, assess the impact of general external factors on organizations.

MCDM methods, when assessing or making decisions, significantly reduce subjectivity from other methods.

They can be defined as the process of selecting a more suitable solution from a set of offered alternatives, based on their performance in relation to the set of criteria for evaluation. In addition to determining the overall performance ratings of the considered alternatives, determining the weight of the assessment criteria is also very important activity in MCDM models (Stanujkić et al., 2017), which is the reason for determining the most influential external environment in the organization.

The strategic annals analyze global, demographic, economic, environmental, technological, political and legal and socio-cultural trends that significantly influence the approach (interests) of stakeholders in today's business of Serbia.

The results obtained have potentially important guidelines by offering a complete strategic analysis to create sustainable business models that will give answers to all stakeholders.

The work is organized in the following way: the first part of the paper is Introduction; in the second part the Theoretical Basis is presented, in the third part explains the methodological techniques used in this paper, the AHP method; The fourth part presents the results and their analysis. The

last part ends with the conclusion and recommendations for further research.

Theoretical Framework

Today, the modern society is characterized by high dynamics manifested through numerous changes as follows: the market penetration and diversification, the chain of international trade becomes stronger, strong competition, intensive research work, a large number of eco-innovations, technology development and others (Beretta, 2018). The result of these trends is a race for better organizational positioning of the organization in the market so it is necessary to analyze the external and internal factors of organization for the customer satisfaction to the extent of fulfilment of their requirements and achieve higher profits. Ozatac et al. (2016), in their study, evaluated customer satisfaction in the banking sector of North Cyprus and come to the conclusion that positive customer satisfaction plays a major role in improving the company's performance.

Analysis of the context of the organization is a fundamental assumption for the success of modern organizations. The context of the organization is made up of its external and internal issues, comprehensive specificities and area of the system application (Castka & Balzarova, 2018).

Analyzing the impact of the external environment is a very complex process and requires knowledge in the field of human resources management, strategic management, multi-criteria decision-making and quality management system (QMS). Human Resource Management (HRM) in some organizations becomes an essential strategic component in achieving competitiveness (Hirt & Ortlieb, 2012; Karabašević et al., 2018).

SWOT is often used to analyze external factors of the organization (Grasseova et al., 2010; various studies including various software (Sullivan et al., 2018, Polat et al., 2017). The team conducting the analysis should have a large number of relevant facts that will accurately determine the organization's ranking, where it is organized in relation to competition, how interested parties are satisfied, employee trust, all of which affects the performance of an organization. It is obvious that the behaviour and confidence of employees can strongly affect the organization's performance (Bren et al., 2011; Brovan et al., 2015).

One of the key changes in the international Standard ISO 9001 of 2015 is Clause 4 The context of the organization. This newly introduced clause requires from organization to determine the strategic analysis of the organization, which consists of the external and internal analysis. Strategic analysis is the first step of the strategic management (Sullivan et al., 2018). This clause was added to the quality management system to comply with the strategy of the organization, with the mission and vision of labour organization. In determining the context of the organization to achieve its goals, the organization takes the external environment, external issues and internal environment, internal issues that are important for the present and future ranking of organization and the quality management system. Stakeholders are those who fit into the ISO Standard 9001:2015. From the organization's management is expected to consider all of their external and internal issues that affect the safety of administration the quality of projects, products, and services. The standards ISO 45001, which replaces the existing OHSAS 18001 puts a stronger emphasis on the context of the organization, which will be compliant with ISO 9001 (Quality Management System) and ISO 14001 (environmental management).

One of the key changes in the international standard ISO 9001 of 2015 is the Clause 4 Context of the Organization. This newly-formed clause requires the organization to determine the strategic analysis of the organization, which consists of an external and internal analysis. Strategic analysis is the first step in strategic management (Sullivan et al., 2018). This clause is added to the quality management system in accordance with the organization's strategy, with the mission and vision of the organization of work. In determining the organization's context for achieving its goals, the organization takes over the external environment, external issues and the internal environment, internal issues that are important for the present and future ranking of the organization and the quality management system. Interested parties are those that fit into the standard ISO 9001: 2015. The organization's management is expected to consider all its external and internal issues that affect the security of administration, the quality of projects, products and services. Standards ISO 45001, which replaces the existing OHSAS 18001, place a stronger emphasis on the context of the organization, which will be harmonized with ISO 9001 (Quality Management System) and ISO 14001 (Environmental Management).

MCDM methods are rapidly evolving towards the methodology for solving real problems and are used by researchers from different fields (Bogdanović & Miletić, 2014; Dadelo et al., 2014; Keshavarz et al., 2015; Miletć et al., 2015; Karabašević et al., 2015; Kosareva et al., 2016; Bogdanović et al., 2016; Mulliner et al., 2016; Miletić et al., 2016; Maksimović etal., 2016; Karabašević et al., 2016: Stanujkić et al., 2017; Zulqarnain & Daya, 2017; Karabašević et al., 2018).

These methods have their advantage, and that is a simultaneous consideration of the conflict, financial and nonfinancial, quantitative, qualitative criteria, proportional and disproportional units. There is a large number of software packages that enable them an easier analysis and solution to all conflict problems, and the best known are the Expert Choice, Plus Decision, Decision Lab, and ELECTRA.

The AHP method was used to rank the general external trends, external environments of the organization, their weight coefficients were determined and weights and how many percents each of them affects the context of the organization.

In order to define the complexity of project management, it is necessary to evaluate the impact of an external general environment (criteria) on the work environment of the organization. A greater complexity of the project can lead to failure if the complexity of the project is underestimated (Bosch-Rekveldt et al., 2011) and does not undertake an external analysis of the overall impacts on the organization. It is important to evaluate external general factors that are most important for strategic organization decisions and quality project management. This methodology helps managers to quickly respond to environmental factors, make appropriate decisions, foresee potential successes or losses, identify strategic directions of the organization, continually adapting to the requirements of standard ISO 9001:2015 for better project management.

The authors Érdila and Erbiyik (2015), by implementation the AHP method through the SWOT analysis, used for selecting the best strategy and management development of the small business of Turkey (Selection Strategy via Analytic Hierarchy Process: An Application for a Small Enterprise and Milk Sector). The authors Bartusková and Kresta (2016), by implementation the AHP method in conjunction with SWOT analysis,

used for strategic analysis of organization (Application the APH Method and the External Strategic Analysis of Selected Organization). Polat et al. (2017), used the same methods for analysis to determine the strategy for the vision of the cadastre, in order to improve quantitative information in the strategic planning process.

This paper analyzes the general external environments of an organization using the multi-criterion analysis. The aim is to show the intensity of operation the external environment to the context of the organization implementing the multi-criteria decision-making method (MCDM). An efficient methodology for analyzing the context of the organization is proposed, which will serve to analyze the general external factors of organizations in order to identify the threats, strengths, weaknesses, and opportunities of the organization, for the purpose of quality project management.

Methodology

AHP is a one-way hierarchical relational model in which the extent and qualitative/subjective and quantitative assessment based on the relative importance of each criterion incorporated at each level of the hierarchy (Modaka et al., 2017). AHP method is an efficient tool for solving complex problems. Decision makers of the AHP method serve to determine and make the best decision. This method is used to make decisions in many areas such as economic, social and managerial sciences (Saaty, 1980). Problems in decision-making are usually very complex and difficult to consider as problems with one criterion (Keshavarz et al., 2016). So, using only one dimension of the decision-making process could lead to unrealistic decisions (Dadelo et al., 2014; Chakraborty et al., 2015; Zavadskas et al., 2013; Zavadskas et al., 2015).

The first is found the goal, then the criteria and sub-criteria and at the end the possible alternative. Comparison of criteria and alternatives is made on the basis of the scale with scores from 1 to 9, Table 1. AHP is a quantitative technique that allows the structuring of complex decision problems with multiple criteria and provides an objective methodology for a wide range of decisions.

AHP is based on the decomposition of complex decision problems in the multi-dimensional hierarchical structure of objectives, criteria, and

alternatives. After that, impact assessment of criteria is done. The comparison of the alternatives in relation to each criterion is made, and the final ranking of alternatives is obtained.

Table 1: *Scale of comparison of decision elements*

Dominance	
Description	**Value**
Equal	1
Weak dominance	3
Strong dominance	5
Very strong dominance	7
Absolutely dominance	9
2, 4, 6, 8 are intermediate values	

Within the general environment, the managers need to investigate the broader global demographic, economic, environmental, technological, political-legal, social and cultural trends that could endanger or enhance the organization, Table 2. The analysis has a positive character because it warns the organizations of the threats and opportunities. It can be said that the external analysis is a general term to identify the opportunities and threats of an organization. The external analysis should be focused on detection the trends affecting the future of the organization (Bartusková & Kresta, 2016).

Table 2: *Criteria for selecting the most influential general external impact on the organization.*

Cr.	**Name**	**Description**
C_1	Global trends	The growing population of some countries such as Nigeria, which will have until the end of this decade higher population than Russia; that means the opening of large markets such as China, India, Arab countries, Latin America and Eastern Europe. The opening of new factories in countries where the population increased (Asia) and cheap labour. So, the global trends are one of the main factors affecting the context of an organization.

C_2	Demographic trends	Demographic conditions include trends in physical characteristics of the population, such as gender, age, education level, income, residence, family composition, employment, the outflow of highly educated and technically skilled workers (popularly called brain drain), etc. Expansion or reduction of the markets, in general, is changed through migration, population growth, or through lower or higher mortality rates. Changes in these characteristics may limit the plans of organization, management and control of managers. Demographic trends affecting a lot the success, growth and development of the organization, its ranking and survival. A great concern was caused by the results of the Report from the World Economic Forum for the period 2010-2011, according to which Serbia remains has a high position in terms of the impact of circumstances that promote the brain drain Pejin-Stokić & Grečić,2012. The modern business requires from managers to analyze the environment in obtaining the information on whom and to whom sell the product and services incurred due to many changes. Since the managers are required to have the ability to quickly detect resulting changes from the environment, to analyze them, to overcome the resistance and to manage them in the organization (Beretta, 2018).
C_3	Economic trends	Economic trends mark the organization to find new ways to maximize profits and thereby increase the performance of the organization. Interest rates, inflation, market fluctuations, exchange rate differentials, fiscal policy, prices of products and services are economic trends that could jeopardize the practice of managing the organization. An organization oriented towards achieving more efficient business has great chances to become competitive in a highly competitive environment.

C_4	Eco logical trends	Organizers of management are forced to approach new demands and find new solutions in order to conquer the market and become competitors (Brad, 2008). Implementation of different management systems, such as Quality Management System (QMS), Environmental Management System (EMS) would be solutions for sustainable business. QMS has already made tremendous progress, and the implementation of other management systems is only a matter of time.
C_5	Techno logical trends	Technological changes are developing lighter solutions, innovation within the organization. Finding technological solutions is a difficult process of innovation. Innovation by definition creates something new, bringing added value or profit to the enterprise, while innovation requires the allocation of resources, both material and human, and the result of an innovative process is difficult to control or predict (Perdomo-Ortiz et al., 2009; Stanojević Šimšić et al., 2014; A. Kostov, et al., 2018).
C_6	Politi cal – legal trends	In the process of formulating the political options, the organization must take into account the externals opportunities and threats for environmental protection, the present and future and internal resources, strength and weaknesses of the organization, competitive advantages regarding the competitors (Voiculet et al., 2010). The political and legal trends cover all laws, regulations and political framework in the organization. These trends give an organization the opportunity to provide the political climate and legal stability, which can encourage or discourage the organization and avoid a risk. Managers of an organization must take the present opportunities, threats, future strengths, and weaknesses of the organization in relation to the competitive advantage. Political changes signal the changes in legal aspect, in the aspect of national legislation focusing the organization on the new opportunities or threats. The political and legal trends have laws that the organization must accept, keeping the internal documentation relating to the financial performances and business compliant to the quality

		system (QMS).
C_7	Socia-cultural trends	Modern business brings different markets, business with the differentiated workforce, more and more business with the multinational companies, which are the key socio-cultural trends that directly affect the organization. Organization management and employees need to acquire knowledge on the cultural diversity of specific markets including language. The socially responsible business can affect the image of an organization, the opportunity and threat. Therefore, the social and cultural trends have a large impact on the working environment (context of organization) of the company.

After defining the criteria, calculation of the weight coefficients of criteria is done. The weight coefficients show the degree of influence of each criterion in the ranking result.

Table 3:*The matrix of comparison of criteria*

Criteria	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**	**C_7**
C_1	1	5	3	6	5	5	9
C_2		1	1/3	1	1	1/5	5
C_3			1	2	3	3	9
C_4				1	1	1	3
C_5					1	3	5
C_6						1	3
C_7							1

It the range from 0 to 1, and the higher its value criteria has a greater impact on the ranking result. The sum of weight coefficients of all considered criteria must be equal to one. Table 3 presents this matrix (dimensions 7x7), obtained on the basis of empirical evaluation the decision maker (a team of experts) in order to determine the importance of each individual criterion for determining the specific external influence on the context of the organization.

Results and discussion

Based on the AHP calculation, the most influential external specific factor is obtained in the context of the organization. The first is the globalization trend (C1), the second is the economic trend (C3), and the third is a technological trend (C5). The degree of consistency is 0.090 what is less than 0.1 so that obtained results can be used for decision making in the further process.

Based on the obtained results, five categories of criteria are distinguished by the severity of the impact of understanding the context of the organization. The results were obtained using the software Criterion Decision Plus, Table 4.

Table 4: *Results obtained by the AHPcalculations*

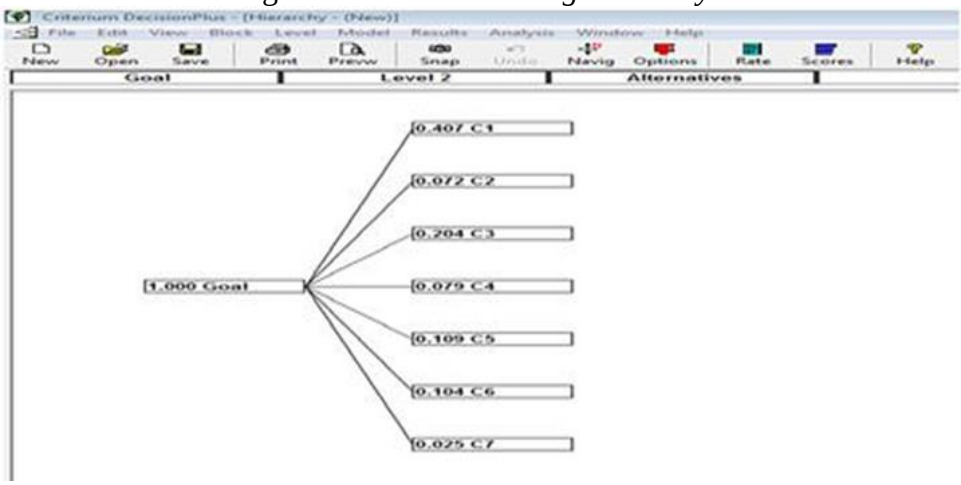
Criterion	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Wight coefficients of criterion	0.407	0.072	0.204	0.079	0.109	0.104	0.025
Consistency coefficient	0.090<0.100						

The first category includes the globalization trend (C1), which has the greatest impact on the contest of organization because it has the highest value weight coefficient of 0.407. So it affects 40,7% to the context of organization. Understanding the context of organization mostly depends on the global trends, as follows: the survival of organization, ranking and competitiveness.

The second category, also significant, includes the economic trends that affect impact with 20.4% on understanding the context of the organization, and those are the interest rates, inflation, fluctuations in the market, foreign exchange, fiscal policy, product, and services prices because its weight coefficient is 0.204, Fig. 1.

Figure 1: *Diagram strength of influence of the external environment on the general working environment of the organization*

Figure 2: *Decision-making hierarchy*



The third category includes the technological (C5) and political-legal trends (C6). They have approximately the same values of the weight coefficients, so they have the same impact on the context of the organization, Fig. 2. The value of their influence ranges from 10.4% to 10.9%.

Technological trends change the fundamental ways of organizational structure, and the political-legal have the laws under which the organizations must be managed.

The fourth category consists of demographic trends (C2) and ecological trends (C4). The weight coefficients are of 0.72 to 0.79, that means that they are approximately the same. They act with 7.2% and 7.9% to the

context of the organization. Demographic trends affect a lot the success, growth, development, survival of the organization, and market reduction and expansion. The ecological factors can be a great threat to the organization; weather disasters can cause a lot of damage, what nowadays often occur, for example, a threat to the food production organization.

Finally, the five category includes the social and cultural trends (C7). Its influence on the context of the organization is 2.5%. The reason is that today's modern business, different markets, operations with the different workforce, cultural diversities, including the language, managers, and employees should be familiar with each other. The companies are undergoing major changes, which are created because of the diversity that needs to be adjusted, businesses around the world, in the local or national culture. Thus, the social and cultural trends with a small percentage have an impact on the context of the organization.

The analysis of the obtained results shows that our results are similar to the results of other researchers in this field. Globalization trends have the greatest impact on the context of the organization.

Conclusions and future perspectives

The proposed AHP methodology enables the organization's managers to identify the risks and opportunities, provides a more effective understanding of the organization and its context, provides better compliance with the ISO 9001:2015 standard, referring to Clause 4 (organization and its context) and Clause 8 (project management) as well as QMS planning, understanding the needs of stakeholders, etc. Analyzing the external influence of the general environment is a very complex process and requires knowledge from the field of strategic management, multi-criterion decision making, and quality management system (QMS).

Based on the analysis of results we conclude that in the context of organizations and project management, the greatest influence has global trends and the smallest impact has social and cultural trends. Thanks to this multi-criteria analysis managers receive the guidance of the general external environment in the context of the organization.

The results obtained show the following:

- the facts and a methodology that managers should use to make strategic decisions;
- the planning and management of the organization and project tasks;
- where and how to position the organization and project activitie;
- the opportunities and threats for the organization and competition for the implementation of new projects;
- the perception of the possibility of survival of the organization and
- the most important identification of the risks and opportunities manage the Quality Management System.

The contribution of this paper is to support managers in evaluating internal and external environments in order to improve the vision and mission of the organization. The contribution of science is in expanding and linking theoretical and practical knowledge on assessing the organization's understanding of the implementation of the MCDM method for risk and a greater chance for the success of project management.

From all (MCDM) methods in order to better understand the context of the organization. This future research should be directed towards the implementation of multi-criteria decision-making resultant model analyzes the context of the organization is to help project managers in making appropriate decisions that will positively affect the satisfaction of all the interested parties.

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INNOVATION AS THE PILLAR OF THE GLOBAL COMPETITIVENESS INDEX OF THE ECONOMY OF SERBIA

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Abstract

The paper presents a comparative analysis of the development of the innovative sector of the Republic of Serbia as one of the basic pillars of competitiveness of the economy. The influence of public management on the increase of the innovation index was also analyzed, and a special review was given to activities in the period after 2000, when certain changes in the RDI policy were made, and the development of the competitiveness of the national economy.

Keywords: *Global Competitiveness Index (GCI), Innovation, Competitiveness, Global Innovation Index (GII), Economy, Innovation Performance*
Jel classificaiton: O00, O10

Introduction

A good connoisseur of the history of Serbian science can conclude that the process of strengthening the innovation sector is one of the most urgent problems. That is why one of the long-term goals is the establishment of a solid link between scientific research organizations and the economy, transfer of knowledge in the economy in order to increase competitiveness, as well as connecting companies with an innovative startup community.

The World Bank warned us that "excellent science can be found at many institutes and faculties in Serbia, but it is not well connected with the private sector." The fact is that Serbian scientists and partners from the

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private sector publish only 6.3 work per million inhabitants, Croatian 11.8, and Austrian 61.9. The World Bank's analysis showed that in the countries of the Western Balkans, if companies invest in research, their sales are growing at 12% and productivity at 6%. It has been proven that innovative companies grow faster 15% in sales and 8% in labor productivity, which together contribute to improving the competitive position of the economy. In Serbia, the increase in R & D allocations to 3% of GDP (the EU stands out 2.03%) brought 6% GDP growth and 13% of the increase in exports. The partial participation of the business sector in Serbia in financing research is only 7.5%, while in OECD countries, the business sector finances 60.8% of research and development costs.

Public management activities in innovation sector after 2000

Until 2000, a little had been done done in this area in terms of legislation and in any other related activities as well, so it was an uneasy task to make up more than a decade of what was missed. Along with intiating the procedures for creating a legal framework, the significant actions have been started to promote and emphasize the importance of this activity for growth and development of the economy and thus the general society of Serbia.

Activities that had been carried out in the period after 2000 and until the Law on Innovation Projects was passed, were related to the development of innovation, and for their most part referred to the development of adequate legal framework that would regulate this matter in accordance with international standards and practices.

However, allocations for the science and technology have not been significantly improved, and remained at about 0.3% of Gross Domestic Product. There have been no larger investments into the infrastructure. A significant number of young scientists and highly qualified engineers are continually leaving the country. Students are less interested in natural sciences and mathematics. The economy fails to invest significantly into the technology. It is quite evident when observing what Serbia is launching on the world market. When analyzing export trends, there is hardly any difference between the contemporary and medieval Serbia.

Investing in science and technology is the only way to create a sustainable economy, because medium and highly developed countries invest more

than 1% of their GDP in science and technology. There is a large number of papers, both theoretical and empirical, demonstrating the key role of Scientific Research (SR) and Research and Development (R & D) and the innovation activities in general, depicting them as a cause of employment and competitiveness growth, and the results gained from Scientific Research, Research and Development, and innovations create a foundation for the economy and society development. The marginal value that has to be achieved, and that provides a faster support to SR, RD and innovative activities in the state, is 1% of GDP (Đurović-Petrović, 2011).

After escaping the difficult period of 1990s, the budgetary allocations for science in Serbia significantly increased in gross amount, from modest €27 million in 2001, to €100 million in 2008, as shown in Figure 1.

Figure 1: *Investments in SRD from 2001 to 2008*

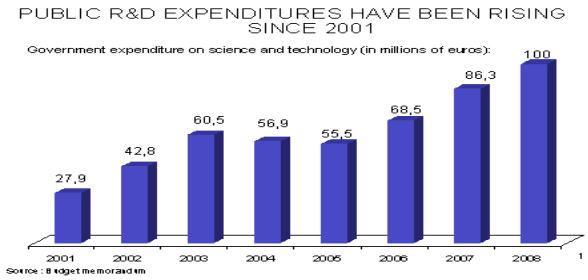


Table 1 provides an overview of investments in science, research and development from public resources over the past eight years, noting that these investments amounted to between $40 million and $60 million in the 1990s, and that the level of investment amounted to about 1% of GDP, which indicates that the financial support to the SRD in Serbia increased several times.

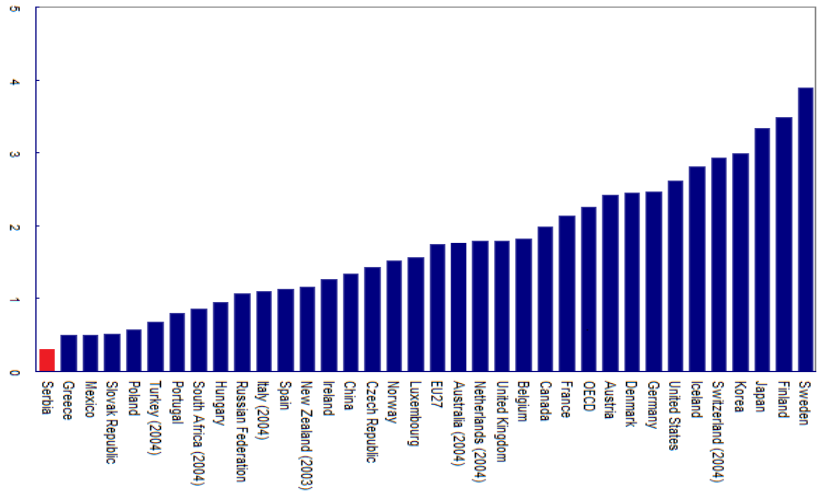
Table 1: *The SRD costs from the public resources*

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Billions of dinars	1.142	1.853	3.132	3.545	4.643	6.258	8.314	9.051	8.233
Millions of euros	19.12	30.13	45.85	44.94	56.0	74.9	101.40	105.04	

Source: *Law on Budget of the Republic of Serbia, author's treatment*

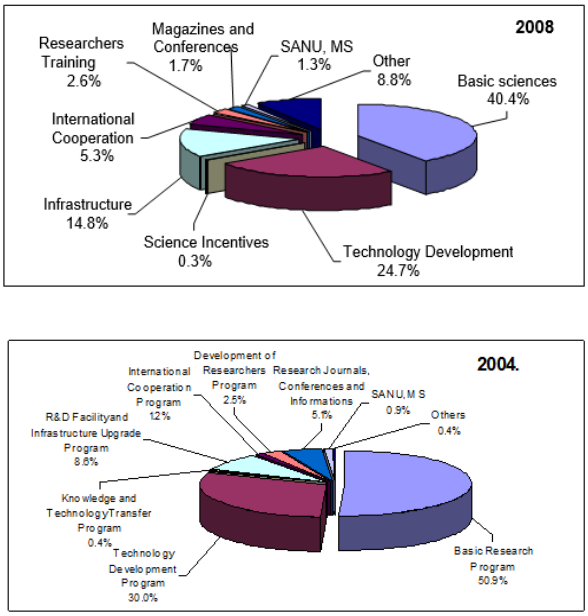
The network of scientific, research and innovation organizations has changed after 2005, by the enforcement of the adopted laws, which among other things, provided for the evaluation of competence of scientific research organizations to conduct scientific research, as well as the accreditation from the Ministry of Science and Technology Development. In that way most research and development units in the former large companies ceased to exist during the ownership transformation, adapting its activities to conditions for the establishment of innovation and development centers (according to the Law on Innovation Projects) (Ministry of Science and Technology Development, 2009).

Figure 2: *The scope of investments in science in some countries*



An example of the allocating funds from the Government budget to specific programs of the Ministry of Science and Technology Development of Serbia is shown in Figure 3.

Figure 3: *The allocation of funds from public resources to programs supported by the Ministry of Science and Technology Development*

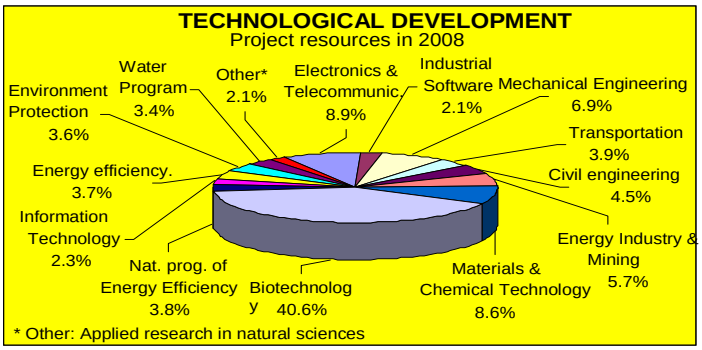


Source: *Law on Budget of the Republic of Serbia, author's treatment*

There is an example given to compare the allocation of funds in 2004 and 2008. Table 1 shows that about 80% of all funds were directed to projects of basic research and technological development in 2004, dominated by basic sciences. Other programs share was less than 10%. Only 1.2% of funds were directed to the completion of international cooperation program. The situation changed in 2008, so that about 2/3 of the total budget for science were directed to the programs of basic research and technological development (around 65%) with the trend of lowering dominance of basic research, and increasing funds (more than twice) for upgrading infrastructure. The international cooperation increased for four times (to about 5%).

Allocation of funds by the area of technological development is shown in the Figure 4. Biotechnologies account for about 40% of all MSTD funds, followed by electronics and telecommunications and materials with a share below 10%, except that now all projects related to energy account for about 13% (Ministry of Science and Technology Development, 2009).

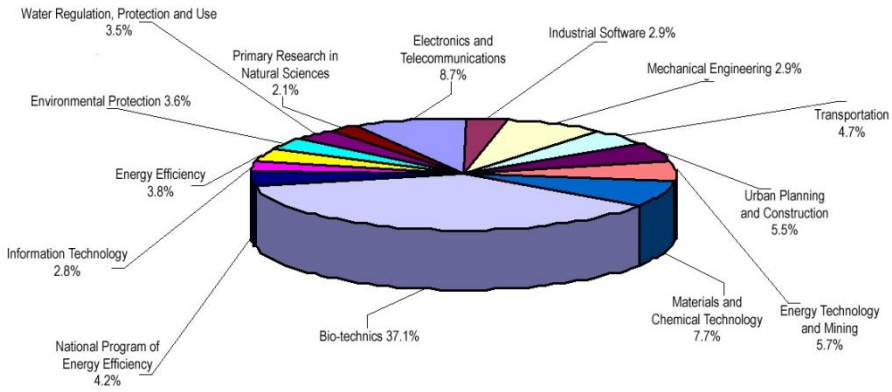
Figure 4: *Allocation of funds for projects by the area of Technological Development in 2008*



Source: *Law on Budget of the Republic of Serbia, author's treatment*

The situation is similar in the allocation of approved research monthly periods (Figure 5) and the number of approved projects in 2008. Again, the biotechnologies take the first place, but it is noticeable that they cover a relatively small number of projects in relation to the funds (which means that projects are more valuable and senior professional researchers have been engaged in them)

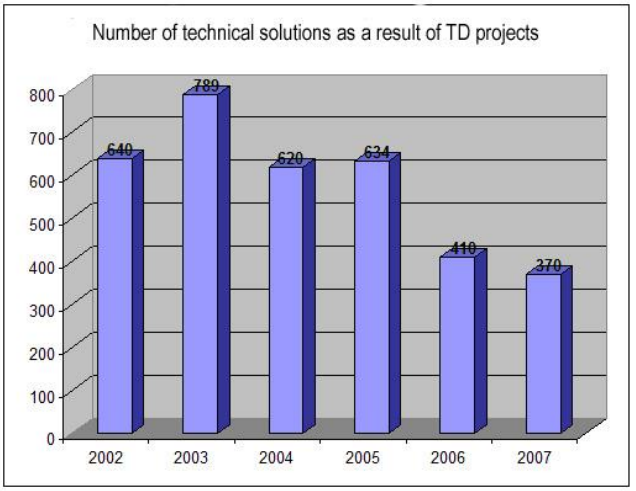
Figure 5: *Allocation of months required for Technological Development research projects in 2008*



Source: *Ministry of Science and Technology Development (2008)*

According to the basic definition and purpose, the technological development projects should provide the applied technical solutions, patents; pilot plants, new varieties, innovations and technological advancement, and those are the results that have direct application. Some 3,400 technical solutions were completed in the field of technological development between 2003 and 2007 (according to the preliminary data (Figure 6) (The Statistical Office of the Republic of Serbia "Questionnaire for Innovation Organizations").

Figure 6: *Number of technical solutions as a result of technological development projects in the period from 2000 to 2007*



Source: *Ministry of Science and Technology Development (2002-2007)*

The special result of innovation policy is the activity related to the patent. Table 2 shows the trend of patent application by domestic and foreign inventors. It could be seen that this activity was quite weak and that it particularly decreased around 2000, and after that it began to recover but was still insufficient compared to the activities of during 1990s. The number of foreign patents was particularly high during 199s, than it significantly dropped around 2000, less than the number of domestic patents, and recently it has exceeded the number of domestic patents. Table 3 provides similar review of the number of small patents application. Although this number fell in 2000, there has been a strong growth trend, except for domestic patents that almost exclusively are dominating here (Đurović-Petrović, 2011).

Table 2: *Figures of applied patents in Serbia*

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Dome-stic	156	161	96	70	112	59	3	31	73	86	65	127	72	81
Foreign	518	350	186	133	137	49	-	11	58	93	110	138	101	126
Total	674	511	282	203	249	108	3	42	131	179	175	265	173	207

Source: *Intellectual Property Bureau*

Table 3: *Figures of small patents in Serbia*

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Dome-stic	54	88	92	65	5	111	86	100	82	88	91	89
Foreign	0	2	1	2	0	1	3	0	1	2	2	2
Total	54	90	93	67	5	112	89	100	83	90	93	91

Source: *Intellectual Property Bureau*

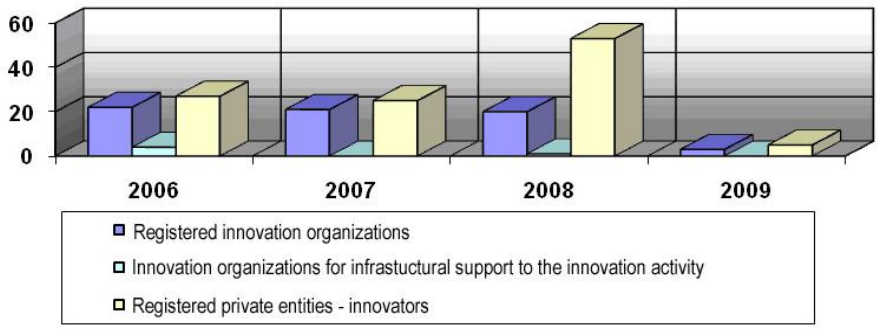
Public management activities in innovation projects after passing the law

There is no doubt that so much has been done in that period to develop innovation activities, especially if we take into consideration that up to then we were far behind the rest of the developed world. This period is significant because of the activities that have created a good basis for the concrete progress in the development of future innovation activities. The first distinct step was taken by passing the Law on Innovation Activity in December 2005.

Law on Innovation Activity together with the supplementary rules and regulations has finally brought the long expected legal regulation in this area. This Law is a crucial starting point for any further action. In accordance with Article 11 of the Law on Innovation Activity, Ministry of

Science and Technology Development established the Register of innovation organizations and the Register of private entities innovators, as well as procedures required for the entry of interested organizations and private entities in the Register. The dynamics of the registration of innovation organizations and private entities innovators by years is given in Figure 7.

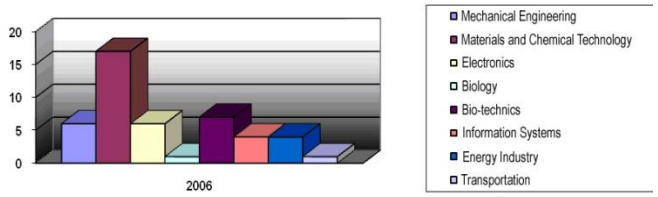
Figure 7: *Overview of the dynamics of innovation organizations and private entities innovators registration by years*



Source: *Ministry of Science and Technology Development (2006-2009)*

After the first public call, 53 innovation projects of legal entities were funded out of them seven are infrastructure projects and 16 applications by private entities. The overview of funded innovation projects of legal entities by their registered areas is given in Figure 8. Some 415 innovators were engaged after the first public call and its projects (Internal data of the Ministry of Science and Technology Development / 2004-2009 /).

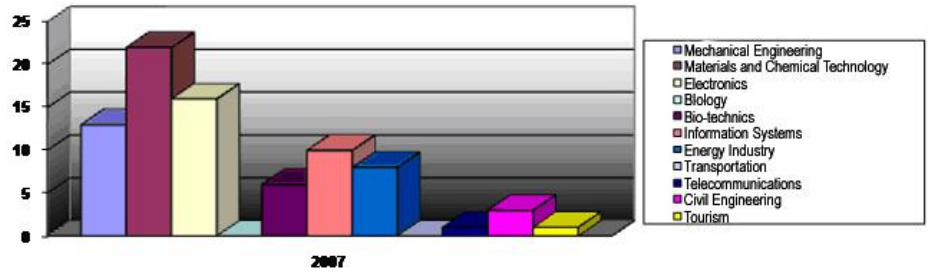
Figure 8: *Overview of the funded innovation projects of legal entities by areas (the first public call)*



Source: *Ministry of Science and Technology Development (2006)*

After the second public call, 95 innovation projects of legal entities were out of them 15 are infrastructure, and 34 applications by private entities. The overview of the funded innovation projects of legal entities by their registered areas is given in the Figure 9.

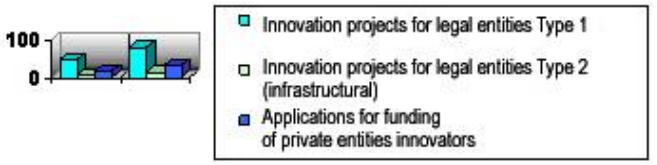
Figure 9: *Overview of the funded innovation projects of legal entities by areas (the second public call)*



Source: *Ministry of Science and Technology Development (2007)*

Some 1,200 innovators were engaged after the second public call and its projects.Comparative analysis of parameters of the first and the second public call is given in Figure 10 (Internal data of the Ministry of Science and Technology Development / 2004-2009 /).

Figure 10: *Overview of the funded projects and private entities applications by the public calls*



Source: *Ministry of Science and Technology Development*

The data presented in "The Global Competitiveness Report 2008-2009", provided by the World Economic Forum, are some of the indicators that best determine the position of the Republic of Serbia in relation to other countries in the region and the world. According to the Global Competitiveness Index Serbia is ranked as 85th country, ahead of Macedonia, Bosnia and Herzegovina and Albania. In accordance with the Innovation Index, Serbia is ranked as 91st, which is also ahead of Macedonia, Bosnia and Herzegovina and Albania, but ahead of Bulgaria

as well ("The Global Competitiveness Report 2008-2009"). Very important indicators are also those given in the document "A new ranking of the world's most innovative countries" by The Economist Intelligence Unit. Serbia was the 55th country according to the research and innovation indicators (number of patents, innovation capabilities, innovation capabilities aggregation, etc.), by which it is ahead of Romania. Indicators given in the research mentioned above and related to predictions for the period between 2009 and 2013, are quite positive, Serbia is ranked as 54th. However, statistics given in the report also show that Serbia has improved its position since 2002, improving its position from the 67th to the 55th, which is a very significant success, but stagnation of the shift in just one position scheduled for the next four years clearly shows that the State has failed to invest enough in this area (The Economist Intelligence Unit: 2008).

Adopting international standards of project evaluation and providing funds for researchers have influenced the increase in the level of scientific production in the area of basic research. Furthermore, the upgrading of the research funding system is required in order to stimulate creativity of scientists, researchers and inventors.

Serbia ought to accept and implement the goals of the Lisbon Declaration by which spending on R & D in Europe should be raised to 3% of the GDP, out of which two thirds would come from the business sector.

Moreover, it is necessary to change the funding system of the Faculty too, and that the funds for scholarships in both Ministries should be focused on students in major scientific fields (Đurović-Petrović, 2012).

Competitiveness analysis of the Republic of Serbia

The annual GDP of the Republic of Serbia, which is an indicator of productivity at the level of the entire economy, ranged from 2008 to 2011 in the range from 4100 to 4550 euros ("MAT - Macroeconomic Analysis and Trends" , 2011). Based on this data, we can place the national economy in the order of the efficiency of guided economies. The analysis of the competitive advantage starts from GDPpc per purchasing power parity (GDPpc (ppp)), at the end of 2010, our country was at 66th place, which should correspond with the level of competitiveness. However, according to GCI, Serbia is in the competition of 139 countries on an

unconscious 96th place. A difference of 30 positions between GDPpc (ppp) and GCI testifies to the wrong strategy of economic growth and prosperity (Klaus & Xavier, 2011).

Table 4: *Position of Serbia - columns GCI*

No.		Rank(of 139)	Rating (1-7)
	GCI 2010- 2011 (139)	**96**	**3.8**
	GCI 2009- 2010 (133)	93	3.8
	GCI 2008- 2009 (134)	85	3.9
	Basic requirements	**93**	**4.1**
1.	Institution	120	3.2
2.	Infrastructure	93	3.4
3.	Macroeconomic stability	109	4.0
4.	Health and basic education	50	6.0
	Improving efficiency	**93**	**3.7**
5.	Higher education and training	74	4.0
6.	Efficiency of the commodity market	125	3.6
7.	Labor market efficiency	102	4.1
8.	Development of the financial market	94	3.8
9.	Technological preparation	80	3.4
10.	Market size	72	3.6
	Innovation and sophistication	**107**	**3.0**

11.	Sophistication of business	125	3.2
12.	Innovations	88	2.9

Source: *Klaus & Xavier, 2011*

Uncompetitive products that find it difficult to find a way to consumers, which affects the market's decline and makes it uncompetitive. Lack of competitive advantages in the field of sophistication of business (eleventh pillar) and innovation (twelfth pillar) with low level of investment in research and development (108 positions) reduces innovative capacity and prevents improvement of operational efficiency and implementation of differentiation strategies.

Analysis of the GCI component components has shown that Serbia is very poor in terms of its competitive advantage. The fact that GDPpc (ppp) is better ranked by GCI suggests there is room for improving competitiveness, which is positive. However, in order for this to happen, it is necessary to change the strategy of future growth and turn to attracting foreign direct investment, which would make domestic products more attractive to broader markets by transferring more modern technologies (Račić & Pavlović, 2018).

Uncompetitive products that find it difficult to find a way to consumers, which affects the market's decline and makes it uncompetitive. Lack of competitive advantages in the field of sophistication of business (eleventh pillar) and innovation (twelfth pillar) with low level of investment in research and development (108 positions) reduces innovative capacity and prevents improvement of operational efficiency and implementation of differentiation strategies.

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The most important recommendation for improving the competitiveness of Serbia is related to the improvement of infrastructure and institutions. The weaknesses in the general segment, in the area of administrative and innovation infrastructure, led Serbia to the very beginning of Europe. The responsibility for solving this problem in the immediate future is primarily on the state. Without the advancement of this segment, Serbia can not come out of the trap of its own underdevelopment, which further narrows the space for export expansion.

According to the report of the World Economic Forum for 2016, Serbia took the 90th position in the ranking list, which includes 138 countries with the value of the Global Competitiveness Index (IGK) of 3.97. In doing so, it should be noted that the theoretical value of IGK ranges from 1 to 7. Compared to the previous year, the value of IGC for Serbia increased by 0.08, which, when taking into account the indices of the indices for other countries, resulted in growth from four places (Serbia ranked 94th in the previous two years). Changes in the value of individual pillars, from which the IGC for Serbia was obtained after weighing, on average were about 3.9% in relation to the values from the previous year.

Tables 5 and 6 represent data on the values of IGC and the ranking of Serbia and the countries from its environment for the period from 2007 to 2016. The tables cover 10 countries: Albania, Bosnia and Herzegovina, Croatia, Hungary, Macedonia, Montenegro, Romania, Bulgaria, Serbia and Slovenia (Tanaskovic & Ristic, 2018).

Table 5: *Global Competitiveness Index (2007-2016)*

	Albania	BIH	Croatia	Hungary	Macedonia	Montenegro	Romania	Bulgaria	Serbia	Slovenia
2007	3,48	3,55	4,20	4,35	3,73	3,91	3,97	3,93	3,78	4,48
2008	3,55	3,56	4,22	4,22	3,87	4,11	4,10	4,03	3,90	4,50
2009	3,72	3,53	4,03	4,22	3,95	4,16	4,11	4,02	3,77	4,55
2010	3,94	3,70	4,04	4,33	4,02	4,36	4,16	4,13	3,84	4,42
2011	4,06	3,83	4,08	4,36	4,05	4,27	4,08	4,16	3,88	4,30
2012	3,91	3,93	4,04	4,30	4,04	4,14	4,07	4,27	3,87	4,34
2013	3,85	4,02	4,13	4,25	4,14	4,20	4,13	4,31	3,77	4,25
2014	3,84	n.a.*	4.13	4.28	4.26	4.23	4.30	4,37	3.90	4.22
2015	3,93	3,71	4,07	4,25	4,25	4,20	4,32	4,32	3,89	4,28
2016	4,06	3,80	4,15	4,20	4,23	4,05	4,30	4,44	3,97	4,39

Source**:** *WEF (2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016.)*

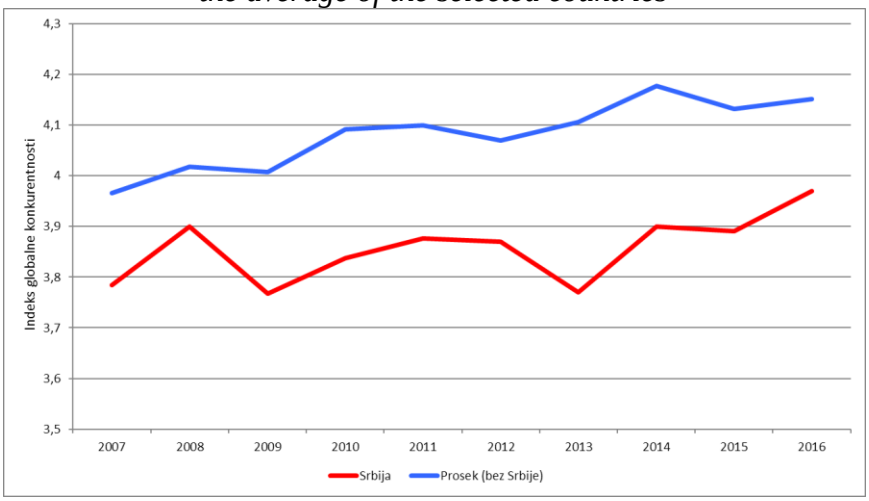
Table 6: *Rank of countries according to the Global Competitiveness Index (2007-2016)*

Albania	BIH	Croatia	Hungary	Macedonia	Montenegro	Romania	Bulgaria	Serbia	Slovenia	
2007[1)]	109	106	57	47	94	82	74	79	91	39
2008[2)]	108	107	61	62	89	65	68	76	85	42
2009[3)]	96	109	72	58	84	62	64	76	93	37
2010[4)]	88	102	77	52	79	49	67	71	96	45
2011[5)]	78	100	76	48	79	60	77	74	95	57
2012[6)]	89	88	81	60	80	72	78	62	95	56
2013[7)]	95	87	75	63	73	67	76	57	101	62
2014[8)]	97	n.a.*	77	60	63	67	59	54	94	70
2015[9)]	93	111	77	63	60	70	53	54	94	59
2016[10)]	80	107	74	69	68	82	62	50	90	56

Source: *WEF*

According to the value of the Global Competitiveness Index, in 2016 Serbia was only better placed than Bosnia and Herzegovina, which occupies the 107th position on the SEF ranking list of the IGK Movement for Serbia and the countries from its surroundings in the period 2007-2016 presented in the following graph. Based on the data from Table 2, the graph shows the movement of the IGC for Serbia and the average of the observed countries, from which it can be concluded that although there is a trend of growth in the case of Serbia, there is much greater instability, which is reflected in significant oscillations in a short period of time average of observed countries. After the outbreak of the global financial crisis in 2009, there was a deterioration in the competitive position of Serbia, which was significantly higher than in other countries in the region. After slow recovery in 2013, there was a fall again on the list that was one of the major in the observed group of countries (Tanaskovic & Ristic, 2018).

Figure 12: *Movement of the Global Competitiveness Index for Serbia and the average of the selected countries*

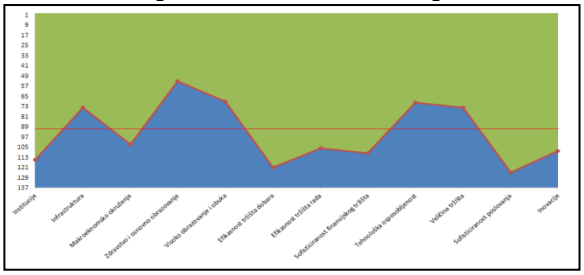


Source: *WEF*

Analysis of Serbia's competitiveness in relation to innovative capacity

Figure 13 shows Serbia's position towards the pillars of competitiveness. The impact of innovations as a twelfth pillar of competitiveness is evident.

Figure 13: *Serbia's position towards competitiveness pillars*

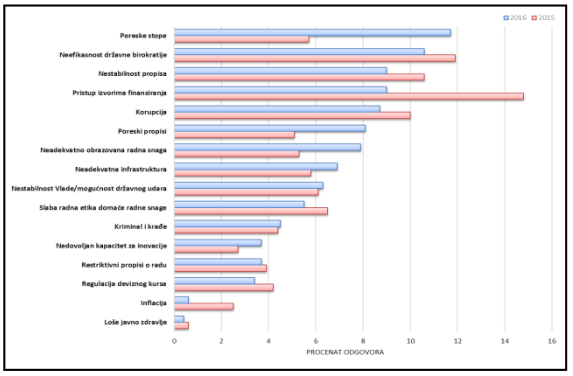


Source: *WEF 2016*

Figure 14 provides a comparison of the analysis of the causes of the weak competitive position of Serbia in 2015 and 2016. It is evident that in the period of a year, the number of answers dropped, that for the bad position

of Serbia, the insufficient capacity for innovation has been blamed. This represents a significant qualitative shift.

Figure 14: *Comparative analysis of the causes of the poor competitive position of the Serbian economy*



Source: *World Economic Forum, 2015–2016*

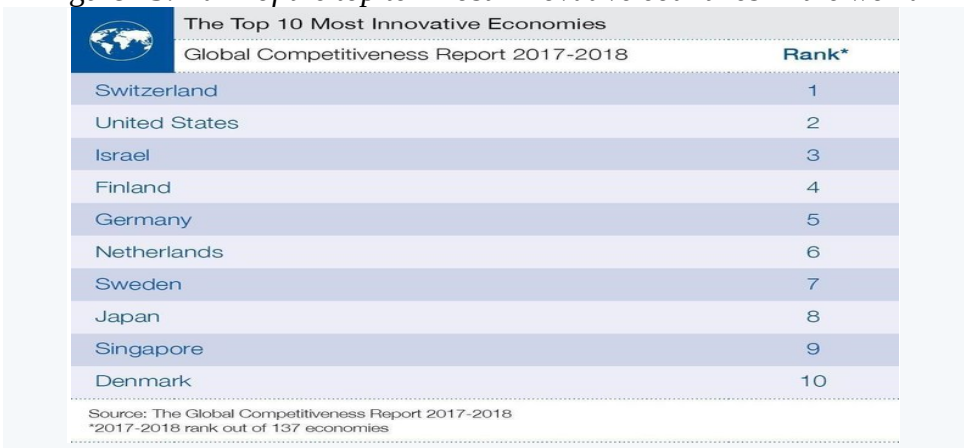
According to the available statistical data for 2017, Serbia was positioned on the 62nd place on the Global Innovation Index (GII) list, from 127 countries. The most innovative countries, according to the GII, are Switzerland (1), Sweden (2), the Netherlands) and USA (4). In front of us are Slovenia (32), Bulgaria (36), Hungary (39), Croatia (41), Romania (42), Montenegro (48) and Macedonia (61), and behind us are the innovations of BiH and Albania.

In the WIPO Global Innovation Index for 2017, Serbia ranked 62nd in a total score of 127 countries. Behind Serbia in the region are only BiH (86) and Albania (92). Best ranked is Slovenia, which is 32nd. WIPO is an independent global Intellectual Property Forum, based in Geneva. WIPO Annual Report on Global Innovation contains a lot of indicators based on copyright, industrial and patent law, as well as indirect indicators of innovation through insight into the market and business climate, the potential for creative capitalization, the state of human capital and social institutions. It should also be said that Serbia moved in 3 places in relation to the 2016 index.

In 2018, Switzerland is the most innovative country in the world according to the Global Competitiveness Index, which was created under the auspices of the World Economic Forum. Switzerland's capacity for

innovation and the quality of scientific research institutions are just two of the set of factors that made it possible to be on the top of the list. Switzerland has topped the list of global competitiveness for six years in a row.

Figure 15: *Rank of the top ten most innovative countries in the world*



The Top 10 Most Innovative Economies	
Global Competitiveness Report 2017-2018	Rank*
Switzerland	1
United States	2
Israel	3
Finland	4
Germany	5
Netherlands	6
Sweden	7
Japan	8
Singapore	9
Denmark	10

Source: The Global Competitiveness Report 2017-2018
*2017-2018 rank out of 137 economies

Source: *World Economic Forum, The Global Competitiveness Report*
Twitter Ads info and privacy

The United States has a strong innovative ecosystem. Like Switzerland, the United States has a high rank on the subindexes, except for patents, where they are ranked only in tenth place. Third place was taken by Israel with similar forces as in the case of Switzerland. Israel has a good capacity for innovation, high-quality scientific-research institutions and a strong private sector that spends and cooperates in research and development.

European Union countries are also leading the innovation index. Of the remaining seven positions in the list, five belong to the European Union, namely Finland, Germany, the Netherlands, Sweden and Denmark. Finland has the best result for a number of scientists and engineers, while Germany tops the corporations that invest in research and development. The quality of Dutch scientific research is to a large extent encouraged by the result of innovation in that country. Sweden, which is in the seventh position, has the greatest success in the application of patents. There is also a remarkable performance in Denmark, which is the tenth place. Japan and Singapore are also among the ten most innovative economies in the world. Japan records the highest results in the application of patents,

while Singapore is strong in terms of state investment in advanced technology products.

This year's list shows that EU performance in the field of innovation continues to grow. This progress has been accelerating over the past several years. The prolonged impact of EU innovation has increased by 5.8% compared to 2010. Predictions announce an additional 6% by 2020. On the other hand, spending on research and innovation expressed through the share of GDP is still below the level of 2010. The fact is that innovation leaders are 20% more successful than the EU average and include Sweden, Switzerland, Denmark, Finland, Luxembourg, the Netherlands and the United Kingdom. Among the strong innovators, who make between 90 and 120% of the EU average, Austria, Belgium, France, Germany, Ireland, Slovenia, Iceland, Israel and Norway ranked among them.

Based on the European Commission's report on the European Innovation Scoreboard for 2018, Serbia has been rated as a moderate innovator that has achieved between 50 and 90% of the average EU criteria and is for the first time ahead of the EU-8 countries. During the previous year, we have achieved the best results in the field of investment indicators, SME partnerships, innovative products, the impact of innovation activities on employment and employment.

According to the Global Innovation Index, Serbia is currently 55th in the city, which is a step forward in comparison to the previous year, but almost all of the regions in the region are better ranked than us, except Bosnia and Herzegovina (77), Albania (83) and Macedonia (84). Serbia in the region are Slovenia (30), Bulgaria (37), Croatia (41), Romania (49) and Montenegro (52). Serbia has improved the business climate, increased productivity and inflow of foreign investment focused on the production of information -communication goods and services. The 62nd edition is more important at the 55th time, which also includes the results of PISA testing, the frequency of entering in Wikipedia, the digitization of state administration, the partial share of IT services in total exports, and the cooperation of industry and universities and management risk.

Conclusion

According to given statistic data, entrepreneurship is not a stronger party, and the Serbian economy is not based on innovations. It is necessary to change the way of thinking and invest in companies in the development of internal capacities for innovation. This often requires much more time than money. Serbia invests only 0.87 percent of gross domestic product in research and development (source World Bank, UNESCO Institute for Statistics), investment in education is insufficient, universities are not well-connected to the economy, and private companies in most cases do not have built capacities for innovation and no incubation Idea (Petrović et al., 2018). Serbia is far from the leading modern industries, but it is evident that it attaches increasing importance to innovation and new technologies and thus raises its GCI (Sedmak & Lozanović, 2009). In that direction, guidelines for further regulatory activities could be:

1. Prevent the outflow of innovation, as even 71.1% of innovations registered by innovators originating in Serbia are registered in the emigration, and less than a third of 1102 measured "Serbian" innovations are registered in Serbia.
2. Significantly increase the government's investment in innovation, as it is obviously correlating with the GCI economy of the Republic of Serbia.
3. Innovate the regulatory area in the innovation sector, as this proves to contribute to the improvement of the competitive position of the Serbian economy in relation to the environment.
4. Long-term innovation strategy that should be achieved by all actors in the innovation ecosystem, starting from the state and the public sector, through the private sector, universities and other scientific and research institutions, financial institutions and entrepreneurs-startups.
5. It is necessary to create quality scientific and research institutions that will be well connected with the private sector, so there are transfer technologies, incubation and acceleration of startup companies for which adequate financial support should be provided.
6. Promote the development of local innovation ecosystems and encourage entrepreneurship, as new sectors and companies are created. It is necessary to create innovation networks and a

collaborative environment so that existing traditional industries can adapt and remain competitive.

7. Focus on the comparative advantages of Serbia, primarily its human resources, as well as the clusters of successful ICT and agro-agricultural companies, which need to be strengthened.

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TRANSITIONAL BUDGET DEFICIT AS A RESULT OF REFORMS IN PENSION SYSTEM OF REPUBLIC OF MACEDONIA

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Abstract

This paper deals with presentation and explanation of the main problem with which the Macedonian pension system is faced. However, to understand the entire system, an explanation will be given as to what this system is composed of, how it operates and its main function. Successful examples from other countries that have successfully managed the problem of transitional budget deficit and the reforms carried out in these countries leading to favorable conditions will be given and explained. What is essential for the pension funds is that they are to be sustainable and financed from own resources, but this is not easy and we shall further see why.

Keywords: *transitional deficit, pension reforms, sustainability, income, expenditures*
JEL: H55, H59

Introduction

Since the time of its gaining independence until today, Republic of Macedonia has been facing, as most of the countries throughout the world, a budget deficit and public debt that has continuously been increasing for the last few years. However, the subject of this paper is another kind of deficit that was created due to the pension reform carried out in our country more than a decade ago.

During the communism, Macedonia, as many other communistic countries and as a country within SFR Yugoslavia, was part of the pension system referred to as "Pay as You Go" (PAYG) which, in fact,

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represents a system based on solidarity of generations. This means that the present-day employees finance, through payment of contributions, the pensions of the retired, i.e., the young and the people capable to work enable regular monthly incomes for the retired. All this functioned more than well during Yugoslavia and after 1991, i.e., after our country gained its independence. However, later in the twentieth century, the pension fund in Macedonia (Pension and Disability Insurance Fund of the Republic of Macedonia) started to face bigger difficulties, both economic and demographic, beginning with ageing of the population and reductions in employment. Also, temporary distorsions, i.e., illogical increase of pensions by the governments to achieve greater rating in the eyes of the people negatively affected the Pension Insurance Fund.(Agovino, 1999)

Table 1: *Employment rate in Macedonia and the Czech Republic expressed as percentage of the employment rate in1989 (1989=100%)*

Country	1991	1993	1995	1997	1999
Macedonia	95,6	86,2	73,9	66,8	65
Czech Rep.	93,6	89,7	92,8	92,4	90,2

The ageing of the population was mentioned as the most important demographic factor. Analyzing the trends of reduction of the young population and the increased benefits for the pensioners, one comes to the conclusion that the percentage of the young population in respect to the total population will be drastically reduced. This is shown in the subsequent table.

Table 2: *Participation of young people, people able to work and elderly people in the total number of population (in percentages)*

Country	1998			2020		
	Under 19	20-59	Over 60	Under 19	20-59	Over 60
Albania	42	49	9	32	55	12
Bulgaria	26	53	21	14	58	28
Czech Rep.	25	57	18	19	54	27
Macedonia	33	54	13	23	54	23

A successful example of successful dealing with these problems are the countries of the West Europe that are old capitalistic countries and know how to function better than former communist countries. Another good example is also the Czech Republic which managed to keep the status as

one of the strongest economies in Central Europe (Batty & Hailichova, 2012). At this point, we can also mention the successful reform in Chile, which was the first country in Latin America that changed the old PAYG system into a new and reformed capitalistic one in 1980/81. The entire Latin America joined this reform and followed the successful example of Chile. Some of them carried out this reform more or less successfully, but all of them changed the old system of functioning of the pension funds (OECD, 2015).So did Macedonia, which was in an unavoidable situation and had to change its old, long lasting obsolete and depleted pension system by a pension reform, which in the short run, has not proved to be very successful, but in the long run, will show good results and an equilibrium between the contributions on one hand and pensions on the other.

Reformed Pension System

The reform of the pension system in Macedonia started with the Law on Mandatory Fully Funded Pension Insurance passed in April 2002. With this Law, the existing solidarity system with the defined contributions was reformed into a new double column system that was later transformed into a pension system with three columns. The new system came into effect in 2006. With this law, a great number of modifications were made. The most noteworthy among these are:

- Shifting of the age limit for retirement to 64 years for men and 62 years for women;
- Introducing of permanent reduction of premature age pension for each month of premature retirement.
- Introduction of pension from private pension funds for all those that want to save and will be part of the second column.

However, in order that we could explain the gap, i.e., the deficit created in the pension system of the Republic of Macedonia, we should, first of all, explain the very functioning of the system and its constituent parts.

Structure of the Macedonian Pension System

As mentioned previously, the Macedonian pension system is composed of three columns and represents a combination of public and private pension insurance:

- Mandatory pension and disability insurance based on solidarity of generations (the first column), organized according to the

principle of ongoing financing (pay-as-you-go) with defined pensions, which is represented by the system that has been existing so far with a certain rationalization. This kind of insurance enables exercising of the rights to pension and disability insurance based on age, disability and death, meaning that part of the age pension, disability and family pension as well as the lowest amount of pension will be paid (in state ownership);

- Mandatory fully funded pension insurance (the second column). This insurance provides exercising of the right to pension insurance based on age, i.e., the remaining part of the age pension will be paid.
- This mode of insurance is based on the principle of collection of resources through payment of contributions to individual (personal) accounts which are further invested and accumulated in the accounts along with profits. After retirement, the accumulated resources will be obtained through annuity or programmed withdrawals (in private ownership);
- Voluntary fully funded pension insurance (the third column) in which there can be included all persons that want to provide a higher scope of material safety than that provided by the mandatory insurance as well as all citizens that are not encompassed with the mandatory insurance (in private ownership).

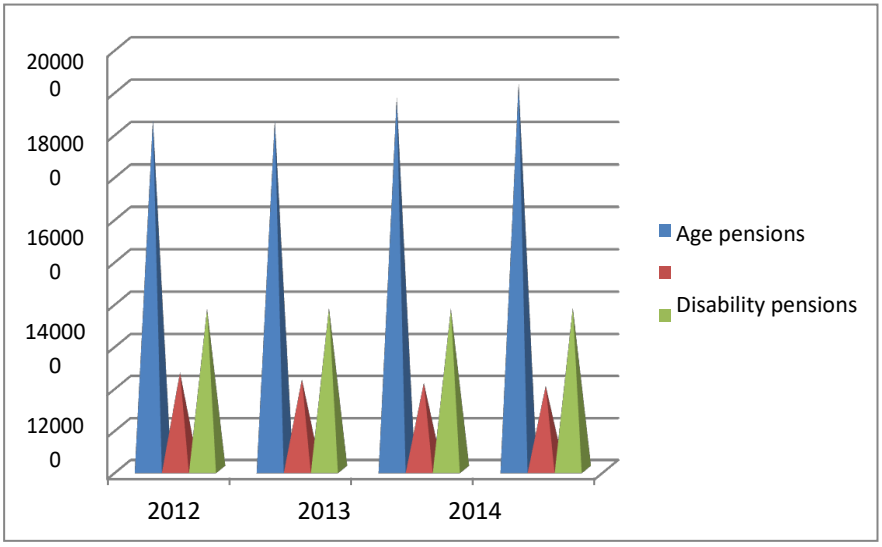
All insurance holders that were employed for the first time had to be mandatorily part of the two-column system (part of the first and the second column) after 1st January 2003. The purpose of this was timely releasefrombig expenditures of the first column that was to continue to pay pensions and be considerably loaded for the next few decades. This will be discussed in detail further in this paper.

All insurance holders in Macedonia have different rights that they acquire with their payment of contributions to pension funds. These are as follows:

- Right to age pension (the insurance holder acquires the right to age pension by becoming 64 years of age for men and 62 years of age for women, with at least 15 years of service);
- Right to disability pension (the insurance holder with incurred general disability to work who cannot be qualified to perform

another work by professional rehabilitation, upon coming to a certain age, acquires the right to disability pension);
- Right to family pension (family pension can be used by members of the family of a deceased insurance holder: spouse, children and parents supported by the insurance holder under the conditions defined by the Law);
- Professional rehabilitation;
- Right to pecuniary compensation for personal injury;
- Right to the lowest amount of pension.

Graph 1: *Structure of pensions for the last 4 years*



According to the graph, age pensions have dominated in respect to disability and family ones for the last four years. Family pensions are constant, characterized by the same figure in the period 2012 to 2015, while disability pensions show a mild decline. However, in this period, there is also a certain increasing trend of age pensions from year to year (starting with 165749 pensioners in 2012 to 182954 pension beneficiaries in 2015). All this shows ageing of the population that, along with the unemployment rate, is one of the main problems of the Macedonian pension system. Increasingly lesser insurance holders will pay for an increasing number of pensioners.

Deficit in the pension system

The deficit that occurs as a result of the reform of the pension system is the main problem with which the Pension and Disability Insurance Fund of the Republic of Macedonia is currently faced (Taleski & Bogdanovski, 2015).

However, let us, first of all, explain how this deficit was created. The first column increasingly generates lesser resources and is mainly oriented to repayment of pensions, while the second column has part of the total contributions of insurance holders and has still not begun with repayment. The first insurance holders who started with their insurance in both columns are the generations that were employed for the first time after 1st January 2003.Sixty-two years should pass in order that they could get age pension, namely they are to wait until the year of 2067. For the entire period, the second column will only generate income and will re-invest it, which is its original goal, in order to make profit from the resources and be able to pay pensions in future. All this is correct and the entire world follows this practice, but in our country, there are some common rules and limitations that make this system problematic. In the meantime, while the second column generates contributions and invests them in favor of the future generations, the first column, which unlike the second and the third column, is in public ownership, must pay pensions. The number of pensioners is permanently increased, while the high rate of unemployment is an additional problem and, on top of this, only part of the total resources from the existing contributions paid by the employees goes to the first column, which is definitely not sufficient enough to fill the so called “gap” that exists.

Table 3: *Number of pensioners in the Republic of Macedonia*

Year	Number of pensioners
2012	288,370
2013	286,081
2014	291,001
2015	301,728
2016	302,080

According to Taleski & Bogdanovski (2015), this gap can be considered from different aspects. We can analyze the difference between the

contributions as income of the Pension and Disability Insurance Fund of RM and pensions as expenditures.We have already seen that the number of pensioners shows an increasing trend. However, what happens with the number of employees that pay the contributions?In2014, 536,191 insurance holders were registered. This was twice the number of pensioners. But is this sufficient enough?At the time of former Yugoslavia, proper functioning of the PAYG system meant that 25 to 30 pensioners required 100 employees to simultaneously cover their pensions.During the single column system, all the contributions went to the Pension and Disability Insurance Fund of RM. With the introduction of the second private column, part of the contributions, or more precisely 1/3 goes to the second private column, while 2/3 go to the first column. At first, the rate of contributions was 21,2% of the gross salary out of which 13,78% were for the Pension and Disability Insurance Fund, while 7,42% were for the mandatory private column. Now, the rate of the contributions is 18%, out of which 12% go to the first, while 6% go to the second column.

The very fact that 1/3 of the contributions does not belong anymore or is taken away from the public column means that it operates with a deficit of resources. On one hand, the fund is exposed to big demographic and economic pressures, while on the other hand, it is deprived of a percentage of the contributions that belonged to it for the purpose of reformation of the pension system of Macedonia and better future of the generations to come. Until the second column starts with payment of pensions, the entire load will be upon the first column.

The gap, i.e., the deficit that occurs in the Pension and Disability Insurance Fund of RM is filled through different items, but most frequently by the state, through transfers from the budget, budget difference, etc. However, the key item on which the operation and the future of the Fund depends are its earnings. Which are the incomes through which it is financed and their amount, i.e., are they sufficient enough for coverage of its regular expenditures?

Financial operations of the Pension and Disability Insurance Fund of the Republic of Macedonia

The budget of the Pension and Disability Insurance Fund of RM for the year of 2015 anticipated financial operation of the Fund by balanced

income and expenditures. Taken as the basis for the balance between the incomes and the expenditures were the macroeconomic indicators of increase of income from contributions for 5,7% (3% from the planned increase of salaries and 2,7% from the increase of the employment rate) and providing resources from the Budget of the Republic of Macedonia for regular legal obligations, i.e., for transitional expenses and coverage of the deficit of the Fund. The increase of salaries in 2015 was of primer importance as a factor of calculation and payment of contributions for pension and disability insurance, while the increase of the employment rate was of crucial importance for the realization of the Fund income given that there was a legal increase of pensions for 5% and an increase of the number of pensioners of 1,81% at annual level. A big role was also played by the payment of the outstanding unpaid contributions, whereat, by certain measures taken in the part of payment of outstanding unpaid contributions, resources to the amount of 163,2 million Macedonian denars were collected in the period until 31.12.2008.With the resources gained from the contributions as well as with the remitted resources from the Budget of the Republic of Macedonia, the resources from the sale of shares and stakes available at the Fund, the income from theexcise duties and other non-tax incomes, in 2015, the Fund realized a total income amounting to 57.254,51 million Macedonian denars, while on the other hand, it made payment of56.789,36 millionMacedonian denars.

The Fund regularly made payments of pensions in the first week of the month for the previous month by borrowing from the Budget and returning the borrowed resources after payment by accumulation of resources from the contributions.

The total income realized by the Fund in 2015 in respect to the resources planned with the Fund budget amounted to 100,8%. In respect to 2014, these resources were higher for 6,46% due to the increased amount of transferred resources for coverage of the ongoing deficit, while the total expenditures were at the level of the resources planned with the budget, or 99,98% and higher for 5,14% compared to 2014.

Income of the Fund

As mentioned before, the incomes are one of the key items for successful operation of the Fund and it can be noticed that these are permanently increased from year to year. But, is this good and why are they increased?

First of all, let us consider what the total income of the Fund is comprised of. The total income is comprised of: source incomes, resources from the Budget of the Republic of Macedonia, income from excise duties, income from dividends, sale of shares and stocks as well as other incomes. All these items have their own importance for the operation of the Fund. Let us take as an example the year of 2015 and analyze the incomes in this year.

The total incomes of the Fund in 2015 amounting to 57.254,51 were realized from the following financial sources:

- From source incomes (contribution from salaries, reduced length of service, contributions from physical persons who perform their activity independently and persons employed by them as well as contributions from individual farmers and the Employment Agency) to the amount of 32.236,20 million Macedonian denars;
- Resources from the Budget of the Republic of Macedoniaamounting to 23.860,89 million Macedonian denars;
- From excise dutie, amounting to 1.016,11 million Macedonian denars;
- From dividends,amounting to 0,09 million Macedonian denars;
- From sale of shares and stocks, amounting to 15,52 million Macedonian denars; and,
- Other incomes,amounting to 125,70 million Macedonian denars.

Contributions from salaries account for the greatest part of the source incomes. In 2015, these were computed and paid per the rate of 18% of the gross salary and were the main source of financing of the Fund. The paid contributions are distributed between the first and the second column and, as mentioned before, since 08.08.2012, with the new Law on Pension and Disability Insurance, the defined fixed rate of contribution has been 12% for the first column and 6% for the second column.

In 2015, resources amounting to 30.967,32 million Macedonian denars were realized only from the contributions from salaries that were higher for 2.251,83 million Macedonian denars or 7,85% compared with 2014. The increase of the contributions from salaries was, to a lesser extent, due to the payment of the outstanding contributions by 31.12.2008 inclusive, amounting to over 163,20 million Macedonian denars out of which 155,78 million Macedonian denars representing contributions from

salaries and 7,42 million Macedonian denars representing interests on their delayed payment. The subsequent table shows the contributions from salaries per months in 2015 and 2014 and their dynamics.

Table 4: *Contributions from salaries per months*

Months	Paid contributions from salaries	
	2015	2014
January	2.072,83	1.959,87
February	2.477,92	2.465,47
March	2.521,95	2.337,19
April	2.739,55	2.422,00
May	2.329,99	2.287,77
June	2.637,18	2.327,69
July	2.862,96	2.472,69
August	2.376,31	2.272,72
September	2.592,36	2.390,37
October	2.640,46	2.540,35
November	2.591,11	2.318,02
December	3.124,70	2.921,35
Total	30.967,32	28.715,49

The table shows that the contribution from salaries in 2015 compared to 2014 was increased for 7,85%, while per months, it was the biggest in April, June, September, November and December.

Income from the Employment Agencywas obtained based on contribution for unemployed persons that receive pecuniary compensation. In 2015, resources to the amount of 21,22 million Macedonian denars were remitted on this basis. Compared to 2014, these were lesser for 9,65 million Macedonian denars, or for 31,3%, while their participation in the total income of the Fund amounted to 0,04%. These incomes were reduced from year to year with the reduction of the number of persons for which contribution was paid due to modification of the legal regulations involving payment of contribution for only those persons whose length of service was less than 15 years.

Income from excise dutiesamounted to 1.016,11 million Macedonian denars, accounting for 1,8% of the total income. These incomes were computed per rate of 9,18% of oil derivatives. Compared to 2014, the income from the excise duties was higher for 13,9%.

Transferred resources from the Budget of the Republic of Macedonia amounted to 23.860,89 million Macedonian denars and were higher than those in 2014 for 5,2%. These resources were intended as follows:

- 3.150,00 million Macedonian denars for legal obligations (for users of minimum farmers' pensions, military pensions, teachers, etc.);
- 4.600,00 million Macedonian denars for transitional expenses;
- 15.981,21 million Macedonian denars for coverage of the current deficit;
- 127,15 million Macedonian denars for transfer to the Ministry of Defense;
- 2,53 million Macedonian denars for coverage of the travel expenses for the spas.

The participation of the income from the Budget of the Republic of Macedonia in the total income of the Fund amounted to 41,7%, while the participation of the current deficit in the total transfer amounted to 66,98%, increasing from year to year. The resources from the Budget represent the second income according to size and an important item in the financing of the pension and disability insurance and its deficit.

Income from dividends and sale of shares and stocks amounted to 15,61 million Macedonian denars in 2015 as follows:

- An amount of 0,66 million Macedonian denars was realized from dividends;
- The sale of shares and stocks gave rise to the realization of resources to the amount of 15,52 million Macedonian denars, being lesser than those realized in 2014.
- As to other income, resources to the amount of 125,70 million Macedonian denars were realized, being lesser than the planned ones for 11,2% and lesser than those in 2014 for 43,2%. These were mostly from rents, compensation for damages, income from pension funds, returned pensions of deceased users in the country and abroad, interests on delayed payment of contributions for pension and disability insurance and other.

Table 5: *Realized and planned income of the Fund in 2015*

Type of income	Budget for 2015	Realized 1.12.2014	Realize 1.12.201
Contributions from salaries	30.636,27	28.715,49	30.967,32
Contribution from income	391,37	351,50	371,12
Private sector	680,05	710,56	747,05
Individual farmers	110,00	99,22	129,49
Income from the Employment Agency	21,00	30,87	21,22
Total income	**31.838,71**	**29.907,64**	**32.236,20**
Income from excise duties	932,75	892,39	1.016,11
Transfers from the Budget of RM	23.838,21	22.677,71	23.860,89
Other income	140,00	290,74	125,70
Income from dividends	2,00	0,66	0,09
Income from sale of securities	50,00	11,54	15,52
Total income	**56.801,67**	**53.780,68**	**57.254,51**

Expenditures of the Fund

With the budget of the Fund for 2015 and the expenditures compliant with the macroeconomic indicators, regular payment of pensions and their increase for 5% starting September 2015 as well as increase of the number of pension beneficiaries for 1,81% per annum was planned. The total expenditures of the Fund in 2015 amounted to 56.789,36 million Macedonian denars and were higher for 5,14% in respect to those in 2014.

The total sum of expenditures was intended for:

- Payment of pensions;
- Contribution to health insurance;
- Payment of compensations for disability insurance, boardingschool accommodation of disabled children and personal injuries;
- Transfer of resources to private pension funds;
- Salaries of employees in the professional service;
- Other purposes.

The expenditures of the Fund also included capital expenditures, expenditures related to reconstruction of the business facilities and procurement of a motor vehicle that accounted for a very small part of the total expenditures of the fund and were negligible.

Expenditures related to payment of pensions amounted to 45.569,24 million Macedonian denars, or 80,25% of the total expenditures (45.138,48 million Macedonian denars for regular pensions, 392,36 million Macedonian denars for military pensions and 38,40 million Macedonian denars for farmers' pensions).

Contribution to health insurance for the pension beneficiaries amounted to 5.954,22 million Macedonian denars (10,49% of the total expenditures). The expenditures for payment of pensions along with the contributions to health insurance amounted to 51.523,46 million Macedonian denars, accounting for 90,73% of the total expenditures.

Expenditures for payment of compensations related to disability insurance, boarding school accommodation of disabled children and personal injuries amounted to 94,70 million dollars (0,17% of the total expenditures) and did not account for a greater part of the total expenditures of the Fund. Within these expenditures, the compensations for disability insurance amounted to 5,09 million Macedonian denars, the compensations for personal injuries amounted to 88,70 million Macedonian denars and those for boarding school accommodation amounted to 0,91 million Macedonian denars.

Transferred resources to private pension funds in 2015 amounted to 4.719,99 million Macedonian denars (8,32% of the total expenditures). These expenditures were at the level of the resources planned with the Budget of the Fund and were higher compared to those in 2014 for 14,06%. The number of insurance holders in the private pension funds amounted to 373.151 at the end of 2014, while at the end of 2015, it amounted to 405.288 members. This increase was due to the mandatory membership in the private pension funds by all newly employed persons. These resources were compensated from the Budget of the Republic of Macedonia.

Salaries of employees in the professional service of the Fund in 2015 amounted to 248,63 million Macedonian denars(0,44% in respect to the

total expenditures). Compared to 2014, these were higher for 3,04% due to the fulfillment of the obligation for turning employment on the basis of deed contracts into employment on permanent basis. In 2015, the Fund had 645 employees.

Other expendituresin 2015 amounted to 183,9 million Macedonian denars (0,33% of the total expenditures). These expenditures in respect to other expenditures in 2014 were higher for 8,44%.

Table 6: *Realized and planned expenditures of the Fund in 2015*

Type of expenditures	Budget for 2015	Realized 1.12.2014	Realized 1.12.201
Total pensions	45.657,00	44.022,77	45.658,04
Transfer of resources to private pension funds	4.720,00	4.138,32	4.719,99
Compensations related to disability insurance	12,00	6,28	6,01
Contribution to health insurance	5.955,00	5.421,47	5.954,22
Salaries and compensations	253,97	241,31	248,63
Other expenditures	203,80	187,30	202,47
Total expenditures	56.801,77	54.017,45	56.789,36

Ratio between income and expenditures of the Pension and Disability Insurance Fund of RM

To get an insight into the deficit of the Pension and Disability Insurance Fund of RM, it is important to compare expenditures and incomes of the Fund and their trend in the last twenty years.

The total expenditures in 2014 in respect to 1994 were increased for 307,42%, while the resources from the Budget of the Republic of Macedonia were increased for 770,01%. The income from the Employment Agency has been drastically reduced since 2009 due to modification of the legal regulations referring to the acquiring of the right as well as in respect to the bases and percentages in the calculations.

In the period 1994 to 2015, the expenditures were also increased as a result of the increased number of pension beneficiaries and harmonization of pensions.

The expenditures for payment of pensions in 2015 amounting to 45.569,34 million dollars were increased for 295,82% compared to 1994, the expenditures related to salaries of the employees were increased for 209,34%, other expenditures were reduced, while the total expenditures compared to those in 1994 were increased for 307,9%. In 2006, in accordance with the Law on Mandatory Fully Funded Pension Insurance, the Fund started to have expenditures based on transfer of resources to private pension funds for contribution to pension and disability insurance of members who accessed private pension funds.These expenditures were increased from 1.325,14 million Macedonian denarsin 2006to 4.719,99 million Macedonian denars in 2015, or for 356,2% due to the increased number of members.

If seen logically, each year, there should be sufficient income to cover all expenditures. Certainly, if the source incomes are not sufficient enough, transfers from the Budget will take place. As to expenditures, the highest values are those of the pensions and are uncontested according to size in respect to other expenditures. One can also notice the decreasing and increasing trend of the main items of income and expenditures as part of the total income and expenditures of the Fund in the last two decades.

The source incomes as part of the total income show a constant decrease. In 1994 and 2014, their participation in the total income was 77,7% and only 55,5%, respectively. With the exception of 2008 (when due to the increased source incomes, there were less resources transferred from the Budget), the transfers from the Budget were constantly increased, participating in the total income with 16,8% in 1994 and 42,1% in 2014.The excise duties as the third item were constantly stable and present, but they never approached one of the two previously stated items.

As to expenditures, pensions certainly dominate compared to the remaining items, reaching 86% in 2004. However, with the coming into effect of the new pension system in 2006, there also occurred the item related to transitional expenses that accounted for 4,2% of the total expenditures of the Fund in the beginning and were increased to 7,6 % in 2014. This rate will continue to increase since 1/3 of the paid contributions of the employees must be re-directed to the private pension funds which, at the same time, represents an expenditure for the Pension and Disability Insurance Fund of RM. These expenditures are

certainly covered by transfers from the Budget of the Republic of Macedonia.

Foreign pension funds

Most of the countries worldwide have already carried out a pension reform as is the case with Macedonia, with the exception of some extreme communist countries like Cuba and North Korea. Both Macedonia and the remaining countries are dealing with the problem of filling the GAP in the pension funds. Perhaps our policy is wrong and we charge a smaller rate of contributions from regular incomes of insurance holders, or the age for entitlement to an age pension is too low? As to the rate of contributions, each country charges a different percentage of the gross salary. The least rate is that in South Korea and Turkey, amounting to 6%, while the highest rate is in New Zealand, accounting to even 40%.

In Macedonia, the rate presently amounts to 18% and we can say thatit is neither too high, nor two low compared to other countries.

Rate of contribution

Can the rate increase contribute to the reduction of the deficit of the Fund? Most probably, yes, but we don't know what exactly will be the effect and to which extent it will, in fact, reduce the deficit. It is for sure that the revolt among the people will increase with lesser available current resources for current consumption.

On the other hand, the age for retirement can be considered. In countries that are part of OECD, the age for retirement is expected to increase from 64 years in 2014 to 65.5 years up to 2060. Everywhere, there is a tendency for increase of the length of service necessary for retirement which definitely will contribute to the reduction of the GAP. In Macedonia, some measures referring to this issue have also been taken. The first age limit for retirement is 62 years for women and 64 years for men. However, it is not strictly established so that each employee is entitled to work over this limit by registering herself/himself at the Fund as an employee, who works over the allowed age limit for retirement. For the academic staff, this limit is set to 65 years for women and 67 years for men and it is expected to be extended in future to 67 years for women and 70 years for men. Different countries have different policies regarding this issue. In some of them, both men and women are allowed

to retire at the same age, while in some other countries, women have the advantage to retire far before men, who are obligated to contribute to the PYGO system for a few years more.

Conclusion

Macedonia has and will have problems in managing the deficit in the pension system. So far, it has thoroughly been financed by means of transfers from the Budget of the Republic and this rate shows a constant absolute and relative increase. However, this should not be a permanent solution, but a procedure must be initiated toward increase of the source incomes and such increased incomes will enable the Pension and Disability Insurance Fund operate more freely and not be completely dependent on the RM Budget.Other world countries that have still not begun with repayment of pensions from the private funds are managing similar problems.The solution for all countries is to postpone retirement by increasing the necessary age for retirement, increase of commissions and penalties for premature retirement and support initiatives for extension of the length of service of the insurance holders as much as possible. Through these measures, the source incomes will be increased to a certain rate and will refresh the public column, while the extent to which this will help will be different from country to country.

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INNOVATIONS AS A KEY FACTOR IN THE DEVELOPMENT OF E-COMMERCE

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Abstract

Digital transformation reshaped and accelerated world economy. Fast changing technology has forced businesses to be more innovative, in order to be competitive and resilient in the long run. In this study, we explored internet usage and online shopping among adults (18-64 y.o.) in Serbia, with particular focus on barriers and incentives for online shopping uptake. Respondents were interviewed by CATI technique in 2016 and 2018. The study shows how to meet customers' needs and how to overcome certain challenges, as well as where is particular space for improvement and implementation of innovations bearing in mind ability to increase business value, profit and customer satisfaction.

Keywords: *innovations, internet users, on-line shopping, e-commerce, internet services*
JEL classification: L81, L86, M21, O30, O31

Introduction

Today's marketplace is characterized by strong competition, speed and change. New technologies affect the way of doing business and rise new market possibilities. These factors force today's companies to quickly respond to new changes and demand situations within short product and service life cycles. Fast changing technology and new market situations have forced businesses to be more innovative and apply strategy of change with continuous innovations of their products and services. The change in perception of innovation from change centric to customer centric is the key driver for the ability to increase business value, turnover and profit. Strategic thinking of those SMEs that search for customer value innovation is new way of thinking that encompasses customer

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satisfaction starting from fulfilment of customer needs to long-term communication with them in co-creative atmosphere.

Strong market orientation empowered by innovative approach is a key factor of SMEs sustainability and growth. (O'Dwyer et al., 2009). Market knowledge helps SMEs to develop a competitive advantage through increased customer knowledge and demand, and thereby taking a strong position in the market. Creation of strategic and marketing plans as well as innovation strategy usually asks for the assistance and outsourcing of consultants in Serbia, which is requires substantial investment. (Mamula & Popović-Pantić, 2015) On the other hand, innovation is arguably one of the main drivers of economic growth and the capacity to innovate among the most important factors enhancing competitiveness on a global scale (Grossman & Helpman, 1991; Nelson, 1996; Baumol, 2002). The strategic planning in the company involves adapting the firm to take advantage of opportunities in its constantly changing environment (Kotler & Keller, 2006) Therefore, company is enforced to innovate in all business functions. It seems that nowadays it is not possible to make good marketing performance without similarly good innovation performance and vice versa. This is because strategic marketing planning and strategic innovation management are interrelated in many aspects. Recent literature shows that co-creation is going to be milestone of the future model for Marketing 3.0. (Kotler et al., 2010). Innovative performance measure some of the key elements of marketing plan regarding the definition of product/services like ability to introduce new products and services to the market before the competitor, percentage of new products in the existing portfolio, number of new products and service projects.

According to 2014 research in Serbia large and medium-sized enterprises have some plans and projections for the future, but in the small and micro enterprises there is no practice of planning the future. This unstable and turbulent environment is not encouraging for progress and most small and medium-sized enterprises are satisfied with the mere survival of the market, while the development occurs spontaneously rather than planned. Serbian SMEs usually create and possess business plans because this is condition for applying for the credits while other documents are considered as added value in applying for some governmental subsidies or participation in some non-financial support programs (Mamula & Popović-Pantić, 2015).

Cravens (2006) explains that at the beginning of the century strategic marketing is faced to exceptional set of opportunities as an outcome of new technologies, digitalisation and globalisation that produced more complex customer' value requirements, stronger competition and unstable markets. One of actual examples of not being open and flexible at innovation is Sears. Sears hasn't turned a profit since 2010 and is $134 million in debt, recently approached several banks to prepare for bankruptcy filing, CNBC reported Wednesday (10.10.2018). Shares have fallen by more than 85 percent in the last year as e-commerce has taken over the brick-and-mortar retail space. Despite pairing up with Amazon in 2017 to sell appliances online, analysts say Sears has not kept pace with change nor made investments in the digital space to the extent that Walmart and Target have done. Companies which do systematic innovation management and systematic marketing management can grow faster than their competitors who are not innovating at all or who are not manage their innovation projects effectively. Lack of access to finance is a great barrier even for the innovative SMEs in Serbia for further development. Therefore, availability of the financial resources and its diversification to the SMEs in Serbia and in the region will be the key trigger for the improvement of their global competitiveness. (Mamula & Popović-Pantić, 2015) Innovation is a discipline that can be measured, managed, and improved. When Innovation Moves at Digital Speed it provides practical guidance for innovation success (*MIT Sloan Management Review, 2018).*

According to the OECD definition, e-commerce for businesses improves efficiency by enlarging the scope of the market and lowering operating barriers and costs. E-commerce offers numerous benefits for consumers, by providing detailed information on goods and services, helping consumers to locate shops and sellers, facilitating price comparisons, offering fast and convenient delivery, and allowing them to purchase easily via a PC or mobile device whenever and wherever they are (OECD, 2013). E-commerce has changed not merely how consumers shop, but also the range of providers from which consumers can buy products and services. The growth of e-commerce has the potential to increase competition within retail markets, to greatly enhance consumer choice, and to prompt and facilitate innovation in product distribution. (OECD, 2018).

Graph 1

Source: *https://www.ecommercewiki.org/reports/614/european-ecommerce-report-2018*

In 2017 ecommerce in Europe has once again shown some double-digit growth. The total e-commerce turnover in Europe has increased by 11 percent last year, making it worth 534 billion euros. For the current year, a growth rate of 13 percent is expected, which would mean ecommerce in Europe will be worth 602 billion euros in 2018. The European ecommerce industry has thus shown some significant growth, if you take into account the industry was worth no more than 307 billion euros five years ago. This is one of the many findings of the new European B2C Ecommerce Report by Ecommerce Europe.

Introduction in study

One of the main objectives of the our study was, from the one side, to measure who and with what purposes use online shopping among Serbian people, and from the other side to see what are the main obstacles in online shopping in order to be improved. This kind of research can help to those who are thinking of starting e-commerce business or those who are already using this channel to increase their productivity and competitiveness. Innovations in e-commerce can only help strengthening business, increase companies efficiency and their reach of new markets (in the country and even abroad).

Different target groups were addressed in the survey, with the same goal – to research the awareness, attitudes and specific behaviours related to Internet usage and specifically online shopping perception, as well as incentives and barriers to uptake. The survey therefore covers the following target groups:
1. Non-users of internet

2. Internet users who do not shop online
3. Internet users who shop online

Research methodology

E-COMMERCE study, CATI (Computer Telephone Assisted Interviewing), conducted with 1400 respondents, representative sample, 18-64 years old (representative by region, gender, age, level of education, income, and urban and rural areas - size of the place of living).

Fieldwork is done in two waves:
1.5th-23rd September 2016 (EU funded survey, 2016)
2. 2nd – 20th April 2018 (Our research)

Quantitative research was conducted on national representative sample, in compliance with ICC/ESOMAR International Code in all phases of the research. Survey technique was Computer Assisted Telephone Interviews (CATI). The survey covered three target groups as we already mentioned. In the table below, sampling error that can be expected for 95% confidence interval for each of the target groups is reported for various incidence percentages.

Table 2: *Sampling errors*

SAMPLING ERRORS	Incidence		
Target group	5%	25%	50%
Non-users of internet	+/- 2.2 %	+/- 4.4 %	+/- 5.1 %
Internet users who do not shop online	+/- 1.8 %	+/- 3.5 %	+/- 4.0 %
Internet users who shop online	+/- 2.1 %	+/- 4.1 %	+/- 4.7 %

Table 3: *Demography gender*

	2016	**2018**
Male	49.7	49.7
Female	50.3	50.3

Source: *2018 research*

Demography age in research in 2016 was: age 18 to 24- 13%; age 25 to 34- 22%; age 35 to 44- 21%; age 45 to 54– 21%; age 55 to 64- 23%; in 2018 was: age 18 to 24- 13%; age 25 to 34- 22%; age 35 to 44- 21%; age 55 to 64- 22%.

Table 4: *Demography Region*

Region	**Both years % respondents**
Belgrade	19
Vojvodina	28
Sumadija and Western Serbia	29
Eastern and South Serbia	24

Source: *2018 research*

E-Consumers in Serbia study

Serbia compared to EU countries

According to Statistical office of RS in 2017, 68.0% of the households in the Republic of Serbia possessed the Internet connection and it was the most widespread in Belgrade, amounting to 77.5%. In Vojvodina, it amounted to 68.7%, and in Central Serbia to 63.8%. While in 2018 this number increased and we have 72.9% of households with internet connection, in Belgrade it was 82.2%, in Vojvodina 70.7%, in Central Serbia 69.3%.

This is still however below EU average, the share of EU-28 households with internet access had risen to 87% (Eurostat, data for 2017). In the same report we found data that the highest proportion (98%) of households with internet access in 2017 was recorded in the Netherlands, while Denmark, Luxembourg, Sweden, Finland, the United Kingdom and Germany also reported that more than 9 out of every 10 households had internet access in 2017. The lowest rate of internet access among the EU Member States was observed in Bulgaria (67%) (Eurostat, data for 2017). When we are taking in consideration individuals, 84% of all individuals in the EU-28, aged between 16 and 74 years, used the internet (at least once within the three months). The proportion of the EU-28's population that had never used the internet was 13% in 2017, while in the same year in Serbia 25.6% population never used internet (IKT, 2017).

Based on the above information, we can conclude that households in Serbia significantly lag behind the average household in the EU, when talking about internet connections, but that some EU members also have a

less percentage of internet connections in households from Serbia, like e.g. Bulgaria.

Online shopping – reasons for using or not using internet

In order to be able to perform online shopping one must first use internet. According to our survey from 2016 and in 2018, we found that internet usage increased by 3%, from 73.5% in 2016 to 76.5% in 2018. Internet users % in our surveys is significantly higher than % we will find in data presented by Statistical office of RS due to the fact that we did not take in consideration population older than 64 years old. Even the number of internet users is increasing on yearly basis; we still have around 25% respondents who do not use internet at all and significant percentage of those who use internet but are not online shoppers.

Non-users of internet research

Table 5: *Demography*

Internet usage	**2016**	**2018**
Internet users	73.5	76.5
Internet non users	26.5	23.5

Source: *2018 research*

Table 6: *Reasons for not using the Internet ranked by the most common reason among respondents*

I don't need it
I don't know how to use it
It is expensive for me
I don't have a device for internet
I don't have time
other

Source: *2018 research*

Main explanation for rejecting Internet is still not feeling the need for using it (58% in 2016 and 56% in 2018). Not knowing how to use it and expensiveness are also important reasons, each reason almost up to 25% in 2016, while in 2018 not knowing to use it is around 20%, while expensiveness still remains around 25%. Those who don’t know how to use it are more often from Vojvodina and Sumadija and Western Serbia

(mostly older people, from non-urban areas, lower education). People from Eastern and Southern Serbia more commonly don't use internet as it is too expensive for them. Those with higher education and income, from urban areas, don't use Internet as they don't need it. For others, basically lack of knowledge and price are more relevant barriers.

If we want to increase internet users, we have to find the way to involve primarily older generations from non-urban areas, to educate and explain them what they can benefit from internet. The potential of Serbia in terms of tourist development is enormous, and tourist offer should be presented more intensely on digital platforms, because that is not only one of the options, but an absolute prerequisite to position Serbia as an international tourist destination (Bejatović & Bugarčić, 2018). Tourism industry, in the last decades has taken on global dimensions, and the concepts of massiveness are considered a key attribute of the tourist market (Bejatović & Ristić, 2016). Only with internet users we can reach this.

Some of the traditional crafts are extinct because, among other things, they do not have customers. Perhaps some of these crafts or specific local products could be preserved / improved if those who deal with them could reach a larger customer base, and the internet is one of the ways to do that. Adequate information (education) in smaller environments on the importance of using the internet and e-commerce could help some local entrepreneurs to improve and preserve their entrepreneurial ventures.

Internet users who do not shop online

Table 7: *Shopping or ordering products/services online*

	2016	**2018**
YES	42.2	55.3
NO	57.8	44.7

Source: *2018 research*

We may notice that there was significant increase in online shopping among those who use internet, just in a two years period. This increase was due to the fact that more and more people are using mobile devices (mobile phones mainly) to access the internet, as well as because of more and more frequent wireless internet connections in public places.

Table 8: *Reasons for internet users who do not shop online - most common reasons according to respondents*

Getting the wrong product
Frauds in online payments (data theft or money theft)
Wrong colour, size or some other characteristic of the product
Defective product
Paid product never arriving
Hidden additional costs
Delivery delay, Delivery to the wrong address
One cannot file a complaint for a product / service (e-consumers are not protected)
Other

Source: *2018 research*

Second target group in our research were individuals who use internet but do not shop online. In the above table we presented most common reason for not shopping online, ranked from the most important to less important according to respondents. In period of 2 years rank of reasons remain the same. Although 44.7% of respondent do not shop online, more than a half of non-shoppers tend to get informed about products on the Internet or read customer reviews before going to store to buy certain product.

This is particularly prevalent in the choice of tourist services, especially when looking for accommodation in specific tourist destinations. During the research of trends in creating a tourist offer in the digitalization era, Bejatović & Bugarčić found that 95% of the examinees do a background check of the hotel, i.e. they want to see other visitors' grades and what comments they have on the hotel. Examinees do not use Facebook and Instagram, but they use digital platforms, i.e. websites like Booking and Trip advisor for the hotel check in 72% of cases. (Bejatović & Bugarčić, 2018)

Risk of getting the wrong product (2016- 59%, 2018- 54%) or some wrong product characteristic (2016-42%, 2018-40%) are among main risks of online shopping for non-online shoppers. Almost one half of non-shoppers are very concerned about data and money theft.

These are the two areas that can be improved by innovation. The Andie Swim brand won the Innovation Award for Product Innovation because the owner of the firm introduced the try-before-you-buy model.

Swimwear industry is a global market of 28 billion dollars, but it still shows an extremely low level of ecommerce penetration. The product is very specific and it is difficult to order a bathing suit that you haven't tried on. Thus, Melanie Travis (owner of Annie Swim) introduced the try-before-you-buy model policy. This implies that customers have 2 weeks from ordering the products to try it at home and return at no cost if they do not suit them. In the same year, the company increased its income (sales via website) by 160%. The firm sells its products in 49 US states.

Frauds in online payments (data theft or money theft) are the next risk that alienates Internet users from online shopping, which can be overcome by e.g. paying via PayPal.

Even though half of non-shoppers recognize that online shopping can saves their time and be more convenient compared to shopping in stores, when it comes to deciding about shopping, consider website safety to be the most important trigger for trying online shopping. Respondents who did not try online shopping would be interested to try it in future mostly for purchase of goods such as clothes, shoes, accessories and electronics on local websites.

Table 9: *Internet use and online purchases EU-28, 2017 % of individuals*

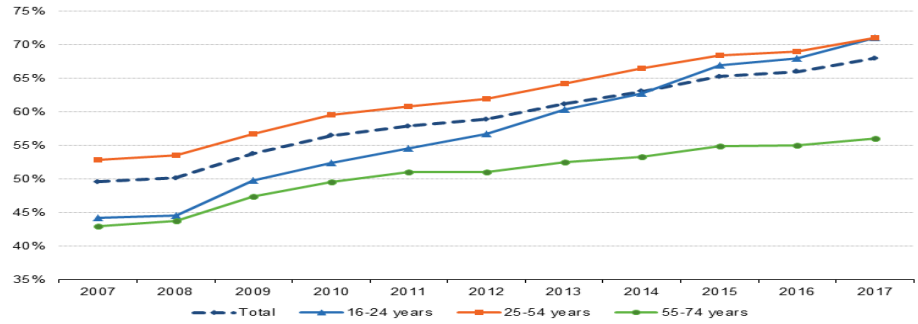
	Proportion of individuals who:	
	Used internet within the last 12 months	Purchased online within the last 12 months
EU-28	85	57
Belgium	89	60
Bulgaria	66	18
Czech Republic	85	56
Denmark	97	80
Germany	91	75
Estonia	89	58
Ireland	82	53
Greece	70	32
Spain	85	50
France	88	67
Croatia	69	29
Italy	73	32
Cyprus	81	32
Latvia	82	46
Lithuania	79	38
Luxembourg	97	80
Hungary	79	39
Malta	81	52
Netherlands	96	79
Austria	88	62
Poland	78	45
Portugal	75	34
Romania	70	16
Slovenia	80	46
Slovakia	83	59
Finland	94	71
Sweden	97	81
United Kingdom	95	82
Iceland	98	76
Norway	98	77
Switzerland	95	77
Montenegro	73	13
Former Yugoslav Republic of Macedonia	76	15
Serbia	72	31
Turkey	66	21

Source:*https://ec.europa.eu/eurostat/statistics-explained/index.php/E-commerce_statistics_for_individuals#General_overview*

From the above table we may notice that even though most EU countries population use internet, in significantly lower proportion they shop online. The proportion of e-shoppers varied considerably across the EU, ranging from 16 % of internet users in Romania to 82 % in the United Kingdom (Eurostat, 2017).

Internet users who shop online

Graph 10: *Internet users who bought or ordered goods or services for private use in the previous 12 months by age group, EU-28 (% of internet users)*



Source:*https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=File:Internet_users_who_bought_or_ordered_goods_or_services_for_private_use_in_the_previous_12_months_by_age_group,_EU-28_(%25_of_internet_users).png*

In the EU-28, in the age group from 16 to 24, in the 10-year period, the share of those who shop online has increased significantly, by more than 20%, while the age group from 25 to 54 is constantly growing, but not at the level of the younger age group. Older generations of the EU-28 clearly accept modern technology and this way of shopping, but online shopping is not nearly as attractive as it is for younger age groups. E-commerce picked up over the 2007-2017 period among all age groups, with individuals aged 16-24 showing the biggest increase (27 percentage points (Eurostat, 2017)

Generation Y is the first generation that grew up on the wave of introduction and application of digital technology and communications. We are witnesses to the fact that without an understanding of who Millenials are and why they think and act in a way that is different from the older generation can disadvantaged when it comes to communication, delegation of activities and building relationships with representatives of

the new generation. The development of IT leads to faster development of generations, and each generation represents the specifics of their period (Mamula, 2016).

Table 11: *Reasons for online shopping- most common reasons among respondents*

Easier than going to the shop
Faster, saves time
Better prices (discounts, promotions…)
Wider choice, Products not available in the country
Easier comparison of different brands, prices, suppliers
Checking product reviews right on the selling website
There are no advantages

Source: *2018 research*

In the above table we presented most common reason for shopping online, ranked from the most important to less important according to respondents and their rank stayed unchanged in both years. The reason why the respondents generally decide to use online shopping is because this way of buying is easier, faster and saves time, the prices of products are more favourable than in stores and they can more easily compare prices with other brands, suppliers, shops. At this point, a large number of respondents from urban areas cite that the main reason for online purchases is because it's easier and quicker, while respondents from non-urban areas shop online mainly due to a greater choice of products.

The most online-purchased goods (over 50% in both years) are clothing, shoes, fashion accessories, electronics are second, followed by services from the domain of health and beauty, books and magazines, household equipment, sport and recreational equipment and other goods / services that are present with less than 10% in both years. Products from the domain of wardrobe are mainly bought by the younger population and in a larger number by women. Products from the field of health and beauty are more present in urban areas, mostly in Belgrade, while books and magazines are mainly purchased by respondents with higher education.

In EU-28 in 2017 most popular online purchase involved clothes and sports goods (64%), travel and holiday accommodation (53%), household goods (46%), tickets for events (39%) and books, magazines and newspapers (34 %). Less than one in five e-shoppers bought

telecommunication services (19%), computer hardware (18%), medicines (13%) and e-learning material (6 %). (Eurostat, 2017)

Above 70% of online shoppers in Serbia in both years prefer local websites, the main reason for choosing domestic website because respondents tend to believe they are more secure, but also because they are familiar with language and pricewise. They believe that they can spot hidden costs more easily on domestic sites than on foreign and in case of mistake, the costs of returning products are acceptable. Only 10% in 2016 and 16% in 2018 prefer foreign websites. Those who prefer foreign sites are mostly from Belgrade or other bigger cities and have higher education.

The main three reasons why they prefer foreign sites are: they offer products that can't be bought in Serbia, they offer more products or services and offer more affordable prices. Respondents who prefer foreign websites mostly over 80% in both years shopping on websites such as Ali express, Amazon, E-bay, and 16% in 2016, and over 20% in 2018 are using booking websites (booking, Airbnb, Wizz air etc). Multiple answers were allowed in a survey. When it comes to local websites, great majority of Serbian online shoppers (75%) prefer shopping websites like Limundo, Kupindo, Kupujem-Prodajem, etc., and they also buy on websites of electronic shops (above 20%) and clothes, shoes and sport equipment shops websites (20%). Multiple answers were allowed in the survey.

E-shoppers from EU-28 are making online purchases from sellers in their own country in 87 %, around 33% making purchase from other EU countries, and only 23% making purchase from sites outside the EU in 2017.

One of the most common reasons for those who do not buy online is fear of getting the wrong product, yet research shows that the vast majority of respondents in both years are very satisfied with online shopping, and over 90% of online customers have never had a problem during internet shopping. The ones that had the problem usually had it with some wrong characteristic of the product, getting completely wrong product, but it also happened they got defective product, or didn't get the product at all. Most online shoppers who experienced any kind of a problem with online purchase have contacted someone in order to solve their problem. But, majority of local online shoppers (2016-85%, 2018- 82%) have no idea of the consumer rights regarding online purchase. Only 15% in 2016, and

18% in 2018 respondents state there is a possibility of product complaint/ replacement.

Website safety is considered the most important factor for online shopping uptake – most shoppers believe overall reputation of website/company to be the most important indicator of website safety, while 45% of them tend to rely on recommendations they get from friends and family (word of mouth). Customer reviews on website as well as on independent forums and blogs are also taken into consideration. However, lower product prices are also very important to online shoppers, and they value fast delivery, precise product description and simple buying procedure. Online shoppers consider online purchase to be easier compared to going to the store (62%), and it's believed that it saves time and it is more affordable (Table 11). Majority (87%) would be ready to recommend online purchase, based on positive personal experience, and because it saves time.

Preferred payment method for 4 out of 5 online shoppers in Serbia would be cash on delivery, and only every fifth shopper would choose to pay with payment cards - online shoppers tend to choose cash upon arrival because it is believed that's the safest payment method, while payment cards are considered to be easiest and fastest payment method.

Conclusion

In this paper, we focused on presenting only a part of the results that we obtained during the research in 2016 and 2018. The research was conducted with the aim of obtaining data on what is needed to be innovatively improved in the process of e-commerce. As we said at the beginning of the paper, innovations can be observed in very different ways, so the following definition is given in the Business dictionary: The process of translating an idea or invention into a goods or services that creates value or for which the customer will pay. Innovation does not mean only innovation in the technical and technological sense, but also all innovative ideas, in terms of products, services, any processes that can improve and add value to processes, communication, goods, services, companies and / or customers.

Based on the information obtained, we can conclude that it is necessary to improve several key segments such as security issues, simplifying shopping procedures and finding a way to reduce the fears of potential

online customers that they will receive wrong or damaged goods in order to have a significant market share of e-commerce in Serbia.

Online buyers in Serbia mostly use websites Kupindo, Limundo, Kupujem-prodajem, that do not sell their goods, but allow individuals who appear as sellers to reach potential customers more easily. Airbnb operates in a similar way. Airbnb will be the largest hotel company in the world without a single asset. It is something similar as aforementioned domestic websites, they do not sell their goods, they are platforms that allow others to sell / buy different types of goods from all over Serbia. However, it is certain that domestic online customers who use the above mentioned sites will much easier choose online shopping of goods and services of specific brands or specialized shops, if they already have experience in online shopping. It is necessary to listen to their needs and take into consideration the reasons that increase their preoccupation.

E-commerce can serve anyone who wants to start, improve and / or develop their business ideas. Bearing in mind that over 70% of households in Serbia have an internet connection, that is, that almost 75% of individuals in Serbia use the Internet is a sufficient fact to take into account e-commerce as a business option. The basic question is how to make an online customer from the Internet users.

The fact that online customers generally prefer local websites is not strange, because it is absolutely the same trend in the EU-28 as well. The inhabitants of the EU-28 countries are also buying on sites from their country of residence. For those who develop their business ideas using e-commerce, it remains to find solutions to these issues. In order for someone to become a buyer, and not just a visitor of the site, they must feel secure. The information that the site itself offers is the key to gaining trust among potential customers. So with simple contact information (where besides email there is also the phone number with somebody to answer), information about site security, easily visible ratings from previous users from other countries, live chat and similar will surely be of use.

Online shopping in Serbia is increasing every year for approximately 3%. In 2017 50.1% of Serbian citizens (aged 18-64) at least sometimes buy or order something on the Internet (IKL 2017), while in EU-28 57% citizen who ordered or bought goods or services over the internet for private use continued to rise. (Eurostat, 2017) This percentage will certainly increase

from year to year. The role of Serbian millennials in online shopping is immense. Some data shows that more than 60% of them have already buying commodities / services and paying bills via internet. (Mamula 2016)

Also, the value of goods/services that are most often bought online should be taken into consideration. In Serbia, we have the situation that over 50% of online customers buy goods/services worth up to 50 euros, while roughly 23% of online customers buy goods/services worth from 50 to 100 euros. When e-commerce is considered as a business option in Serbia, information on the average value of goods must be taken into account.

E-commerce will surely be more and more present in the world, and also here. Researches in the domain of usage, habits, barriers, user expectations is necessary because they can provide us with concrete guidelines, how to use e-commerce in the best possible way, but also which domains we need to improve and innovate, for the purpose of developing an entrepreneurial initiative, an environment that will stimulate growth and the development of SME enterprises and in the end facilitate the creation of jobs and increase trade competition in Serbia.

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THE EVALUATION OF BANK'S FINANCIAL PERFORMANCE AND ITS DETERMINANTS: A CASE STUDY ON SERBIA

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Abstract

The contemporary role of banks in a national economy is multiple. In addition to attracting financial resources, banks perform financing of various entities through different financial services and consequently influence on the development of the overall national economy. Regular monitoring of the banks' financial performance is necessary in order to prevent the occurrence of financial difficulties. Therefore, the intention of this paper is to provide a useful tool for monitoring banks financial performance and to examine its main determinants. In order to achieve the stated goal the selected multi-criteria methods will be applied. For determination of weight coefficients the CRITIC method will be applied and for construction of the financial performance indices for each of the bank on the basis of selected financial indicators PROMETHEE method will be applied. In the second part of the paper regression analysis will be applied for assessment of the basic determinants of financial performance.

Key words:*CRITIC method, PROMETHEE method, regression analysis, bank performance*
JEL classification: C33, C60, C87, G21

Introduction

Contemporary business surroundings is mainly characterized by the liberalization of the economic environment, hasty technological revolution, the frequent crises and globalization of the market (Krstić & Veselinović, 2015). Globalization led to the gradual elimination of control over cash flows and the increase of international capital markets (Boskov et al., 2018). These changing environment has generated a lot of different factors which may affect the business of various entities.The impact of

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these factors depends largely on the characteristics of the country and the environment in which the entities operate. Regarding banking sector in the Republic of Serbia in the last two decades,it has undergone remarkable changes primarily reflected in the creation of developed banking system, reduction of the number of state banks and restoration of the population trust. Before the reforms conducted starting from 2001, Serbia banking sector was experiencing severe difficulties.Main characteristics of the banking sector in that period were low profitability, high level of insolvency of the largest banks and extraordinary amount of non-performing loans. With the reform process, the development of the banking sector of Serbia began. Liquidation of insolvent banks was conducted and foreign capital was allowed to enter the market thus leading to the reduction of the number of banks and creation of competitive banking sector. Currently, 31 banks with work permit operate in the Republic of Serbia, with an organizational network of 1,633 business units and 23,095 of employees (Banking sector in Serbia: Report for the 1st quarter of 2018). It can be observed that banking sector is human capital intensive and it relies heavily on its human resource capital to offer services to its clients (Radjenovic&Boskov, 2017) therefore it is important to adequately assess its performance since wellbeing of employees depends on its financial success.During first quarter of 2018, the overall banking sector has operated profitably, wherein profit was recorded by 24 banks. Regarding the structure of banking sector, it can be observed that tenbanks control more than 80% of the market,measured in by total balance sheet assets value, while fifteen banks control 92% of the market (Table 1).

Table 1: *Balance sheet assets (in RSD bln) and share in total balance sheet assets (%) of ten largest banks in the Republic of Serbia*

Bank	Total assets	Share
Banca Intesa	558.7	16.5
Unicredit Bank Serbia	390.4	11.5
Komercijalna bank	367.1	10.8
Societe Generale bank Serbia	290.0	8.6
Raiffeisen Bank	272.0	8.0
AIK bank	201.1	5.9
Eurobank	162.7	4.8
Erste Bank	161.2	4.8
Bank Poštanska štedionica	146.5	4.3
Vojvođanska banka	117.6	3.5

Sber banka Serbia	108.9	3.2
ProCredit Bank	97.3	2.9
Addiko Bank	88.2	2.6
Credit Agricole bank Serbia	84.7	2.5
OTP bankSerbia	69.4	2.1
Total		92.0

Source: *Banking sector in Serbia: Report for the 1st quarter of 2018*

This consolidation of banking industry led to increase of banking sector profitability. Largest banks are the most profitable which is obvious when considering the fact that 72% of the total net profit of the banking sector is obtained by six banks (Banking sector in Serbia: Report for the 1st quarter of 2018). The trend of banking sector profitabilitygrowth can be observed after 2013 through analysis of ROA and ROE indicators. It can be perceived that the value of these indicators has an upward trend (value of ROA was -0.07 in 2013 and 2.08 in 2017; value of ROE was -0.36 in 2013 and 10.57 in 2017), indicating that current banking sector has satisfactory profitability rates.In terms of the achieved level of capital adequacy indicators and in terms of the regulatory capital structure, the banking sector of Serbia has been adequately capitalized. The average value of capital adequacy indicators at the level of the Serbian banking sector was above 20% which is significantly above the prescribed minimum by the National Bank of Serbia (8%). In order to maintain the course of increased profitability, it is necessary to determine the main factors which have contributed to the growth of profitability. Due to these reasons, the examination of the bank's financial performance and main bank specific and macroeconomic variables have become a topic of numerous researches in the financial field.

Although there aredifferentfinancial ratios for the assessment of the firm's performance (ROA, ROE, NIM, Loan to Deposits ratio etc.) true state and achieved level of financial performance can be assessed only through integration of these various ratios into singe index. In order to achieve that, it is possible to use various multiple criteria decision methods.Therefore, the main aim of this paper is to provide a comprehensive framework for assessing banks financial performance and for analysis of its main factors. With the intention of achieving the specified aim,we will present the main financial ratios used for assessing bank's financial performance for stated fifteen banks (Table 1) which have operated in the Republic of Serbia in the period from 2013 to 2017

and conduct the determination of weight coefficients for each of the ratiousing the CRITIC method. Subsequently, construction of financial performance indices,on the basis of chosen financial indicators, will be conducted for each of the banks using PROMETHEE method. Furthermore, thepanel data regression analysis will be applied in order to identify basic determinants of bank's financial performance.

Based on the given objective, the rest of the paper is structured so that, in addition to the introduction and conclusion, it contains the following components: (1) Literature review and methodology; (2) Construction of financial performance indicators; (3) Panel data regression model specification and analysis of the results.

Literature review and methodology

Numerous methods were applied with the purpose of assessing the bank's performance and ranking of banks: Data Envelopment Analysis (DEA) (Staub et al. 2018; Aggelopoulos & Georgopoulos, 2017), PROMETHEE (Doumpos & Zopounidis, 2010; Mareschal & Brans, 1991), integrated AHP-TOPSIS (Akkoç & Vatansever, 2013). Additionally, there is a vast number ofstudies dealing with factors that influence the profitability of banks. Kosmidou et al. (2005) have examined the influence of bank-specific, market specific and macroeconomic variables on UK owned commercial banks' profitability over the period 1995-2002. As bank-specific variables, they have used cost to income ratio as an indicator of management efficiency,ratio of equity to total assets representing capital strength, ratio of liquid assets to customer and short term funding to symbolize liquidity, the total assets of a bank signifying its size and ratio of loan loss reserves to gross loans as an indicator of banks' asset quality. Market specific variables used in their analysis are concentration in the banking industry and stock market capitalization, while as macroeconomic variables inflation and GDP growth rate are used. Their findings show that capital strength, bank size, GDP growth rate, inflation concentration and stock market capitalization have significant influence on banks' profitability. Al-Tamimi & Hussein (2010) investigated main performance determinants of Islamic and conventional national banks in UAE over the period 1996-2008. As explanatory variables they used liquidity, size, cost, concentration, number of branches, financial development indicator and GDP per capita. Their finding reveal that concentration and liquidity are the most significant determinants of

conventional national banks' performance, while cost and number of branches are the most significant determinants of Islamic banks' performance. Petria et al. (2015) examined the main banks' profitability determinants in EU27 during the period 2004-2011. In order to conduct the assessment they used bank-specific, industry specific and macroeconomic variables. The bank-specific factors used in the analysis are: bank size, business mix, credit risk taken, financial structure liquidity risk, income-expenditure structure and capital adequacy. Market concentration represents the industry specific factor, while macroeconomic factors are inflation and economic growth. Their findings indicate that management efficiency, credit and liquidity risk, the diversification of business, the market concentration and the economic growth have significantimpact on bank profitability. Ongore & Kusa (2013) investigated financial performance determinants of commercial banks in Kenya. Assessment was conducted using bank-specific and macroeconomic factors. The following indicators were used as bank-specific factors:capital adequacy, asset quality, management efficiency, earnings ability and liquidity, while GDP growth rate andinflation rate denoted macroeconomic variables. The results of their study indicate that capital adequacy and management efficiency have significant positive influence, while asset quality has significant negative influence on the commercial banks' performance.Regarding macroeconomic variables it has been shown that inflation has strong negative influence oncommercial banks' financial performance. Djalilov & Piesse (2016) examined the determinants of bank profitability in the early transition countries of Central and Eastern Europe (CEE), and in the late transition countries of the former USSR. In order to conduct panel data regression analysis, they used following variables: capital, credit risk, cost, size, Herfindhal-Hirschman Index, GDP growth, inflation, government spending, fiscal freedom and monetary freedom. Dietrich & Wanzenried (2011) analyzed the profitability of commercial banks in Switzerland during the period 1999-2009. Analyzed profitability determinants consist of bank-specific and industry-specific and macroeconomic factors. Among bank-specific factors authors include: ratio of equity to assets, cost-income ratio, loan loss provisions over total loans, yearly growth of deposits, growth of a bank's loan volume relative to the average market growth rate of loans, bank size, interest income share, funding costs, bank age, bank ownership and nationality. Macroeconomic and industry-specific characteristics include effective tax rate, real GDP growth, term structure of interest rates and Herfindhal-Hirschman Index.

Regarding analysis of banks' financial performance in the Republic of Serbia, several authors have conducted research in this area. Mandić et al. (2014) have proposed a fuzzy multi-criteria model with intention to ease the evaluation of the banks' financial performance. They performed an integrated Fuzzy AHP and TOPSIS method on the sample which encompasses entire banking sector in the Republic of Serbia covering the period from 2005 until 2010. Stanujkić et al. (2013) conducted comparative analysis of several MCDM methodsand the aim of their analysis was to give an overview of different methods which could be applied in the analysis of financial performance of banks. Marinkovic & Radovic (2010) have examined determinants of interest margin on the case of banks operated in the Republic of Serbia during the period 2001-2003. Their findings reveal significant positive relationship between bank interest margins and proxies of interest-rate risk, negative relationship with risk averseness, positive relationship with credit risk variable and not so strong influence of foreign bank entry. Marinković & Radović (2014) have investigated bank-specific, industry-specific and macroeconomic determinants of the net interest margin in the Serbian banking industry. Their results show that among bank-specific factors equity-to-asset ratio and proxy for loan default risk have statistically significant influence on NIM value.Regarding industry-specific determinants, only the proxy for concentration have significant influence on NIM. Knezevic & Dobromirov (2016) examinedthe influence of bank-specific, market-specific and macroeconomic determinants on the profitability of the banking sector in Serbia in the period 2004–2011. Their findings indicate that market-specific and bank-specific determinants have impact on bank profitability, while macroeconomic determinants do not. However, in the stated papers only one indicator of financial performance is analysed (NIM or ROA) while there are a lot of different indicators of financial performance. Therefore, that is the advantage of the intended analysis of financial performance. Through a three - step analysis the construction of financial performance indiceswill be conducted with the aim of assessing financial performance of each of the banks and its main determinants. The objective criteria weights will be determined during the first step. In the second step, indicators of financial performance will be constructed by means of PROMETHEE method. In the third step, basic determinants of financial performance will be identified by means of regression analysis.

CRITIC method

The impact that specific criterion $C_j(j=1,...,n)$ has on the final decision of the decision maker may be of varying intensity, depending on the relative significance of criteria for decision makers (Popović et al. 2015). There are numerousmethodologies that can be used to determine the relative importance of criteria. In order to obtain an unbiased ranking of alternativesthe determination of objective weights is desirable.Objective weights are calculated by quantifying the fundamental information of each evaluation criterion (Diakoulaki et al. 1995). One of the most used objective approach for weights determination is CRITIC (CRiteria Importance ThroughIntercriteria Correlation) method proposed by Diakoulaki et al. (1995).

In order to solve the multi-criteria decision making problem, it is usual to form the so-called decision matrix. Let the decision matrix A be given with n alternatives and m evaluation criteria f_j.For every criterion f_j a membership function $x_j$which will transform the values of f_j to the interval [0, 1] needs to be defined (Diakoulaki et al. 1995):

$$x_{aj} = \frac{f_j(a) - f_j^-}{f_j^+ - f_j^-} \qquad (1)$$

The concept of an ideal point represents the basis of this transformation. The value x_{aj} expresses how much the alternative a is near to the ideal value f_j^+ which represents the best value of the criterion j, and how far it is from the anti-ideal value f_j^- which is the worst value of the criterion j(Milićević & Župac, 2012).Using this transformation procedure, the original decision matrix is converted into a normalized matrix with elements x_{ij}.Additionally, for every vector x_j the standard deviation σ_j is calculated. Standard deviation measures the contrast intensity of the matching criterion. In the continuation of the method it is necessary to construct a symmetric matrix with dimensions mx$m$consisting of elements r_{jk} which represent coefficients of linear correlation between the vectors x_j and x_k. Consequently, higher disagreement between the criterion j values and criterion k values of the alternatives lead to the lower value of the coefficient $r_{jk}$and *vice versa*. The measure of conflict created by criterion j in relation to other criteria in the given decision-making situation is measured by the following sum (Diakoulaki et al. 1995):

$$\sum_{k=1}^{m}(1 - r_{jk}) \qquad (2)$$

In order to determine information transmitted by criteria,it is necessary to consider both thedecision criteriaconflict and contrastintensity. Therefore, the quantity of information $C_j$transmitted by thej^{th} criterion can be obtained by the following formula (Diakoulaki et al. 1995):

$$C_j = \sigma_j \sum_{k=1}^{m}(1 - r_{jk}) \quad (3)$$

Therefore, it can be concluded that a higher value of C_j implies a greater quantity of information obtained from a given criterion and consequently a higher relative significance of the observed criterion. The objective weights of a criterion are obtained by normalizing the values of C_j(Diakoulaki et al. 1995):

$$w_j = \frac{C_j}{\sum_{k=1}^{m} C_k} \quad (4)$$

PROMETHEE method

The PROMETHEE (Preferential Ranking Organization Method for Enrichment Evaluations) method also applies to multi-criteria decision making and was developed in 1982 by Jean-Pierre Brans (Brans et al., 1986. It was first used for decision making in health care and later expanded to other sectors. In this paper, authors used Visual PROMETHEE multi- criteria decision making software to analyse banking sector of Serbia according to PROMETHEE II. This method is based on the pair-wise comparison of alternatives along each selected criterion. PROMETHEE II requires two additional types of information:

- information on the weights of the criteria: in this paper, the criteria weights are determined by means of CRITIC method.
- a decision-maker's preference functionswhich were used for comparing the alternatives.

For each alternative (preference) $a \in A$, the input and output current values are based on the $\mathbf{\Phi}^+$ coefficient which is formed in the interval from -1 to 1 and it shows the degree of connection between two or more variables or alternatives based on the dichotomy of their criteria. Basically, it is very similar to Pearson's correlation coefficient. The greater value of $\mathbf{\Phi}^+$ coefficient indicates the greater domination of the given alternative in the total set:

$$\Phi^+(a) = \frac{1}{n-1}\sum_{x \in A} S(a,x) \quad (5)$$

$$\Phi^-(a) = \frac{1}{n-1}\sum_{x \in A} S(x,a) \quad (6)$$

The PROMETHEE I method gives the partial relation and then the net outranking flow is obtained using the PROMETHEE II method which ranks the actions according to a complete ranking for calculated net flow. This modified flow is called the net score **Φ'**, and is subsequently multiplied by 100 to obtain results in the [0, 100] interval:

$$\Phi(a) = \Phi^{+}(a) - \Phi^{-}(a) \qquad (7)$$

Regarding the preference function type, only one type of function can be used to simplify application of the PROMETHEE II method: a linear type accompanied by indifference and preference thresholds. Using only a linear type represents a linearization-based approximation used often in different statistical analysis.

The next step is to automatically calculate preference function thresholds. Authors used approach which calculates the mean value and standard deviation of a set of differences between criterion evaluations. Subsequently, the difference between the mean value and standard deviation is set as the indifference threshold, whereas the sum of the mean value and standard deviation is set as the preference threshold. This approach is called 'Mean-Std' and it is used in Visual PROMETHEE.Formation of the model in the program Visual PROMETHEE requiers definitions of the alternatives, evaluation criteria and their values. Also, it is necessary to define weight coefficients for the given criteria. The weight coefficients calculated by the CRITIC method are going to be applied in this analysis.

GAIA (Graphical Analysis for Interactive Aid) presents a very specific analysis within the Visual PROMETHEE program for multi-criteria decision making. Namely, this analysis allows to look at the spatial distribution of alternatives and criteria in the quadrants of the coordinate system and to follow interactionamong these alternatives and criteria.Mathematically,this analysis is based on the Principal Component Analysis concept. The mentioned statistical procedure uses the orthogonal transformation of a set of potentially correlated variables into a set of values of linearly unverified variables called the main components. GAIA groups alternatives and criteria by quadrants toobserve what distinguishes a particular group from another. This facilitates making decisions about the choice ofthe optimal alternative, as it provides visual representation of the relationship between alternatives and the criteria by which they are ranked.

O/I ratio describes a performance measurement computed as a ratio between normalized output and input flows. Namely, the Input actually represents a net flow computed for the input cluster of criteria. On the other hand, Output represents a net flow computed for the output cluster of criteria. So, O/I score, known as Aggregated score represents a percentage score corresponding to the O/I ratio: the best performing action has a 100.00score.

Panel data regression model

Panel data or longitudinal data represent a combination of cross-sectional and time series data. In comparison to purely cross-sectional data, panels often encompass far more information than single cross-sections and thus allow for an improvedaccuracy in estimation (Hoechle, 2007).Panel data consist of observations on the same N entities at several time points$T$.Therefore, panel data-set consists of N cross-sectional units, denoted i = 1, 2.....,N, observed at each of T time periods, denoted t = 1, 2.....T (Alexiou, &Sofoklis, 2009). Basic panel data regression model can be represented as (Baltagi, 2013):

$$y_{it} = \alpha + X_{it}\beta + u_{it} \quad i = 1,2 \dots n \quad t = 1,2 \dots T \quad (8)$$

where$i$ denotes an entity and t denotes time. Hence, subscript $i$indicates the cross-section dimension while subscript t indicates the time-series dimension, α represents a scalar, β indicates a vector of regression coefficients and X_{it}denotes the observation of i^{th} entity characteristics in the t^{th} time period. Additionally u_{it}represents composite error term expressed as $u_{it} = \mu_i + \lambda_t + v_{it}$where $\mu_i$symbolizes the unobservable individual effect or unit-specific heterogeneity,$\lambda_t$represents the unobservable time effect and v_{it}symbolizesthe residuestochastic disturbance term or idiosyncratic errors. The model (1) represents two-way error component model, while one-way error component model has composite error in the form $u_{it} = \mu_i + v_{it}$. In econometric studies of the panel data three models can be identified (Alexiou, &Sofoklis, 2009):

- The pooled model (pooled OLS) – this model is characterized by the constant value of the intercept and slope coefficients across entities and time (constant α and β).
- The fixed effects model -The main characteristic of the fixed effects model is that an assumption of a constant intercept α for all the entities and time periods will not be correct if there is substantialtemporal or substantial cross sectional effect. Therefore,

if the $\mu_i$and λ_t are presumed to be fixed parameters to be estimated and the residue stochastic disturbance term is independent and identically distributedv_{it}~IID $(0, \sigma_v^2)$, then the model represents a two-way fixed effects error component model (Baltagi, 2013).

- The random effects model – If all components of the error term are independent and identically distributed μ_i~IID$(0, \sigma_\mu^2)$, λ_t~IID$(0, \sigma_\lambda^2$) and v_{it}~IID$(0, \sigma_v^2)$then this model represents the two-way random effects model. Additionally, random effect model assumes that individual-specific effect, time-specific effect and idyosincratic error represent a random variables that are uncorrelated with the explanatory variables of all past, current and future time periods of the same individual (Schmidheiny& Basel, 2011).Therefore, in random effect model μ_i represents a set of factors related to the particular entity *i* that are not encompassed in the regression model (Alexiou, &Sofoklis, 2009).

Precise econometric test can be used with the purpose of selectingthe appropriate model. In order to test fixed effects F-test can be used, whereby rejection of the null hypothesis gives favour to fixed effects model. The random effects are tested by the Breusch-Pagan Lagrange multiplier test and the rejection of the null hypothesis means that the random effects model is favoured.A Hausman test can be used for choosing between fixed or random effects. If the null hypothesis is not rejected, a random effect model is favoured.

Construction of financial performance indices

Data from income statements and balance sheets of the stated fifteen banks in Serbia during the period from 2013 to 2017 were used with the aim of creating financial performance indices. Based on the review of the relevant literature,the following indicators were used:

- Return on Average Assets (ROAA) – denotes an indicator of bank's profitability and it provides the information on how efficient the management of a bank in generation of earnings is. It is calculated as ratio of net profit and average total assets.
- Loans to Deposits Ratio (LTDR) – representthe ratio calculated by comparing loans (which represent banks' assets) to deposits (which represent banks' liabilities) and indicates financial liquidity of the observed financial entity. Higher level of this indicator signifies higher risk in the short time period. However,

loans represent basic profit producer for banks and higher profitability compared to other assets with similar risk. Hence, banks tend to increase this indicator since it leads to higher net interest income.

- Net Interest Margin (NIM) – symbolises the indicator of bank's profitability and indicates bank's ability to earn income on its assets. This ratio is calculated by dividing net interest income with the interest earning assets. The higher value of this indicator demonstrates that the bank is well managed and also indicates forthcoming profitability.
- Bank liquid reserves to bank assets ratio (BLRBAR) – denotes an indicator of liquidity risk. Banks tend to have a higher level of this indicator since it means they would be able to stand a sudden deposit withdrawal.
- Loan Loss Reserves to Gross Loans (LLRGL) – shows bank's ability to absorb losses from non-performing loans. It is useful for determining the loans' quality. Loan loss reserves are used to cover potential losses when borrowers are incapable to reimburse their loans.
- Capital and Reserves to Total Assets (CRTA) – indicates the degree of bank's risk aversion. Banks tend to maintain higher level of this indicator since it means that in the event of financial difficulties their operation will not be endangered due to sufficient level of capital and reserves.
- Loans to Assets Ratio (LAR) – measures the relation between the loans of the bank and the bank's assets. On the one hand, higher value of this indicator signifies higher level of default risk and amplified operational costs.On the other hand, loans represent highly profitable assets and banks with higher level of this ratio are more profitable.
- Debt-to-Assets Ratio (DAR) – denotes measure of bank's financial leverage. It stipulates the quantity of bank's assets funded by debt. Higher value of this ratio indicates higher level of financial leverage and consequently higher financial risk. Therefore, banks tend to decrease this ratio.
- Debt to Equity Ratio (DER) – represents another measurement of bank's financial leverage and shows possible financial risk. It is calculated as the ratio of bank's debt financing and equity financing. The main characteristic of financial institutions is that they have a higher value of debt-to-equity ratio, primarily due to

the fact that banks represent financial intermediaries whose main role is to gather financial assets in order to lend them. However, too high level of debt-to-equity ratio may indicate higher possibility of financial distress, hence it is desirable to have relatively lower levels of this ratio.

In the first part of the financial performance index construction CRITIC method has been used to determine weights of the criteria in each of the observed years and the results are shown in the Table 2:

Table 2: *Criteria weights obtained by CRITIC method*

	ROAA	LTDR	NIM	BLRBAR	LLRGL	CRTA	LAR	DAR	DER
2013	0.095	0.092	0.149	0.119	0.145	0.099	0.115	0.092	0.094
2014	0.080	0.094	0.131	0.147	0.178	0.103	0.093	0.089	0.084
2015	0.100	0.087	0.089	0.165	0.168	0.104	0.095	0.094	0.098
2016	0.113	0.094	0.097	0.146	0.147	0.092	0.104	0.107	0.100
2017	0.113	0.094	0.123	0.137	0.120	0.091	0.120	0.103	0.098

Source: *Authors' calculation*

The calculated net score **Φ**' is given in Table 3 and represents the nest score for each analyzed bank between 2013 and 2017. Also the value of net score represents ranking place of the bank for the current year. In addition value ofO/I score is presented and this value denotes indicator of banks' financial performance.

With the purpose of conducting an analysis, it is necessary to verify validity (information quality) of the model, ie to varify that criteria and alternatives are well-chosen. Model is satisfactory if it exceeds 75%. In the case of banks ranking according to selected criteria, the quality of the model is 89.9% (Figure 1), which is more than enough to confirm its validity when we examine year 2013.

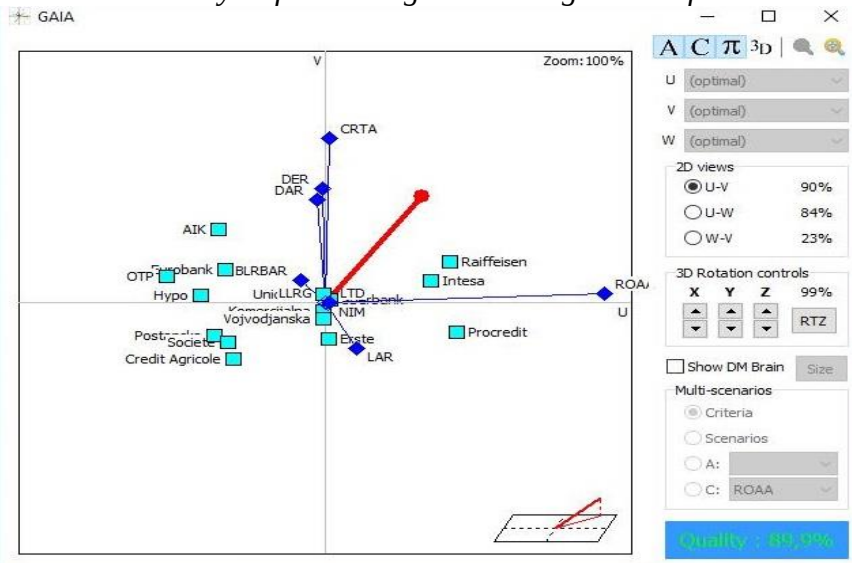
GAIA analysis literally groups alternatives into mini clusters by quadrants, based on criteria that are dominant for given alternatives. Thus, in the case of multi-criteria decision-making for the banking sector of Serbia, certain groups or clusters of alternatives appear.

Table 3: *Preference flow, rank and O/I score for the analyzed banks*

Banks	2013			2014			2015			2016			2017		
	Pref. flow	**Rank**	**O/I score**	**Pref. flow**	**Rank**	**O/I score**	**Pref. flow**	**Rank**	**O/I score**	**Pref. flow**	**Rank**	**O/I score**	**Pref. flow**	**Rank**	**O/I score**
AIK	-0.005	7	84.54	0.041	4	93.95	0.0245	5	92.77	0.072	1	100	0.014	1	100
Credit Agricole	-0.075	13	73.52	-0.094	14	71.61	-0.059	12	78.48	-0.072	12	74.96	-0.017	15	94.13
Erste	-0.213	15	81.82	-0.087	12	72.62	-0.022	10	84.45	-0.033	10	80.94	-0.01	13	95.46
Eurobank	-0.012	8	83.39	-0.015	8	84	0.062	1	100	0.072	2	99.84	0.009	2	99.09
Addiko	-0.044	11	78.14	-0.04	10	79.84	-0.060	13	78.27	-0.060	11	76.64	0.003	6	97.82
Intesa	0.0556	2	95.43	0.028	5	91.53	0.029	4	93.62	0.014	6	88.91	0.005	5	98.33
Komercijalna	0.013	5	83.2	-0.020	9	83.05	-0.078	14	75.59	-0.126	14	67.09	-0.005	11	96.44
OTP	-0.043	10	78.28	-0.008	7	85.14	-0.01	8	86.55	-0.011	8	84.63	0.006	4	98.49
Poštanska	-0.079	14	72.23	-0.108	15	69.71	-0.096	15	72.83	-0.204	15	57.24	-0.013	14	94.9
Procredit	0.035	3	91.61	0.052	2	95.9	0.021	6	92.04	0.071	3	99.7	-0.004	10	96.53
Raiffeisen	0.079	1	100	0.072	1	100	0.031	3	94.01	0.066	4	98.8	0.007	3	98.6
Sberbank	0.020	4	88.82	0.020	6	90.06	-0.022	9	84.52	-0.029	9	81.61	-0.002	7	97.27
Societe	-0.062	12	75.44	-0.080	11	73.66	0.052	2	98	0.004	7	87.12	-0.003	9	96.77
Unicredit	0.008	6	86.75	0.042	3	94	0.018	7	91.6	0.053	5	96.23	-0.003	8	97.25
Vojvođanska	-0.017	9	82.48	-0.091	13	72.08	-0.054	11	79.22	-0.079	13	73.82	-0.009	12	95.56

Source: *Authors' calculation*

Figure 1: *GAIA analysis for ranking the banking sector of Serbia in 2013*



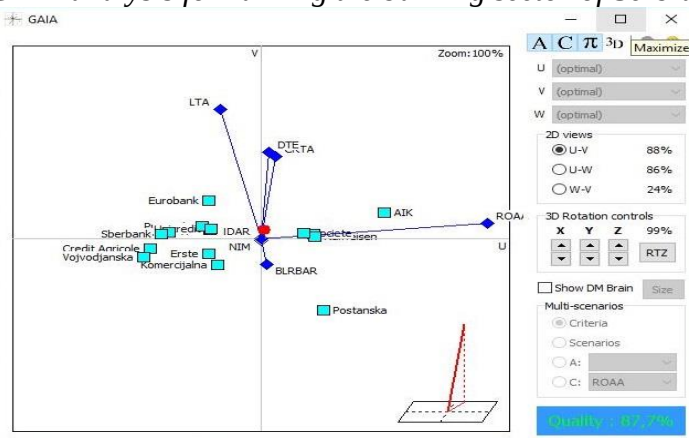
Source: *Authors' calculation*

The first group of alternatives is the one that is most distinguished in the coordinate system, and is in the fourth quadrant. These include Raiffeisen, Intesa, Sberbank, which stand out in particular when it comes to the criteria of ROAA and LTD, which points to their efficiency in business. Also, around the GAIA "red decision stick", which tilts the orientation of the model, correspond DAR, DER and CRTA criteria, even though they are shifted more towards the coordinate start. The "Red Decision Stick" indicates that alternatives from the first quadrant are optimal solutions and that making a decision on the best alternative should be oriented in line with criteria such as ROAA and LTD.The second group of alternatives is located in the second quadrant and contains the largest number of banks for the observed year, which are classified according to the criteria of BLRBAR and LLRGL and do not show significant flexibility in business when it comes to other criteria. In this quadrant are AIK, Eurobank, OTP, Unicredit and Addiko (former Hypo Alpe-Adria bank). It is noticeable that AIK bank is the most distant from the coordinate start and orientation of the model itself. It can be concluded that thisbank from the observed group is far from the optimal way of doing business for the observed year under the given criteria.Vojvođanska, Poštanska, Erste, Societe and Credit Agricole are located in the third quadrant. They have had tendency to the orientation of the model which indicate that they try to improve their business. Also these group of banks correspond more with LAR and NIM

criteria. In the fourth quadrant is lonely Procredit bank and it also strives towards the red decision stick orientation coressponding with ROAA criteria.

On the other hand, when the year 2017 is analysed, it could be concluded that the optimal business wave has spread across the entire banking sector of the Republic of Serbia. All bank groups, in all four quadrants, as well as most indicators (CRTA, ROAA, LLRGL, BLRBAR ...) gravitate towards a coordinate start and orientation of the model that is expressed in a "red decision stick". The orientation of the model in this year gives the least priority to a group of banks in the first quadrant, which again means that the trend of harmonized business policies and positive values of indicators contributed to the increased awareness of the importance of optimal and above all efficient business. And this time it is the exception of Poštanska štedionica, which was the only one which failed to keep the pace with the other banks. The validity of the model is 87.7% and again above the average.

Figure 2: *GAIA analysis for ranking the banking sector of Serbia in 2017*



Source: *Authors' calculation*

Panel data regression model specification and analysis of the results

Panel data regression analysis was performed with the intention to define main financial performance determinants. The data set consists of five time periods (2013-2017) and 15 banks which operated continuously in the observed time period. Generally,variables that influence banks' performance can be divided into two groups: internal (bank-specific) and external (industry specific and macroeconomic) variables. By reviewing

the relevant literature, the main internal and external factors were identified. Bank-specific variables to be considered in this research are: branches, business mix, management efficiency, age and bank size. Regarding external variables, industry specific variable is represented by market concentration expressed by Herfindahl-Hirschman Index (HHI). Macroeconomic variables included in the analysis are inflation and economic growth. Bank specific variables are gathered from income statements and balance sheets. Data on market concentration are gathered from Quarter Reports issued by National Bank of Serbia. Macroeconomic variable related to GDP growth rate are taken from World Bank data base, while data on inflation rate are collected from Inflation Report issued by National Bank of Serbia. Dependent variable in this model is Financial Performance Indicator (FPI), obtained by PROMETHEE method expressed through O/I score,aggregated score which corresponds to the O/I ratio (Table 3).

The model that is going to be assessed is structured as follows:

$$FPI_{it} = \beta_0 + \beta_1 BRANCHES_{it} + \beta_2 MANEFF_{it} + \beta_3 BUSSMIX_{it} + \beta_4 AGE_{it} + \beta_5 SIZE_{it} + \beta_6 HHI_{it} + \beta_7 INF_{it} + \beta_8 GDP_{it} + u_{it} \quad (9)$$

In order to select appropriate regression model for the stated data set several econometric tests have been conducted.The fixed effects have been tested by the F test and the results indicate that fixed effects model is more appropriate than the pooled OLS (F (14, 52) = 2.15, Prob> F = 0.0233). The results of the Breusch-Pagan Lagrange multiplier test indicate that right specification is pooled OLS(chibar2 (01) = 2.38, Prob> chibar2 = 0.0616). Additionally, Hausman specification test indicates selection of the fixed effects model(Sargan-Hansen statistic 25.491, P-value = 0.0006). Therefore, the selected specification for observed panel data set is fixed effects model. Further analysis was focused on the testing of the presence of heteroscedasticity, autocorrelation, cross sectional dependence and multicollinearity. The results of the Modified Wald test for group wise heteroscedasticity in fixed effect regression model indicate presence of heteroscedasticity (chi2 (15) = 94.14, Prob>chi2 = 0.0000).

Wooldridge test for autocorrelation in panel data indicates that there is no first order autocorrelation (F (1, 14) = 0.457Prob> F = 0.5101). Pesaran's test of cross sectional independence shows that there is no cross sectionaldependence in the model (-1.582, Pr = 0.1137). Also, values of Variance Inflation Factors (VIFs) indicate that there is no

multicollinearity (highest VIF value is 3.60 and mean VIF is 2.22). The results of the estimated model are given in the Figure 3. Model is statistically significant (F(8,14) = 16.84, Prob> F = 0.0000) with the R^2 of 49.57%.

Table 4: *Estimated fixed effects panel data regression model* (*obtained robust standard errors*)

FPI	Coefficient	Robust Std. Err.	t	P>t	[95% Conf.	Interval]
Branches	.0004782	.0000746	6.41	0.003	.000271	.0006853
ManEff	-.0542213	.0600895	-0.80	0.418	-.2210566	.112614
BussMix	-1.389402	.6204159	-2.24	0.089	-3.111953	.3331487
Age	-.0446552	.0039769	-11.23	0.000	-.0556968	-.0336136
Size	-.0435923	.0445935	-0.98	0.384	-.1674036	.0802191
HHI	.0037409	.0001056	35.42	0.000	.0034477	.0040342
Inf	.0177376	.0007241	24.50	0.000	.0157271	.0197481
GDPgr	-.0035642	.0007712	-4.62	0.010	-.0057054	-.0014229
_cons	-.6822722	.7424541	-0.92	0.410	-2.743655	1.379111

Source: *Stata output of estimated model*

According to the results of the panel data regression model, variablesAGE, Branches, HHI, Infand GDPgrhave statistically significant influence on the FPI at a significance level of 5%. Impact of variables ManEff, BussMix and banks size are not statistically significant.Based on the obtained results several conclusions can be made. First, number of branches positively affects the banks financial performance due to the fact that banks with the wider branch network can provide better banks' services which is in accordance with the results obtained by Al-Tamimiand Hussein (2010).Therefore, banks should tend to spread their branch network in order to obtain better financial performance. Second, considering the age of the bank, the results indicate that younger banks in the Republic of Serbia have better financial performance than the older banks. This findings are consistent with the results obtained byDietrich and Wanzenried (2011) and could be explained by the fact that older bankshave problems with organizational rigidities. Also, younger banks are more flexible, they have better IT infrastructure and they adapt better to changing market conditions. Hence, the banks' management should focus on adaptation to the new business environments and creating flexible organizational structure. Third, market concentration has been recognized as one of the factors of banks' financial performance in the Republic of Serbia.The obtained results indicate that there is a positive association between market concentration and financial performance. These results are consistent with the results obtained by Kosmidou et al. (2005), Chirwa(2003), Delis and Papanikolaou (2009).Therefore, in order

to improve financial performance of banks, it is important to continue the process of consolidation of the Serbian banking industry. This will result is stronger competition which should lead to better quality of banks, lower interest rates, expansion of the credit offer and introduction of new forms of banks services.Fourth, inflation represent a factor that has positive influence on banks financial performance which is consistent with the findings of Kosmidou et al. (2005).This is in accordance with the economic theory which states that inflation, if it is anticipated, should positively affect to the bank performance due to the fact that higher inflation rates lead to the higher interest rates on loans and consequently to the better financial performance of banks.

Fifth, our study revealed a negative influence of GDP growth rate which is opposite to the finding of Kosmidou et al. (2005) and Petria et al. (2015). This indicates that financial performance of banks in the Republic of Serbia is not closely tied to the wealth of the domestic economy.

Conclusion

The banking sector in the Republic of Serbia has experienced substantial changes in recent decades. Contemporary trend of liberalization enabled the entry of foreign capital which led to an increase in competition and the issue of financial performance of banks got noteworthy attention. Adequate measurement of banks' financial performance and identification of its main determinants may provide aid tobank managers and also country policy makersin term of providing useful guidelines during decision-making.

The subject of this paper was a comprehensive analysis of the financial performance of banks in the Republic of Serbia. In the first part of the analysis asingle financial performance indicator was constructed using integrated CRITIC-PROMETHEE method. The results have revealed that in the 2017 AIK bank was the most successful regarding its financial performance. However, observed through years there have been a lot of fluctuations in achieved value of financial performance indicator, so it cannot be concluded that there is a bank with superior financial performance in the analysed sample.

In the second part of the analysis the effects of the selected internal and external factors on the financial performance indicator have been evaluated through the suitable empirical model. Our findings indicate that

number of years operating on the market, size of the branch network, market concentration, inflation and GDP growth rate are determinants that have statistically significant impact on the financial performance, wherein GDP growth rate and number of years operating on the market have statistically significant negative impact on the profitability. In order to obtain better financial performance managers of banks should consider the influence of stated determinants. Therefore, banks should focus their strategy on their branch networks spreading which will lead to better provision of services to banks' clients and improve banks' financial performance. However, these spreading should be done until the point where future expansion of branch network would cause increase of fixed cost,which would exceeds the benefits acquired due to enlargement of branch network.Also, managers should be focused on solving the problem of organizational rigidities which will lower the costs, generate an opportunity for creation of financial innovations and subsequently improve financial performance.Furthermore, since there is evidenceof significant positive influence of market concentration on banks' financial performance managers of analysed banksmay wellfocus on the process of mergers and acquisitions of the banks which are not included in the sample. This would result in an increase of market share, a reduction in costs, an increase in solvency and the expansion of the scope of banking products.In addition, inflation can influence positive on financial performance only if it is anticipated,therefore the process of targeting inflation and publication of forecasts regarding the movement of the inflation rate is very important for banks' financial performance.

Conducted research faces thelimitation reflected in the nature of the data from financial statements since their truthfulness depends on the respect of basic principles of financial reporting.

The paper contributes to the empirical literature in the field of bank's financial performance evaluation by presenting empirical data concerning performance assessment of banks in the Republic of Serbia. The study could be extended in a variety of directions, the most important one being to complement the analysis by extending the sample with the data from years before 2013 and examining other relevant determinates that can affect the financial performance of banks which are not covered by this research.

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ANALYSIS AND EVALUATION OF THE BASIC INDICATORS OF THE QUALITY OF SERVICES IN THE RURAL AREAS OF SERBIA

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Abstract

Serbia is a country known for its vast rural areas. These are areas with a natural and anthropogenic environment, with special economic and social-cultural features. However, these areas are not sufficiently affirmed in terms of tourist offer on the market. In this paper, the authors were based on the analysis and assessment of the quality of services provided in 15 rural parts of Serbia, survey research, on several occasions during 2017. Data processing was performed by the SPSS program version 19.0, and a descriptive statistical analysis of the grouped variables was presented in two factor groups. The authors have shown that the number of independent variables depends on the purpose of the research, so only those that have shown the applicability and purity in this paper, are used. Also, the goal was to point out the basic advantages of quality services in the development of rural areas, but also the main shortcomings in order to make key changes, due to the massive development of rural areas, and hence tourism as an economic activity in these areas.

Key words:*rural areas, quality, development, Serbia.*
JEL:R11, Z32

Introduction

Rural areas are defined as special areas of exceptional values, ecological areas, bearers of traditional culture and diversity of ethno-cultural heritage

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(Gajić et al., 2018). Rural areas in Serbia differ in economic, socio-cultural and demographic terms. The differences are conditioned by their geomorphologic characteristics, the number of inhabitants, the economic structure, infrastructural equipment, as well as the development potentials. Rural tourism is a very broad concept which includes, not only a holiday in the countryside, but also all other tourist activities in rural areas (Cvijanović & Ignjatijević, 2017). Based on the research literature, it can be noted that this form of tourism is affirmative and popular in many countries in the world (Fotiadis, 2011).For many political and economic reasons, rural areas of Serbia are becoming less inhabited, and in the seventies and eighties of the last century rural tourism developed sporadically and unplanned (Cvijanović & Gajić, 2017). The 2011 Population Census shows that the demographic trends in Serbia, especially in its rural areas, are becoming increasingly unfavorable. Rural products, especially accommodation, are often included in a rating system aimed at offering tourists an objective assessment of quality standards (Yasuo et al., 2007; Gajić et al., 2017). However, there have been difficulties in designing and implementing unique quality standards in a sector such as rural tourism (Kosić, 2009).

The significance of quality has become the sphere of interest of the entire civilized world, and has spread to all its pores, and broadly speaking, it reflects on the overall quality of life of a modern man. Given that rural tourism in Serbia is still in development, we identified certain services as potentials for development in our work and identified shortcomings that prevent faster development (Cvijanović et al., 2017). The most prominent researchers contributed to the setting of the concept of quality of service, the establishment of a model for measuring services, and the development of methods and tools needed to improve the quality of services in various activities. It is believed that the people who provide this type of service are active participants of the development itself (Davis et al., 1988). It is therefore very important to understand the true socio-economic situation of the site and involve local communities in decision-making to enable the sustainable development of this type of tourism. The authors of the work were researching in 15 rural areas in Serbia, pointing out the quality of services provided in rural households. A survey questionnaire method was used, to a total of 323 interviewed respondents. Only a part of the research will be presented in the paper, which refers to the quality of the services provided. The services provided are grouped as variables into two factor groups, and data processing is done in the SPSS version 19.0.

The author's opinion prevails that have been grouped into two factors, but there are also those who have identified and named up to nine factors (Kunasekaran et al., 2011; Kim et al., 2013). The paper focuses on the presentation and understanding of the existing conditions in rural tourism of Serbia. For this research, it is important to determine the position of a tourist product - the rural tourism of Serbia in the awareness of tourists, what are the attitudes of tourists, which is an indicator of the success of the tourist economy and the marketing actions that have been implemented, as well as what its identity is and the specificity of the destination on the basis of which it differs from the competitor's destinations.

Literature review

Rural areas are occupied by about 90% of Serbia and live in around 43% of the total population (Todorović et al., 2007). Statistics in rural tourism are based on estimates, both for capacity and for traffic. Given that around 90% of Serbia is rural, for rural tourism it can be assumed that a significant part of the nights realized in mountain and spa resorts, as well as in other tourist and other places, can be treated as overnights in this segment of the offer (Petrović, 2013).The development of rural areas in Serbia faces numerous limiting factors, among which can be distinguished: scarce knowledge of new approaches to the development of rural economy; the lack of an institutional framework (in particular legislation), which would ensure the coordinating role of the state and greater involvement of local authorities in integrated rural development; underdeveloped infrastructure; inadequate diversification of activities; dominance of sectoral policy, etc. (Lankford, 1994; Baum, 2011; George, 2009; Gajić et al., 2018). The rural areas of Serbia, certainly represent a significant tourism potential for the development of tourism, but also for all the economic sectors of the state.

Rural tourism includes country holidays, but also special forms of tourism in nature, eco-tourism, hiking, riding, adventure tourism, sports and health tourism, hunting and fishing, crafts and heritage, and in some areas ethnic tourism. The importance and contribution of rural tourism to the local economy is well documented (Fleisher et al., 1997; Page et al., 1997; Bramwelet al., 1994) and describe rural tourism as a multiple activity, and not just as rural tourism.Rural tourism is seen as a means, by which the problem of weakening agricultural potentials of agrarian areas is solved in order to provide additional income, which triggers the inevitable issue of expectations of certain services versus the delivered services (Davies et

al., 1992). As Flecher & Pizam (1997) note, rural tourism is growing. Taking into account the views of numerous authors (Pearce et al., 1989; Bramwell, 1994), rural tourism destinations can, create a distinct tourism product that is primarily based on a small-scale economy, friendly to the environment, "colored" by ethnic elements, in a word, "sustainable".Rural tourism represents tourism in rural households, but also certain breaks and resorts in the nature of rural areas, as well as manifestations, festivals, recreation, production and sale of handicrafts, craft products and agricultural products (Košić, 2009).

The quality of services is the main indicator of the achieved level of tourism development. For the past three decades, the quality of services has been dealt with by scientists, businessmen and other researchers, due to the fact that it has a great impact on customer satisfaction and loyalty, pricing, business success and profitability. There is no single and generally accepted definition of the concept of quality in the literature. However, theorists Reeves & Bednar (1994) emphasize that "there is no general definition of quality, and that different definitions are used in different contexts in which quality is observed. The quality of a product is a measure of its usefulness, that is, its suitability to satisfy consumer demands.In whatever way the quality is defined, one thing is certain, for the consumer only the quality that is in accordance with his expectations is acceptable. Quality is the fulfillment of customers' demands, where the buyer is the one who decides whether his requirements are met (Keogh, 1990). What is nevertheless characterized by most of the definitions, is that quality is considered a multidimensional concept, which implies that a portion of one product or service can have high quality, and the other part low quality (Mason et al., 2000; Vesey et al., 2001).Theorists, Reeves & Bednar (1994), emphasize that there is no general definition of quality, and that different definitions are used in different contexts in which quality is observed. The word quality itself comes from the latin word qualitas which means quality, value, character and composition.

General data on the state of rurality and rural tourism development in Serbia

There are 6,158 settlements on the territory of the Republic of Serbia, of which 193 are urban (3.1%) and 5,965 are settlements, which are considered as rural in automation. Since 1981 Statistical Office of the Republic of Serbia has applied the administrative criteria for determining the type of settlement, according to which the settlements are divided into

"urban" and "other". The division was made on the basis of the administrative decision of the local self-government unit to declare a certain settlement urban. All other settlements, not declared as urban, are classified as "other".In favor of negative demographic trends in rural areas, the data show that in about 1,000 settlements, the number of inhabitants is less than 100, which practically indicates that every fifth settlement is ahead of the extinguishing. The largest concentration of such settlements is in the south and east of the country, where every third settlement has fewer than 100 inhabitants (RS Agriculture and Rural Development Strategy 2014, 2013).One of the key characteristics of demographic development in Serbia is the increasingly unfavorable age structure. Changes in the age structure in the period 2002-2011. years, indicate a continuation of the process of declining youth participation, while at the same time increasing the share of the elderly. Parameters of the age structure of the rural population are even more unfavorable (RS Agriculture and Rural Development Strategy 2014, 2013).Today, it is estimated that more than 32,000 beds (registered and unregistered) in rural areas have a significant role in the rural tourism sector, and about 300 rural households with 8,000 beds provide catering services and realize more than 150,000 overnight stays per year (Petrović, 2014; Rural Development of RS 2014, 2013).

In the period 2002-2011.there was a decline in the total number of inhabitants by 4.15%, which is primarily a result of negative natural increase and departure abroad. In this period, the rural population decreased by 311,139 inhabitants (10.9%), declined to below 3 million, and now accounts for 40.6% of the total population of Serbia (RS Agriculture and Rural Development Strategy 2014, 2013).According to the data of the Tourist Organization of Serbia (TOS) in 2006, tourist traffic was organized in 18 municipalities (44 villages, 140 households with around 750 beds) and in 2009 in Serbia there was organized tourism in 41 municipalities (119 villages, in which it was registered 164 households, with 570 rooms and 1,628 beds).Today, in rural tourism in Serbia, there are 408,580 overnight stays, or about 6.2% of the total number of overnight stays in Serbia. Domestic visitors are 100% of all visitors of rural tourism in Serbia (Strategy of Development of tourism in Serbia 2015, 2006). On average, the price of accommodation in the mentioned facilities for accommodation of a rural tourist is 15 euros, which means that the average earnings of rural tourism based on accommodation and catering capacities, about 6,200,000 euros (Strategy of Development of tourism in Serbia 2015, 2006).

Methodology of research and hypothesis development

The survey was carried out several times during 2017, in 15 rural areas belonging to the municipalities of Serbia (Subotica, Sombor, Novi Sad, Irig, Kovin, Valjevo, Kosjerić, Gornji Milanovac, Kisić, Čajetina, Majdanpek, Negotin, Knjazevac, Pirot and Dimitrovgrad) - in three clusters according to the Tourism Development Strategy of the Republic of Serbia (Vojvodina, Western Serbia, Eastern Serbia), where the development of rural tourism is at an optimal level.The aim of the paper is to determine the real state of the quality of the services provided to rural tourism in its entirety, and based on the established situation, suggestions for a more successful development of rural tourism in Serbia, and achieving its competitiveness in the tourism market. Although the research examined a large number of socio-demographic and other independent characteristics (variables) related to the attitudes of tourists about the quality of services they received while staying. The work does not yet include all independent variables from the multidimensional point of view of the scale of attitudes, but only those necessary for this work.The data collected by the survey of inhabitants from the analyzed rural settlements, were entered into the database and all further analyzes were carried out using the SPSS (Statistical Package for Social Science, version 19.0). A large number of researchers analyzed a sample that ranged from 200 to 300 subjects (Schneider et al., 1997; Vesey et al. 2001), while in some studies the sample was less than 200 subjects (Burns, 1996; Schneider et al., 1997; Mason et al., 2000; Wang et al., 2006; Wang et al. 2008, Petrović, 2013). Taking into account the above research, it can be concluded that a sample of 323 subjects used in this study is representative.

Authors have grouped all variables or test items into two groups or twofactors. Within the F1 factor, there are a total of 13 variables, which is the case with F2, with the same number of grouped variables. Tables 2 and 3 give an insight into the grouped variables by the factors F1 and F2. Factor group F1 - Host attitude towards tourists, belong to variables from v1-v13, while factor group F2 - Quality of services, belong to variables from v14-v26. Descriptive statistical analysis, as well as the values of the Cronbach alpha coefficient, was made. The basic measure, which based on the obtained data, describes the observed sample, is a descriptive statistical analysis.The analysis was used to calculate the average grades on the questions and by the determinants of the scale used. In order to determine the internal consistency of each statement that is grouped.

Based on the value of this coefficient, the reliability of the variable is determined, taking into account that they are measured through a number of statements.

Table 1. *Grouping variables into factors F1 and F2*

	F1 -Relation of the host to tourists
F1-v1	The hosts fulfill all requirements for tourists
F1-v2	The hosts meet the wishes and needs of tourists
F1-v3	The locals provide the necessary help
F1-v4	The locals try to solve the problems in time
F1-v5	The hosts provide advice to tourists
F1-v6	The hosts care for a pleasant stay
F1-v7	The host treats each guest as an individual
F1-v8	The locals know a foreign language
F1-v9	The hosts do the job without mistake
F1v-10	The host is always present in the household
F1-v11	The hosts are always available to guests
F1v-12	The hosts provide guide services
F1v-13	The locals know the food
	F2 -Quality of services
F2-v14	Quality food provided
F2-v15	Hygiene is at a satisfactory level
F2-v16	They offer home-made food and products
F2-v17	Availability of souvenirs
F2-v18	Preserved furniture
F2-v19	Authentic interior
F2-v20	Rural exterior
F2-v21	Proven safety for tourists
F2-v22	All rooms are marked
F2-v23	Authentic marketing
F2-v24	Price as a reflection of quality
F2-v25	Folk clothes as a kind of marketing
F2-v26	Inclusion of tourists in the activity

Source:*data obtained by the author's research*

The authors set up the following hypothesis H: The satisfaction of tourists with the content and quality of the tourist offer of rural households in Serbia is an indicator of the current development and conditions of rural tourism.

Results of exploration and discussion

In the sample of the total number of respondents, 59.4% of men and 40.6% of women. From 18-30 years of age, there are 23.5% of respondents, from 31-60 years in total 41.8% of respondents. Over 60

years of age, there was a total of 34.7% of respondents. The highest percentage of respondents with completed secondary school was 43.7%, while with higher education 34.4%, with master and PhD 17.3% of examiners, while at least with elementary school 4.6%. Of the total number of respondents below 200 euros of monthly salaries have a total of 8.4%, from 200 to 500 euros a total of 39.6% of respondents, from 500 to 1000 euros 46.1% of respondents, and the least polled are with over 1000 euros in monthly earnings of only 5.9% of respondents.

The data obtained using the statistical data analysis descriptor, as well as the determination of the reliability of the questionnaires and dimensions - the Cronbach alpha coefficient, are given in the tables. Many theorists have argued that any items whose crown coefficient is lower than 0.5 is deleted, but many theorists also argue that this value can be tolerated, not to go below 0.30 and to be taken into account.Such items may also have the significance of research. It has been shown that the results of the factor analysis for both investigated factors are very similar, that is, the minimum coefficient is 0.30 for the factor values shown in the final scale, as some authors have recommended (Pallant, 2011). The reliability of the measuring instrument was tested using the Cronbach Alpha (α) coefficient (Cronbach's Alpha Reliability Coefficient).

This measurement instrument is among the most commonly used indices of the internal agreement of the scale, i.e. the degree of similarity of the items from which the scale consists (Pallant, 2011). Ideally, the Cronbach alpha coefficient should be greater than 0.7 (De Vellis, 2003). According to Pallant (2011), short scales (less than 10 items) often have rather small Cronbach coefficients (below 0.5), so in that case it is more convenient to calculate mean inter-item correlation). In this case, values from 0.20 to 0.40 are recommended as the optimum range of correlation between items (Briggs et al., 1986). Although reliability coefficients of less than 0.70 are generally considered inadmissible, coefficients above 0.60 are sometimes accepted. According to Leman (2005), the ideal value of the coefficient of internal consistency is that which is in the interval from 0.80 to 0.90 (Petrović, 2013).

Table 2: *Item-Total Statistics for Factor F1 (v1-v13)*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
V1	21,58	14,487	,099	,419	,446
V2	21,47	14,492	,086	,422	,450
V3	21,33	16,323	-,185	,460	,530
V4	21,48	15,325	-,045	,558	,488
V5	21,49	13,331	,277	,355	,394
V6	21,20	13,899	,171	,216	,425
V7	21,03	14,014	,197	,405	,419
V8	21,61	12,679	,397	,751	,357
V9	21,24	14,651	,069	,610	,454
V10	21,68	13,459	,283	,781	,394
V11	21,48	13,610	,217	,551	,412
V12	21,33	13,419	,316	,386	,387
V13	21,71	13,286	,325	,648	,383

Source: *data obtained by the author's research*

Table 3: *Scale Statistics F1 (v1-v13)*

Mean	Variance	Std. Deviation	N of Items
23,22	15,793	3,974	13

Source: *data obtained by the author's research*

The obtained model is presented with 26 questions grouped in two factors, with the first factor explaining 15,793% variations, which is named as follows: F1 - Host attitude towards tourists. The second factor explains 23.519% of the variance, defined as F2 - Quality of Service. These data indicate that the set model is subdivided and that the obtained results are scientifically corroborated.

Table 4: *Item-Total Statistics for Factor F2 (v14-v26)*

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
V14	20,55	22,956	,004	,429	,740
V15	20,39	22,003	,093	,205	,736
V16	20,36	18,597	,570	,523	,669
V17	20,04	19,194	,514	,615	,679
V18	20,54	21,646	,163	,556	,725
V19	20,73	20,701	,443	,744	,693
V20	20,77	21,705	,225	,332	,715
V21	20,64	22,673	,049	,343	,735
V22	20,02	19,208	,454	,734	,686
V23	19,81	18,723	,591	,602	,668

V24	20,31	19,054	,599	,603	,670
V25	20,24	20,760	,349	,633	,701
V26	20,26	19,399	,434	,529	,689

Source: *data obtained by the author's research*

Table 5: *Scale Statistics F2 (v14-v26)*

Mean	Variance	Std. Deviation	N of Items
22,06	23,519	4,850	13

Source: *data obtained by the author's research*

The values of the Cronbach alpha coefficient range from 0.383 to 0.740. In this study, only five dimensions have a value lower than 0.50, all other dimensions show high values of the Cronbachalpha coefficient, which indicates a high degree of reliability and all the statements grouped around them are internally consistent.

As part of the descriptive analysis carried out above the sample of tourists, several relevant parameters were described, which describe the average estimates for each of the defined questionnaire items. Using this method, data can be displayed in the form of number of cases, within individual categories, percentage and absolute views (frequencies and percentages), measurements of the central tendency.

Table 6: *Descriptive Statistics of factor group F1 - Host attitude towards tourists(with variables of v1-v13)*

F1 (variable v1-v13)	N	Sum	Mean	Std. Deviation	Variance
V1	323	531	1,64	,827	,683
V2	323	566	1,75	,860	,740
V3	323	609	1,89	,924	,853
V4	323	562	1,74	,885	,783
V5	323	558	1,73	,856	,733
V6	323	653	2,02	,879	,773
V7	323	706	2,19	,786	,618
V8	323	519	1,61	,847	,718
V9	323	638	1,98	,837	,701
V10	323	496	1,54	,808	,653
V11	323	563	1,74	,881	,775
V12	323	612	1,89	,769	,591
V13	323	487	1,51	,793	,630
Valid N (listwise)	323				

Source: *data obtained by the author's research*

By descriptive analysis of the group of variables v1-v13, which belong to the factor group F1 - Host attitude towards tourists, it is noted that the values of arithmetic meanings are moving at the level of total knowledge within the defined factors. The lowest value of the arithmetic mean is 1.61, while its value is 2.19. The standard deviation ranges from 0,786 to 0,924, relatively large, and due to the approximate values, it is a symmetrical distribution of frequencies.

By descriptive analysis of the group of variables v14-v26, which belong to the factor group F2 - Quality of services, it is noted that the values of the arithmetic meanings are moving at the level of total knowledge within the defined factors. The lowest arithmetic mean value is 1.33, while the highest value is 2.24. Additionally, since these values are very approximate, it can be said that this is a symmetric distribution of frequencies, whose standard deviation is relatively large in the range from 0.591 to 0.853.

Table 7: *Descriptive Statistics of factor group F2 - Quality of service (with variables from v14-v26)*

F2 (variable v14-v26)	N	Sum	Mean	Std. Deviation	Variance
V14	323	486	1,50	,732	,536
V15	323	538	1,67	,870	,757
V16	323	548	1,70	,853	,728
V17	323	651	2,02	,813	,661
V18	323	488	1,51	,805	,648
V19	323	428	1,33	,608	,369
V20	323	415	1,28	,659	,434
V21	323	458	1,42	,715	,511
V22	323	659	2,04	,885	,784
V23	323	724	2,24	,810	,656
V24	323	563	1,74	,747	,558
V25	323	587	1,82	,710	,504
V26	323	579	1,79	,876	,767
Valid N (listwise)	323				

Source: *data obtained by the author's research*

Descriptive analysis has been indicated in the variables or items under the F1 group, to a large extent, to the positive extent. More precisely, the relationship of the host to the guests is at a satisfactory level, starting with the host fulfilling the requirements and the wishes of the tourists, then pointing help and reacting promptly to newly emerging problems. A major disadvantage in rural services is insufficient education of the host in terms of knowledge of foreign languages. The largest percentage of

tourists, over 41% of them, gave a negative answer. In most cases, the hosts do not know some of the foreign language, or they do it partially. Other variables or examined quality items carry a positive attitude from the tourists. Namely, hosts are always present in their households and available to tourists, but do not provide tourist guide services.Variables in group F2 - The quality of services is assessed mainly by the positive attitude of tourists. Visitors are satisfied with the quality of food, hygienic conditions, as well as authentic interior and rural exterior. However, the availability of souvenirs and craft workshops is not at an enviable level. The premises in the households are not adequately labeled, and marketing is not sufficiently represented. Tourists argue that the price is a reflection of quality, but in this case, some thought that the offered quality was above the price, it is true that the services are quite cheap. Tourists were also satisfied with their involvement in rural and domestic activities. The hypothesis, which was a key starting point in the research, reads: The satisfaction of tourists with the content and quality of the tourist offer of rural households in Serbia is an indicator of the current development and condition of rural tourism, was confirmed by summing up all the results of the research. The estimates of the quality of offered services by tourists, were certainly a measure of the current level of rural tourism development in Serbia.

Conclusion

Rural areas in Serbia are not at an enviable level when viewing tourist visits. There are major problems that rural areas face. Some of them are depopulation of villages in Serbia, poorly developed communal infrastructure and low level of productivity of rural economy. Also, the low level of education of the rural population, as well as the minimal efforts in preserving the historical and original rural environment, are major obstacles that hinder further development (Gajic et al, 2018). It was noted that current laws, standards and regulations do not contribute significantly to overcoming these problems. Low level of integration and partnerships between tourist organizations and local self-governments affects inefficiency in business and degradation of tourist attractiveness of rural areas of Serbia.The currently achieved level of competitiveness of Serbia in the sphere of rural is not particularly good, which is based on the evaluation of all key success factors. The quality of services was dealt with by scientists, businessmen and other researchers due to the fact that it has a great impact on customer satisfaction and loyalty, price formation, business success and profitability. In this period, continuous research is

carried out with the aim of defining the definition of quality of services, setting the concept of quality dimensions for measuring the quality of services, establishing procedures for achieving and maintaining the quality level. Research on the concept of quality of services points to very different concepts of service quality concepts, which primarily derives from their characteristics, the diversity of organizations that provide services, the diversity of services, and also because of the subjectivity in the perception of service quality, which makes scientists, researchers, managers and users different present their views.

In the focus of the research, the authors of the study put the satisfaction and expectations of tourists with the quality of accommodation units and services offered to them in the rural areas of Serbia. The results of the statistical satisfaction analysis represent the basis for the conclusions, in which case the hypothesis has been retracted or confirmed. The satisfaction of tourists with the content and quality of the tourist offer of rural households in Serbia is an indicator of the current development and conditions of rural tourism.All tourist services are defined as variables and grouped into two factor groups: F1 - Host attitude towards tourists, F2- Quality of service. Exploratory factor analysis was made and found that all variables are important, although some values go below 0.50. because many theorists claim that because of the smaller number of samples being tested and Cronbach's coefficient has a lower value.

Descriptive statistical analysis presents the results of certain variables, which actually indicate the attitude of tourists about the quality of services provided. The authors of the paper focused on only one part of the research, which usually has a much larger number of variables and methods used. And the research is broader. The analyzed data showed that a large percentage of tourists are satisfied with the variables related to the attitude of the host to tourists. The hosts are always available, ready to help, meet the requirements and needs of the consumer. However, items such as foreign language skills, and the role of the host as a tourist guide are not positively assessed. Also, the souvenir availability items, developed marketing are not rated the best. Hypothesis - The satisfaction of tourists with the content and quality of the tourist offer of rural households in Serbia is an indicator of the current development and the state of rural tourism, is confirmed.All analyzed data indicate that rural tourism is not at an adequate level of development, but that there are tendencies and prerequisites. Serbian rural tourism has a good

perspective, if further consideration is given and changes in all the changes and the problems that prevail in the market.

The key problem is the low level of information and expertise of the owners of rural households, and that the efforts of organizations, local self-governments and state authorities are insufficient to improve and create a basis for the sustainable development of rural tourism in Serbia (Petrovic, 2013). On the other hand, there are no fewer constraints and weaknesses: inadequate production and ownership structure; the inefficiency of human potential and mechanization in agriculture; underdeveloped infrastructure in rural settlements; lack of entrepreneurial spirit, cooperation and motivation in the economy of local communities, problems and obstacles for the development and categorization of small-sized capacities (Vujko et al., 2014). Establishing quality is a key requirement for meeting the needs of visitors who in turn should provide business advantage on the market. The development of rural areas in Serbia faces numerous limiting factors, among which can be distinguished: scarce knowledge of new approaches to the development of rural economy; the lack of an institutional framework (in particular legislation), which would ensure the coordinating role of the state and greater involvement of local authorities in integrated rural development; underdeveloped infrastructure; inadequate diversification of activities; dominance of sectoral policy, etc.

Rural tourism allows the economic development of less developed regions. In order to facilitate identification and information among tourists in relation to the offered level of quality, it is necessary to homogenize the applied standards in different centers. Therefore, entrepreneurial associations and state bodies should actively participate in the establishment of common norms, and to promote and coordinate all actions related to the creation of an accreditation draft. The development of entrepreneurial associations and networking sites that defend homogenous quality management models can be an element that contributes to the creation of trust of tourists. Above all, the standards highlighting the difference in quality should take into account tourist expectations. The results of this research provide more information about tourists and the aspects that it evaluates for the service they receive.

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THE ECONOMIC DIMENSION OF SUSTAINABLE AGRICULTURAL DEVELOPMENTOF SERBIA

Milan Marković[1]

Abstract

In the Republic of Serbia, agriculture is one of the most important economic activities (on the basis of macroeconomic indicators that show the importance of agriculture in exports, creating employment and gross value added), so it is of utmost importance to preserve the economic, environmental and social principles in order to achieve sustainable development of this production. The aim of the concept of sustainable agriculture is the production of high quality, healthy and safe food with the simultaneous achievement of adequate level of profits, environmental protection, and preservation of social stability. The paper shows the main determinants, potentials and strategic directions of the economic component of sustainable agricultural development in the Republic of Serbia and recommendations for further development.Secondary data of theoretical and empirical research, as well as the Republican Bureau of Statistics and World Bank databases, were used in this paper.

Key words:*sustainable development, agriculture, productivity, structural changes, economic problems, Republic of Serbia.*
JEL classification:Q01, Q15,O13.

Introduction

The main premise of the paradigm of sustainable development is that ecological and economic development are not collision activities that mutually exclude and limit, but that there is a positive mutual relationship between them (Lješević & Markićević, 2009, p. 129). Those authors conclude that respecting environmental laws leads to the optimization of resource use (increase in productivity), reduction of scrap, prolonging the exploitation period of resources, reduction of negative consequences for the environment, etc.

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Consequently, the development of modern agriculture is increasingly focused towards restoring destroyed, as well as preserving and further rational use of existing natural resources for the economical production of sufficient quality food (Vasić et al., 2013, p. 106). Sustainable agricultural development (as the most important activity of the rural economy) should allow the valorization of agricultural and rural resources. In practice, there is a significant relationship between rural and economic development.

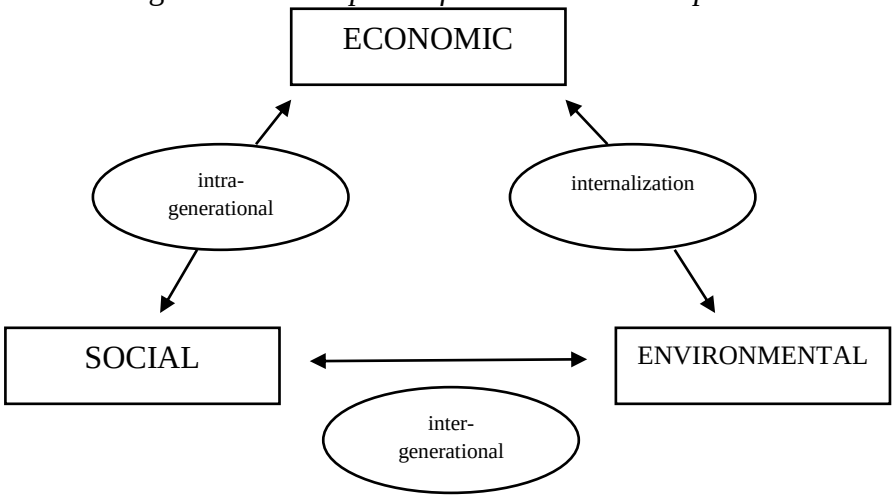
By elaborating research problems, the following goals are highlighted:

- Emphasizing the importance of sustainable agricultural development,
- Consideration of the connection of the basic aspects of the sustainable agricultural development,
- Analysis of the key determinants of the sustainable agricultural development in the Republic of Serbia from an economic point of view.

The concept of sustainable agricultural development

Sustainable development is a multidisciplinary topic. We talk about the overall sustainable development, sustainable development of agriculture, the economy, education, etc. From the definition of the concept of sustainable development can be derived definition of sustainable agriculture as an activity of food production in which the harmonized environmental (through ecological valence and "capacity" of space), economic (the high productivity) and social (satisfaction of the population) aspects of sustainability (Lješević & Markićević, 2009, p. 129). In short, sustainable development represents the preservation of welfare over time (inter-generational equity). Figure 1 shows the main aspects of sustainable development.

Figure 1: *Main aspects of sustainable development*



Source: *Munasinghe, 1993.*

Sustainable development is a concept that (in the narrow sense) emphasizes the need to harmonize economic and ecological development. Constant increase in production and profits should not be the only goals of the society.In contemporary business conditions, economic development and a healthy environment are heavily dependent on each other. Economic development in the long run must support rational spending of limited natural resources without disturbing the natural environment. Excessive use of resources undermines the environment, which prevents the survival of life on the planet. Therefore, it is necessary to balance economic development and the need to preserve the natural environment.Through internalization, it is intended that through taxes or pollution reduction premiums producers are making an effort to take care of environmental objectives.

Environmental requirements are primarily imposed emergence and popularization of the concept of sustainable development of agriculture. This concept emphasizes that in agriculture, as a significant economic activity, the sustainable management of production resources is essentially the same as in other production activities. It is particularly important in less developed countries that irrationally and ineffectively manage of their own natural resources. Large consequence of inadequate use of resources is the pollution of the environment (land, water) due to inadequate management of the means of production.

The goals ofsustainable agriculture are:

- Ensuring food security of the population,
- Maintenance of the existing and improvement of the quality of the environment and natural resources,
- Ensuring the economic viability of production,
- Improving the quality of life of farmers, consumers and society as a whole.

Achieving sustainable agricultural production guarantees the optimal use of agricultural and other resources, and the protection of agro-environment (Tomić et al., 2009). Although the main objective of agricultural production is providing enough food for the growing population, production must be organized in a way that does not violate the limited resources and natural diversity. The ecological aspect of sustainable agriculture refers to environmental sustainability. The ecologically responsible behavior of agricultural producers implies a reduction in the use of chemicals and pollution of the rural environment, the preservation of natural pastures, etc.Otherwise, environmental pollution and loss of biodiversity will represent a major potential threat. Determinants such as water, land, plants, animals, and humans should be connected to a system that is not harmful to the environment and the local population. It is the use of all natural resources in a sustainable manner.

In order to preserve natural resources for the purpose of sustainable development of agriculture it is necessary to:

- Ensuring the maintenance and increasing fertility of the land,
- Proper use of underground and surface waters and irrigation water,
- Adequate selection of varieties and plant speciesand
- Compliance with animal welfare standards.

Among the most significant negative factors that distort ecological objectives cited over-exploitation of resources and the extensive treatment of agricultural land. It is also necessary to point out that each crop has its own ecological requirements (Lješević & Markićević, 2009), which must be taken into account. Environmentally friendly extensiveness of agriculture means the preservation of landscapes, biodiversity and efficient management of organic agricultural production. Ecological factors for sustainable agricultural production include the protection of agro-environment, as well as the preservation of biodiversity (Pešić & Janković, 2006).The integration of biodiversity into food security and anti-hunger policies islikely to generate more socioeconomic benefits

(includingsupporting poverty alleviation efforts) than in any other sector (Toledo & Burlingame, 2006, p. 478).

Agriculture is an economic activity in which most of the production is carried out in an open area, so it is highly dependent on the living (natural) environment. It is dependent on conditions and resources of the environment. On the other hand, it is essential that economic activity does not disturb the environment. Excessive use of agrochemicals inevitably leads to contamination of soil, water, air…

Agriculture is a key economic activity that in less developed countries has an essential role in economic development. However, this sector is also a cause of degradation of agro-environment, reduction of soil fertility, as well as environmental pollution by using various pesticides. The greening of agricultural production is inevitable under conditions of globalization. Although there is a need to ensure food security and eliminate the lack of food in some countries, areas and regions, excessive mechanization of agriculture and chemical contamination creates a risk of disturbing the ecological balance and the production of unsafe food.

The social aspect of sustainable development is closely linked to the previous aspects. It includes the implementation of a high quality of life for farmers (settling basic needs), as well as the overall development of rural areas. It focuses on the employment of the rural population and the preservation of human health. It should be noted that the benefits of sustainable agricultural production realized by farmers (through increased income), consumers (healthy food), but also the entire economy. The effects can be further discussed at the global level (healthy environment). All this increases the quality of life of the entire society.

Increasing employment and retaining the population in these rural areas is one of the basic social aspects of the concept of sustainable rural development.This also solves the problems of regional development and demographic flows (migrations). Abandonment of rural areas is the result of poverty due to reduced employment opportunities and low living standards (Bogdanov & Vasiljevic, 2011).

The economic component of sustainable agricultural development in the Republic of Serbia

The Republic of Serbia has extraordinary potentials in the agricultural sector due to favorable weather conditions and good characteristics of agricultural land, but this potential is still not sufficiently exploited (Vehapi & Šabotić, 2015). When it comes to natural resources, Serbia has a significant advantage compared to other countries in the region. When we observe the average area of arable land per capita, we can notice a significant comparative advantage of the Republic of Serbia in relation to the countries in the region.The Republic of Serbia has an average of 0.56 hectares of arable land per capita (Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014-2024, 2014).

In the conditions of the economic crisis, Serbia's agriculture was faced with numerous problems. The most important are: the reduction of agricultural producers' income, the lack of foreign direct investment and the reduction in the purchasing power of consumers (Tomić& Ševarlić, 2010, p. 39). The global economic crisis, the risks and relatively low yields in this area, reduce investments in the agrarian sector. At the same time, the purchasing power of consumers is reduced, which affects the instability and a relative decrease in the income of farmers, as well as the low level of utilization of production capacities of the processing industry.

In the modern conditions of market economy, each production must be economically justified. However, mathematically speaking, it is a necessary (required), but not a sufficient condition for sustainable development. In fact, it must be desirable from the standpoint of preserving the natural (living) environment. Non-rational use of natural resources leads to endangering ecological sustainability.Low level of productivity and efficiency are a serious obstacle to sustainable agricultural development from an economic point of view. Due to the wars of the 1990s, productivity in the field of agriculture gradually declined, which destroyed many industries that buy agricultural products, but also those that produce inputs for agricultural production.

According to the latest World Bank data for 2016, Serbia generates productivity, which is calculated as the added value of agriculture per worker, from $ 6,907, which is the lowest level of productivity in the region after Bosnia and Herzegovina and Romania. The leader in Europe

is Norway, which has as much as $ 127,065. Iceland ($ 120,752), and the Netherlands ($ 78,714) also have high productivity. These are developed countries that have a well-developed agricultural sector at the same time.

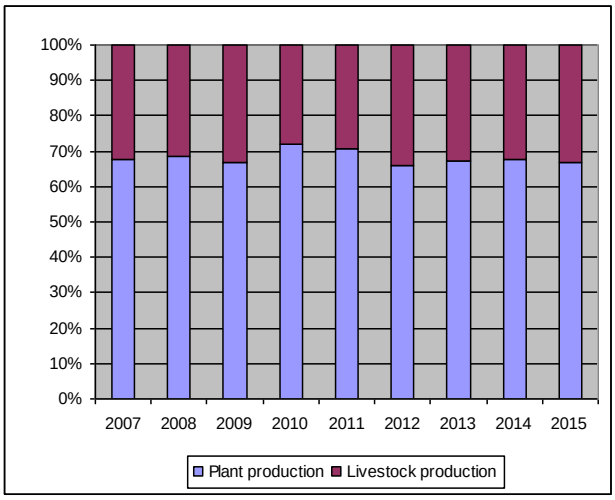
Table 1: *Productivity of agriculture in selected countries in USD (added value per worker)*

Country	Agricultural productivity
Serbia	**6.907**
Bulgaria	10.199
Bosnia and Herzegovina	6.037
Macedonia, FYR	7.885
Montenegro	24.238
Romania	5.153
Croatia	16.470
Slovenia	20.790
Iceland	120.752
Netherlands	78.714
Norway	127.065

Source: *World Bank, 2018.*

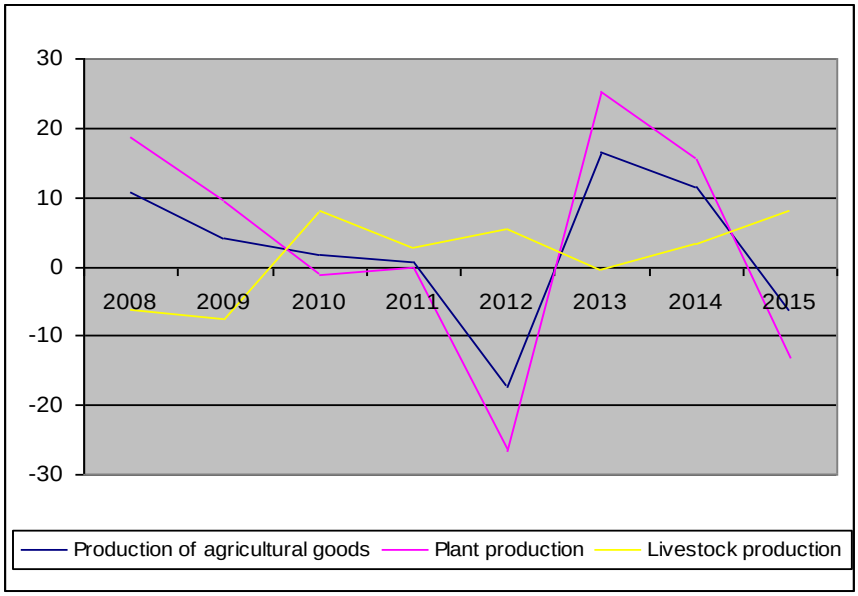
In order to increase the productivity level, it is necessary to have an agrarian policy that will initiate structural changes in production, as well as the development of activities that generate greater added value. Modernization of agriculture and faster grow of livestock production in relation to crop production can be key determinants of productivity growth in the coming period.For many years the Republic of Serbia has recorded a high share of plant production (Figure 1), which is a feature of less developed countries and countries with a low level of agricultural development. In addition, livestock production is one of the rapidly growing branch of agriculture,significantly more stable for the continuous satisfaction of domestic and foreign demand, more resistant to potential market disturbances (Figure 2) and includes products with higher added value. Therefore, structural changes towards the relative increase in livestock production are one of the more important conditions for the sustainable development of agriculture in the Republic of Serbia.

Figure 2: *Structure of the production value of agricultural goods from 2007 to 2015*



Source:*Republički zavod za statistiku, 2016.*

Figure 3: *Rates of change in the value of plant, livestock and the production of agricultural goods in the Republic of Serbia*



Source: *Republički zavod za statistiku, 2016.*

The most important limiting factors in achieving an adequate level of profitability of agricultural production in Serbia are: extensive processing

of agricultural land, fragmentation of the holdings and a shortage of young farmers. Extensive agricultural production leads to resource rupture due to significant soil pressure, erosion and soil contamination, which affects the level of profitability, decrease in productivity, even the exclusion of land from the category of arable land.This further leads to social problems, such as, for example, migration of the rural population and reduction of the living standard of the remaining inhabitants of rural areas.In this example, it can be seen that components of sustainable agricultural development cannot be viewed in isolation. Also, relatively extensive agricultural production contributes to the decline in the physical volume of production, especially in years with unfavorable climatic conditions (Bogdanov & Vasiljević, 2011, p. 50). Outdated agricultural machinery, unfavorable and inaccessible bank loans, as well as the rapid increase in the average age of the active agricultural population are very unfavorable characteristics that prevent the achievement of the main goal - increasing the competitiveness of production.On the other hand, such agriculture cannot be immune to the tendency of liberalizing global trade in agricultural products and the penetration of cheaper foreign (primarily European) products. Therefore, the high average age of the agricultural population and the abandonment of agricultural potentials are an increasing problem of sustainable development of Serbia's agriculture.

The fragmentation of the land creates problems of impossibility of achieving the effects of economies of scale.Serbia is among the countries with the highest share of small parcels (up to 5 hectares) in total agricultural land (Table 2). On such fragmented holdings, modern technology cannot be used in a rational way. This further creates additional problems of low productivity, the inability to compete with cheaper agricultural import products, as well as the abandonment of agricultural land and the entire rural areas.Due to the process of globalization, small independent family farms simply cannot enter the international market for agri-food products. In the global economy, small farms will be replaced by larger ones, which are most often controlled by large global multinational corporations (Pirnea et al., 2013, p. 40).

Table 2: *A comparative overview of the structure of agricultural holdings in Serbia, Luxembourg, the Netherlands, Denmark, France and the United Kingdom*

Country/Land	0-5 hectares	5-10 hectares	over 10 hectares
Serbia	77,7%	14,1%	8,2%
Luxembourg	17,2%	10,0%	72,8%
The Netherlands	29,2%	13,9%	43,1%
Denmark	4,8%	19,6%	75,6%
France	27,0%	26,9%	46,1%
The United Kingdom	16,0%	13,3%	70,7%

Source:*Vehapi & Šabotić, 2015.*

Irrigation is of paramount importance to increasing productivity on existing agricultural lands(Elliott et al., 2014, p. 3239). The negative factor is that the river flows very little use for irrigation.Moreover, the latest data from the World Bank (average from 2013 to 2015) show that the share of irrigated land in the total agricultural land in the Republic of Serbia is only 0.9 percent. A similar situation exists in neighboring countries (for which data are available).European countries with the highest percentage are mainly island and peninsula countries.

Table 3: *Agricultural irrigated land (% of total agricultural land)*

Country	Irrigated land
Serbia	**0,9%**
Bulgaria	2,0%
Romania	1,0%
Croatia	0,9%
Greece	16,6%
Italy	19,1%
Albania	19,2%
Cyprus	19,9%
Malta	36,2%

Source: *World Bank, 2018a.*

The Republic of Serbia has relatively significant land resources for crop and livestock production development. However, many comparative

advantages have not been transformed into competitive advantages. Despite numerous advantages, the Republic of Serbia is still not using its potential fully. One of the biggest problems is low productivity.The cause of this is a very high degree of fragmentation of holdings, which results in uneconomical agricultural production. Natural resources are under-utilized; there is a low level of specialization in production, as well as a very low level of motivation of employees, due to low average wages (Pejanović, 2009, p. 6).

The relatively low prices of agricultural products are not only a result of increased supply, but also the lack of organization of farmers. Monopoly market structure significantly reduce the bargaining power of farmers. Developmentof infrastructure for the agricultural growth implies a well-developed road network, irrigation systems, anti-hail protection, etc.

Also, the production and processing are still at a low level of implementation of the standards in the field of food safety, which is very bad bearing in mind that the biggest part of Serbian export is realized in the European Union market. Given the importance of the European market from the standpoint of Serbian foodexports, reorientation to non-price factors of competitiveness is of great importance.This is because thegoal of improving the competitiveness of European agriculture is at the top of their priorities (Marković, 2015). High standards in production must be respected, in order to ensure healthyand safety products, as well as their overall quality. Due to the low production and geographical diversification of exports, there is an increased risk of achieving lower foreign currency inflows from the fall of prices of these products in the European Union market, which is disastrous for export-oriented agricultural producers, but also for the entire economy of Serbia, bearing in mind the high share of exports of these products in total exports, i.e. the importance of agrarian exports.

So, this is a developed market where our country records a permanently high percentage of exports, and consumers in this market have high standards in terms of quality and safety of products. Thus, in order to ensure and improve the quality of food, as well as increase the export of agri-food products, not only in the European Union, the following quality standards are important from the economic, environmental and social aspect within the sustainable agricultural development (Ristić, 2013):

- ISO 9000 - a series of international quality management standards,
- ISO 14000 - environmental management,

- HACCP - hazard analysis and critical control points in the food chain (from farm to fork),
- GMP - good manufacturing practice,
- BRC - standard of food safety,
- HALAL - standard for the food in accordance with Islamic religious practices,
- Kosher - in accordance with Jewish law and custom,
- ISO 26000 - guidance on social responsibility,
- ISO 22000 - food safety management system,
- CE - an indication that the product complies with European Union rules.

The key potentials of Serbian agriculture include the following two important characteristics: a large area of arable land per capita and significant share of the agricultural population in the total population. Also, Serbia has competitive advantages as regards the level of education of young farmers, as well as the existence of a huge number of researchesand scientific and educational institutions.

The basic direction of the future development of the agriculture and food industry is the optimal use and preservation of the available capacities, the construction of new ones, the increase in the volume of agricultural production, changes in the production structure in favor of intensive production types for export, and the production of high quality and, first of all, healthy products (Anufrijev & Dašić, 2012, p. 153).

Bearing in mind the natural resources, favorable soil and climatic conditions, biodiversity and relatively healthy agricultural ecosystems, it can be said that in the Republic of Serbia there are favorable conditions for the development of integrated and organic production (Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014-2024, 2014). The dominant type of agricultural land of high nature value are grasslands. Grasslands represent a highly productive resource, they are getting cheap and quality fodder, and thus quality meat and milk, maintain a favorable balance of water and air in the soil and protect the environment from erosion.

Increasing the competitiveness of agricultural production is the most important factor of sustainable development from an economic point of view. This is especially important on the road to the European Union. Therefore, it is necessary to increase the level of productivity, introduce a

system of quality assurance and environmental principles of production. The development of organic production can be a significant determinant of increasing the quality of export supply, and therefore the value of total exports. In the process of European integration,the need for greeningthe agricultural production is increasingly being discussed. The bombing of Serbia was very disturbed (up to then very high) ecological quality of agricultural land and products.

Achieving higher production and environmental protection should not be collision goals. This, because taking into account only economic goals, raises the question of the possibility of further profits, because the concept of sustainable development is not respected.

Sustainable agriculture is the main orientation of the strategic action of Serbia's agrarian policy, which sees multifunctional agriculture as the most important economic sector, bearing in mind the sustainable development of the agrarian sector, which implies the following (Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014-2024, 2014):

- The growth of economic efficiency of agriculture based on innovation and modern technical and technological solutions,
- Responsible management of natural resources and their preservation for future generations, with the long-term conservation of agro-biodiversity, diversification of product portfolio and organic production,
- Reaching the welfare of the rural population, that would stop the further deterioration of the demographic trends.

In the reforms of the Common Agricultural Policy of the European Union until 2020, the importance of developing sustainable food production and sustainable management of natural resources is also emphasized (Marković & Marković, 2014). The creation of economically viable and environmentally friendly agricultural production, which should be the basis of the existence of the rural population in the areas where there are natural preconditions to achieve the appropriate level of competitiveness for penetration into the European and other markets, is a key objective in the perspective of sustainable agricultural development of the Republic of Serbia (Radosavljević et al., 2014).The main condition is to solve the economic problems of agriculture, because, without it, it is impossible to achieve the social objectives of sustainable agricultural development.

Conclusion

The concept of sustainable development is based on the use of technologies that maximize productivity while minimizing harmful effects on nature and people. Therefore, the development of technologies must at the same time preserve the environment from the impact of the effects of agricultural production. Environmental degradation is largely derived from the improper use of resources in agricultural production.

Sustainable agricultural development includes the following aspects:

- Development of agricultural production while ensuring self-sufficiency in food,
- Sustainable development of the society to the implementation of the principles of social justice and
- Environmental protection with the sustainable use of resources.

Sustainable development is economic growth while preserving natural resources and implementing of standards of social responsibility. The basic task of such a policy should enable high-quality production.The biggest problems are due to the low competitiveness of agricultural production, which directly affects the main component of sustainable development – the economic component. In addition, crucial importance is the provision of stimulating measures of agrarian policy, an increase of the agricultural budget, return of young people to rural areas, development of the food industry, consolidation of the property and development of the insurance and storage system.

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ECOLOGICALLY ACCEPTABLE TECHNOLOGIES FOR COPPER PRODUCTION

Dragana Božić[1], *Vesna Conić*[2]

Abstract

Ecological metallurgical processes such as adsorption and hydroxide precipitation for copper production from mine acid waters and metallurgical waste solutions have been considered in this work. The mine water from a local abandoned copper mine was used as a model-system in this study. After completing the adsorption, the loaded sawdust was drained, dried and burned. The copper bearing ash was then leached with a controlled volume of sulphuric acid solution to concentrate copper therein. The technology process based on the column adsorption is proposed and discussed. In the paper the results were shown that adsorption and hydroxide precipitation are possible technologies for obtaining cathodic copper 99.99% of quality. These processes don't make ecological hazard and there are environment friendly technologies. After processes of pre-treatment adsorption and hydroxide precipitation of mine and metallurgical waters the solvent extraction and electrowinning are followed processes from which it can be obtained cathodic copper.

Key words:*Mine waters, Adsorption, Hydroxide precipitation, Solvent extraction, Environment protection*
JEL classification:**Q 53, Q 55**

Introduction

The present state of copper production in Bor indicates high ecological environmental damage, especially pollution of the watercourses of the region by outpouring of copper mining and metallurgical solutions. In the past period, the RTB Bor also examined the metallurgical processes for the extraction of copper from mining and metallurgical solutions, but none of them didn't completely give satisfactory results. These processes include the production of copper sulphate from the electrolysis process

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(Cvetkovski, 1981), copper cementation from mine water (Stamenković et al., 1992), improvement of the quality of cement copper (Nedeljković et al., 1998; Marković et al., 1998), neutralization of the mine waters pH 2.5-3.5 by transferring them to the flotation tailings pH 9-11 (Stefanović et al., 1993; Cvetkovski et al., 2008), electrolysis of copper from metallurgical solutions (Conić et al., 2013; Cvetkovski et al., 2009; Conić et al., 2014).

Mine waters are as a rule acidic with the pH value mostly between 3 and 4 due to an elevated concentration of sulphuric acid contained in them, as a second product of bacterial oxidation of sulphide minerals. Pyrite is the most abundant mineral in poly-metallic sulphide ore deposits and in mining waste dumps. The oxidation of pyrite and copper minerals in an aqueous environment occurs via two simultaneous mechanisms, i.e., biochemical involving bacteria and chemical way and can be described by the following stoichiometric reactions:

$$2FeS_2 + 7.5O_2 + H_2O \xrightarrow{\text{bacterial}} Fe_2(SO4)_3 + H_2SO_4 \quad (1)$$

$$2FeS_2 + 7Fe_2(SO_4)_3 + 8\,H_2O \xrightarrow{\text{chemical}} 15FeSO_4 + 8H_2SO_4 \quad (2)$$

$$FeS_2 + Fe_2(SO_4)_3 \xrightarrow{\text{chemical}} 3FeSO_4 + 2S^0 \quad (3)$$

$$S0 + H_2O + 1{,}5O_2 \xrightarrow{\text{bacterial}} H_2SO_4 \quad (4)$$

The above reactions describe how acidity is generated and maintained in mine dumps.

Cement copper with low copper content, low efficiency and high iron consumption are produce in copper cementation plant by treatment of these waters. Final product is not producedby this process yet co-product which are further treated in smelter plant.

Also, by treatment of these waters, by ion exchange extraction process,cement copper with higher copper content in the range of 90% is produced and thengoes to further treatmentssuch as co-product in the smelter and tank house with aim of cathodic copper production. In this

process by-product is sulphuric acid which can generate ecological hazards if it is not neutralized.

Products of these two processes are actually co-products which further are treated in smelter with aim of cathodic copper production.

Treatment of mining and metallurgical solutions by ion exchangers are produce cement copper with higher copper content, in the value of 90%, which is further treated in the smelter and electrolysis in order to produce commercial cathode copper. In this process, an acid solution with a content of 100 g/L H_2SO_4, are forms which can cause ecological harm if not neutralized.

Low recovery and low copper content, in the products of these plants, require further processing in a smelter, which is often not economical (Conic et al., 2008). The current situation in RTB Bor indicates that the losses of copper with mining waters are about 200-300 t/year with a content of Cu - 0.3 to 1 g/L, pH 1.8 to 3.5, and with metallurgical solutions of about 50 t/year, with a content of Cu - 3 to 20 g/L and H_2SO_4 - 20 to 400 g/L.

Adsorption as efficient technique is becoming more and more important in hydrometallurgy for industrial production of noble metals as well for treatment of industrial waste waters to remove certain cations on anions from them. This method is especially suitable for more diluted solution, such as waste waters mainly, often containing only few mg/dm^3 of certain ion specie.

With the new laboratory facilities for solvent extraction and electrowinning, we will investigate the possibility of copper extraction from the mentioned mining metallurgical solutions as well as the production of copper from primary copper raw materials.

These studies will enable the preparation of a preliminary feasibility study for the production of copper by hydrometallurgical processes and water protection in the region by the construction of the plant.

This is an ideal procedure for the treatment of mine waters, whereby, after the process of pre-treatment and the solvent extraction produces copper of commercial quality. Not only does this generate income, it is also possible to protect the environment of eastern Serbia

Materials and methods

Two mining waters were selected, one from the mine in Bor and the other from the surface mine in Cerovo. The collected quantities and quality of the samples are; 22m^3 from the underground mine, containing up to 0.3 g/L of copper, 2.2 g/L of iron at pH 3.2 and 5 m^3 from the surface mine Cerovo mine containing up to 0.5 g/L of copper, 0.6 g/L of iron at pH 4.5. Samples were mixed together in the reservoir shown in Fig. 1. The total amount of the solution was 27m^3 (copper content 0.33 g/L, iron 1.75 g/L, pH 3.5).

Figure 1: *Tanks for the acceptance of the copper mine waters*

Adsorption

Adsorbate

Adsorption experiments have been carried in column. Column experiments were carried out with mine water from the Cerovo. This AMD was chosen because of its significantly lower concentration of copper and associated metals, as shown in Table 1.

Table 1: *Average concentrations of heavy maetal ions (mg/L) in the AMDs from the closed copper mine ''Cerovo''RTB Bor, Serbia*

Metal	Cerovo	MAC[a]
Mn	9.7	-
Cu	132.45	<0.1
Fe	0.14	0.3-1
Ni	0.07	0.05-0.1
Co	0.32	0.2-2
Cd	0.05	0.005-0.01
Zn	5.7	0.2-1

[a]Maximum allowed concentration according to the Regulation on hazardous substances in waters

Adsorbent

Poplar sawdust, produced in local timber mills, was used as adsorbents in this study.

The sawdust was sieved through a set of laboratory sieves and sieve fraction < 0.4 mm was used in the adsorption experiments.

Experimental procedure

Adsorption column experiments were performed in a laboratory column (diameter 32 mm and 500 mm in height) filled with 50 g of sawdust forming a fixed bed therein the height of which was 40 cm. At the top and the bottom, a layer of glass wool was used serving as a calming section in the first case and as a bed support and a filter in the second one preventing particles to go out with the exit stream. The column was fed with mine water gravitationally, from a feeding reservoir positioned above the column. Passing through the bed in a down-flow mode, the solution came out at the bottom. Water layer height above the sawdust fixed bed was kept constant in order to have an approximately constant flow-rate (10 ml min^{-1}) through the column. The column experiments were performed in a single pass mode as it is present in Figure 2.

The samples of the solution passed through the column were assayed periodically at a known volume of the solution passed through and analyzed. From the mass balance, the adsorbed amount of metal ions was then calculated.

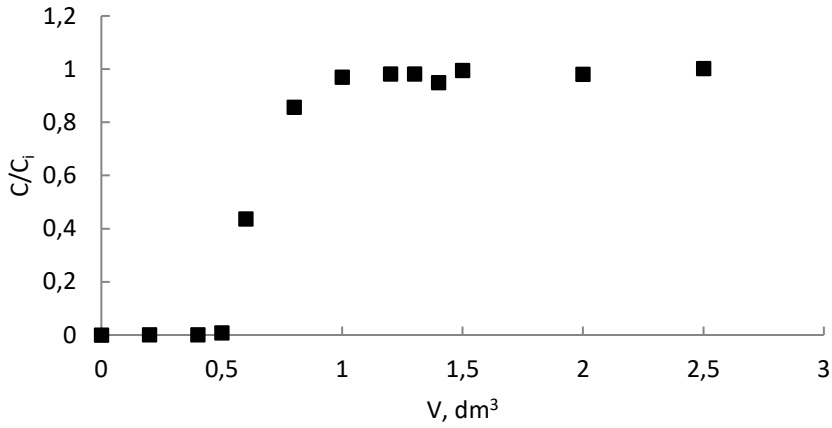
Figure 2: *Column adsorption*

Column adsorption study

To determine the adsorption capacity of sawdust under flow conditions, a series of column adsorption experiments were performed in down-flow mode, as described in the Experimental part. Mine water from the Cerovo was used in this series of experiments.

From an engineering point of view, determination of the breakthrough curve allows the adsorption capacity of a column to evaluate.

Figure 3: *Normalised copper concentration plots against the volume passed through the column: ×- mine water (Cu= 0.135 g/L)*

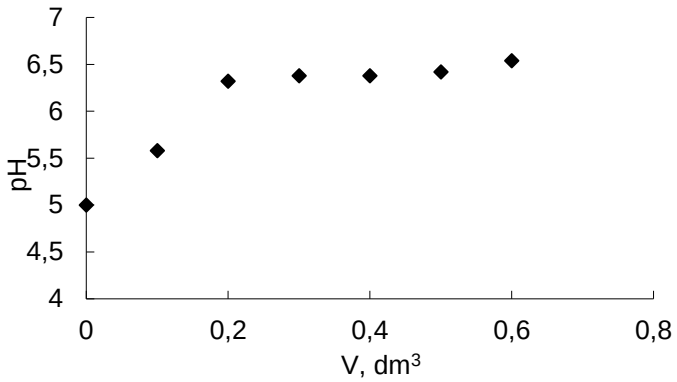


The results are presented in Fig. 3 by plotting the normalized concentration change of Cu^{2+} against the volume of water passed through the column. It means that the adsorption capacity of sawdust, calculated on copper, is slightly reduced.

It was observed and discussed by (Božić et al.,2009) that the initial pH changes during the adsorption.

When measuring the pH of assayed samples in the column adsorption process a certain increase in the solution pH with the volume passing through the column was also noticed, as presented in Fig. 4.

Figure 4: *Change of the initial pH of solution with the volume passed through the column poplar sawdust, particles size <0.4 mm; flow rate 10 ml min^{-1}*



The pH increase means a co-adsorption of protons with metal ions. This effect causes an equivalent decrease in sawdust adsorption capacity which is a bad aspect of the process. A positive aspect is that sawdust, adsorbing H^+, affects the wastewater acidity decreasing a consumption of an agent which has to be spent in the neutralization process that should follows the adsorption step, if the complete treatment of mine waters occurs, prior to its releasing into a natural recipient.

Process technology for metal ion removal and recovery from mine waters

Not much attention has been paid so far in the relevant literature to the stripping of adsorbed metals from loaded sawdust. In few cases only, desorption has rather been mentioned than studied extensively (Fiol et al., 2006; Yu et al., 2000; Yu et al., 2001; Ajmal et al., 1998). The achieved desorption degree, in the mentioned references, was rather modest and did not exceed 50% of the metal amount adsorbed by sawdust.

Further treatment of sawdust, comprising washing out the stripping solution from sawdust renewing it for the next adsorption cycle has not been considered at all by anyone discussing a desertion stage. Using "low-cost" adsorbents like sawdust, the question is always what is more convenient and economically sustainable:
- to regenerate and renew the loaded sawdust by desorption using a proper desorption agent;

- or to destroy the loaded sawdust burning it in order to produce heat and to recover a metal content from the produced ash.

Starting from the position that sawdust is a cheap material, not quite suitable for recycling – we have considered and experimentally checked the second way as a possible process route for metal removal and recovery from loaded sawdust. It comprises the following: After completing the column adsorption, instead of desorption, the loaded sawdust was drained, dried and burned concentrating the metal content in the produced ash; the collected copper bearing ash was then leached with a small volume of sulphuric acid solution to concentrate copper and other metals therein. In such a way, the obtained leach solution had a concentration of copper ions cL >15 g/L, what is more than two order of magnitude higher than the concentration in the feeding solution (0.135 g/L).

The concentration of copper ions in the leach solution is suitable to be further treated by the electrowinning in order to recover copper in this case and, in principle, some other valuable metal from the leach solution (Juttner & Galla, 2000; Gorgievski et al., 2009). The proposed process could be particularly suitable, besides mine waters treatment, for other similar solutions originating from extractive metallurgy of copper as well as for rinse waters from metal working and electroplating plants.

Hydroxide precipitation

Neutralization and hydroxide precipitation were carried out in tanks located in the open space of thecementation plant. Neutralization to pH 5 gave 130kg of wet hydroxide sludge. Dry sludge, containing 16 kg of copper hydroxide, 80 kg of iron hydroxide and 8 kg of impurities in the form of hydroxides and insoluble substances, was additionally treated in the laboratory of the Institute for Mining and Metallurgy in Bor.

Hydroxide dissolution

In the laboratory of the Institute for Mining and Metallurgy in Bor, the hydroxide sludge is soluble in sulfuric acid. As a result, a solution (4 m^3) containing 2.5 g/L copper, 11 g/L of iron and soluble impurities at pH 1.5 was obtained.

Oxidation of ferrous ions and impurities

Oxidation of the leach solution with 30% oxidant H_2O_2 was used for oxidation ferrous to ferric ions. The obtained solution with the content of ferric iron was treated in the next process.

Selective hydroxide precipitation of iron, arsenic and impurities

Neutralization of mine waters was done using sodium hydroxide. By neutralizing the leach solution to pH ~ 3.0-3.5, selective precipitation of metals such as: ferric ion, arsenic and other except copper, was achieved. The content of iron in leach solution is lowered to min. value to 3 g/L Fe.

Purified sulphate solution of copper (leach solution)

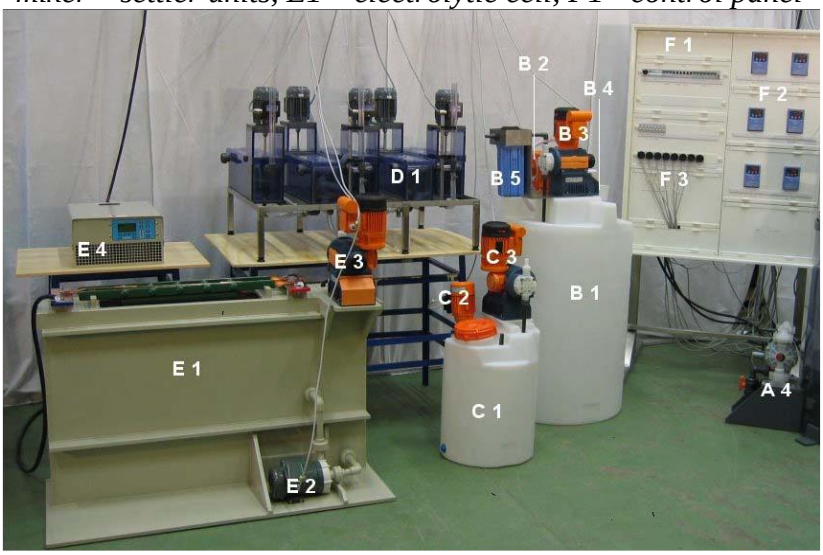
The purified leach solutions from both processes of pre-treatment contained: Cu ~ 2.3 g / L, Fe ~ 1.5 g / L, pH 2. This solution is further treated by solvent extraction and electrolysis with insoluble anodes.

Solvent extraction and electrowinning

The process of extraction and stripping of copper was done with the ratio of organic phase flow to aqueous O/A = 1. The ratio of the organic phase to the aqueous in the stripping was O/A = 8. The extraction of the copper was accomplished in 3 mixers, of which 2 were in extraction and 1 in stripping section Fig 5.

After pre-treatment, 4 m^3 of leach solution with copper content of 2.5 g/L Cu and pH 2.5 was produced which is suitable for further treatment by the solvent and electrolytic extraction process-SX-EW.

Figure 5: *Laboratory plant for solvent extraction and electrowinning B1 - feed tank for leach solution, C1 - reservoir for organic solution, D1 - mixer – settler units, E1 – electrolytic cell, F1 - control panel*



The solvent extraction process for the treatment of a solution can be presented by the following chemical reactions:

Extraction:

$$2[RH]_{(org)} + [Cu^{2+}] + 2[SO4^{2+}]_{(aq)} = [R2Cu]_{(org)} + 2[H+]_{(aq)} + 2[SO4^{2+}]_{(aq)} \quad (5)$$

Stripping:

$$[R2Cu]_{(org)} + 2[H+]_{(aq)} + 2[SO4^{2+}]_{(aq)} = 2[RH]_{(org)} + [Cu^{2+}] + 2[SO4^{2+}]_{(aq)} \quad (6)$$

The basic technological operations of the solvent extraction are explained and then shown in Figure 6:

• 1. Mining copper solution is introduced into the extraction section.

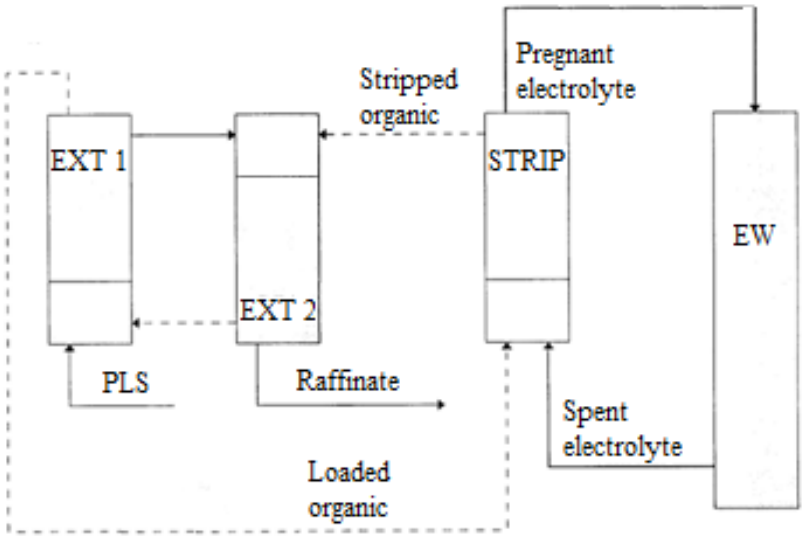
• 2. The mine solution and the organic solution are contacted into extraction mixer. The copper are extract from the mine solution into the organic phase.

• 3. In the extraction stage the stripped mine solution are then separate from the organic phase into settler. The raffinate, acidic solution is discarding.

• 4. The organic solution which contain copper (saturated organic phase) are further send on stripping section.

• 5. The saturated organic phase are contact with-stripped electrolyte. The copper go through from organic into liquid faze-reached electrolyte.
• 6. A mixture of rich copper electrolyte and organic solution (unsaturated organic phase-stripped organic phase) are separated into the stripping section. The stripped organic phase is returned to the extraction mixer settler unit.
• 7. The rich copper electrolyte is introduced into the electrolytic cell in which copper are deposits by the action of DC power. Quality of cathode copper contains 99.99% Cu.
• 8. The partially stripped copper electrolyte is returns to the beginning of the process into the extraction section.

Figure 6: *Conventional solvent extraction circuit with 2 extractions and 1 strip stage*



Electrowinning

The electrolyte from the stripping section unit's process is introduced into the electrolytic cell. Oxygen is released on anode. The DC power is adjusted to a certain value in order to maintain a constant copper content in the electrolyte and produce a high quality cathode copper.
Chemical reactions in copper electrowinning are as follows:

$$Cu^{2+} + 2e- = CuO \text{ (oncathode)} \quad (7)$$

$$H_2O = 2H^+ + 1/2O_2 + 2e- \text{ (on anode)} \quad (8)$$

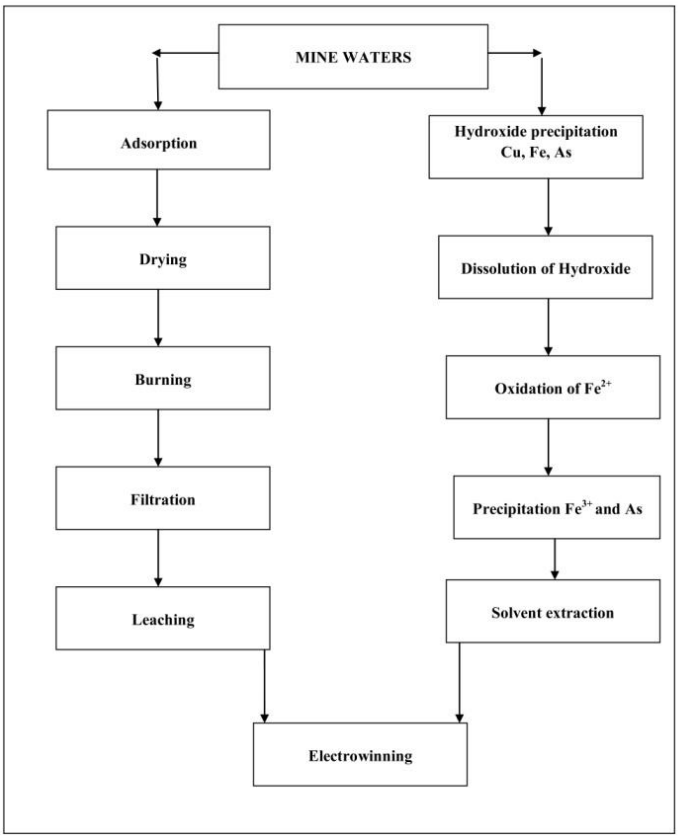
Experimental investigations were carried out in a laboratory electrolytic cell that is part of the solvent extraction. The research was aimed at producing cathode copper by electrolysis with insoluble anodes.

The weight of the produced cathode was 10kg and it is shown in Figure 7. The content of copper in cathode copper was 99.99%.

Figure 7: *Cathode produced in laboratory L-SX-EW facilities*

The proposed ways to purify mining waters are presented in Fig. 8. Two possibilities for water pre-treatment are shown: adsorption and hydroxide precipitation.

Figure 8: *Technological scheme for processing mining solutions: a) adsorption b) hydroxide precipitation*



Conclusion

Two samples of mine waters, one from the mine in Bor, another from the surface mine in Cerovo, were selected in this experiment. Two different pre-treatment processes have been carried out, whereby the result of the process of solvent extraction and electrowinning shows that with this procedure it is possible to obtain copper of commercial quality. It can be concluded that copper can be extracted from mining water. Beside, using this process we can get benefit, it is also possible to protect the environment of eastern Serbia

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MULTI-CRITERIA PRIORITIZATION OF RESTRUCTURING PROJECTS OF UNDERGROUND COAL MINES IN SERBIA

Slavica Miletic[1], Vesna Conić[2]

Abstract

Prioritisation of restructuring projects of underground coal mines in Serbia, which are integral parts of the Public Company for Underground Exploitation of Coal Resavica,represents very important step in the overall process of restructuring this public company.The aim is to select the optimal order of projects realizationin order to get the best results of therestructuring process.Prioritisation of restructuring projects was done by multi-criteria analysis using combination of AHP and PROMETHEE method.Restructing process consists of three projects regarding technical–technological, organizational and managing aspects of restructuring.The criteria for prioritization of restructuring projects include the most important characteristics of this process.AHP method is used to determine the influence of every criteria and PROMETHEE method is used for the complete ranking of projects and sensitivity analysis. Obtained results indicate that the proposed methodology gives excellent results and can be used for solving the most complex problems in the economy.

Key words:*Restructuring, AHP, PROMETHEE, Project, Underground Coal Mines*
JEL Classification:C44, D81, L16, P31

Introduction

Nowadays, the situation regarding undergraund coal exploitation in Serbia is characterized by the existence of a large number of deposits,intentedness of mines, complex geology, different types of coal, various levels of reserves, etc. All underground coal mines in Serbia make thePublic Company for Underground Exploitation of Coal based in

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Resavica (JPPEU Resavica).In accordiance with the fact that fossil fuels (including coal, natural gas, and oil) continue to be the world's primary energy source (Benalcazar et al., 2017),JPPEUResavicarepresents an unwieldy system that is necessary to restructure before the ownership transformation.This company consists of eight coal mines.Total reserves of coal is about 260 million tons.The overall production of coal is 600-700 000t/year with the trend of continuous decline, as a result of a set of objective circumstances (Ivkovic, 2012).

The aim of the Government of the Republic of Serbia is to make JPPEU Resavica more efficient organization, and then to solve its proprietary status ie. to privatized it.In the previous period, there were several attempts to restructure this company, but none applied model was not successful, except the process of downsizing, which has significantly reduced the number of employees.The cause of failure was that the Government of the Republic of Serbia wanted just to sell this company, without conducting substantial restructuring measures.In that way, the restructuring would be the task of the new owners, but there was no one interested in this company.

Related to all previous mentioned, this paper discusses the process of a comprehensive restructuring of this company, which consists of three separate and independent projects from the order of realization of the given projects.Projects include technical and technological, organizational and managing aspects of the restructuring.All data used in this article are obtained by the management of JPPEU.

The order of realization of restructuring projects of JPPEU Resavica is determined because the funds for restructuring is limited, so it is possible to realize only one project at a time. The regular order will allow the realization of certain previously planned positive effects of the work of this company, then gradual execution of the entire restructuring process which allows better control, easier adjustment and less resistance from employees.

Forming of restructuring projects as well as choosing the sequence of their implementation is a very complex, difficult and time consuming process that requires the involvement of experts from various fields who have extensive knowledge and experience.Team that realizes this process should have at their disposal a large amount of relevant information.

The aim of this study is to determine the order of realization of restructuring projects by applying the appropriate method, taking into account all the influential factors and the specificity of this process.For this reason, determining the order of realization of restructuring projects of JPPEU Resavica is here understood as a process of multi-criteria decision with final number of alternatives - projects. On the other hand, relevant data or factors that determine the order of realization of restructuring projects are the criteria for making the decision.

Multi-criteria analysis has many methods and techniques for ranking alternatives and decision making.The advantages of these methods are that different criteria in the selection procedure such as financial and non-financial, then the quantitative and the qualitative and others can be simultaneously consider. Also, today there are a large number of software packages that allow quickly set up and solutions of tasks.The most famous of these methods are evaluation models, analytic hierarchy process–AHP, analytic network process–ANP, TOPSIS, ELECTRE and PROMETHEE, as well as some of their combinations.

Selection of appropriate method of multi-criteria decision-making is important, but the most importantly is the proper structuring of the problem, which includes consideration of appropriate alternatives and the selection of the most important criteria, according to the specific situation (Bufardi et al., 2004; Mergias et al., 2007). Multi-criteria decision-making methods can be defined as the process of selecting the most appropriate solution from a set of available alternatives, based on their performance in relation to the set of criteria for evaluation (Stanujkić et al., 2017).

AHP-PROMETHEE integrated method was selected to determine the order of realization of restructuring projects. Analysis of the structure of the process of determination the order of realization of the restructureing projects as well as determination of thecoefficient weights of criteria, were done byAHP method.After this, final ranking of alternatives and sensitivity analysis were done by using PROMETHEE method. Also, PROMETHEE method was used to analyse the influence of the criteria–project costs on the result of the project ranking.

During the last decade, MCDM methods serve as auxiliary tools for solving real problems in different areas: construction (Zavadskas & Turskis, 2015); sustainable development (Ghosh et al., 2016, Conic et al., 2014, Conic et al., 2013); management and economics (Urošević et al.,

2017; Karabašević et al., 2018); mining (Stojanović et al., 2015) and other areas.

Materials and method

Restructuring can be defined as the process of comprehensive transformation of the company or industry (Borowiecki, 2003; Dorozik, 2006). Restructuring can be directed towards the development or survival of company (Romanowski, 2001; Cyfert, 2006; Brandenburg, 2010; Kalowski & Wysocki, 2014). On the basis of the area of operation, the restructuring may include technical, organizational, marketing and financial aspects of the work or the area of the manpowerand employment.

Experiences from other countries are very different, with different results. Most countries have used one of the two models of restructuring - gradual transformation (gradualist transformation) and the rapid transformation (a big-bang). China is an example of successful implementation of the model of gradual restructuring; Poland is a successful example of a big-bang approach to restructuring. However, in most countries the restructuring process has not given good results. For example, Ukraine has not yet completed the process of restructuring, although it chose the style of a gradual restructuring (Borshchevska, 2015). A similar situation is in Serbia, where they started with a big–bang style of restructuring, but no attempt has been brought to an end and did not give the desired result, except a downsizing. The most important reasons for failure were inadequate preparation or bed implementation, external factors, property and others. It is particularly difficult to restructure the organization, which are state property. There arise many problems, ranging from political forms of decision-making, lack of flexibility and knowledge and a variety of other disorders (Bhattacharyya, 2007; Zhao, 2009; Apostolov, 2011).

Consequently, restructuring processes require further research in order to their modification and development, especially in Eastern European countries. One of the possible solutions proposed in this paper is to realize the restructuring process as a multi- project where each individual project refers to a specific functional area of restructuring (Ross, 2006; Rachwal, 2011; Viciua, 2013).The main goal of restructuringis to make from JPPEU Resavica profitable company.

Restructuring multiproject

As it was noted above, a multi project of restructuring should include all the most important aspects of this process. Considering that the JPPEU Resavica is state-owned, the Government of the Republic of Serbia is helping to finance this company, so that it pays all its obligations and has no major debts.This assistance will last until the completion of the restructuring of the company. Also, in the previous period, the number of employees was significantly reduced, so now this company has the optimal number of workers.

Taking this into account, the proposed restructuring process does not include the financial aspect of the restructuring and downsizing. On the other hand, it is proposed that the restructuring include the aspect of the technical - technological advancement of the mine, which will make this company even more attractive for privatization. According to this, it is proposed that a multi-project of restructuring consists of the following three separate projects as follows:
Project of technical-technological restructuring of the underground coal mines (alternative A_1) includes the planning and implementation of new technical and technological solutions. The focus is on intensive mechanization and automation of mine.This includes the implementation of a new generation of automated plows for thin coal layers with thickness below 1.5 m, implementation of automated equipment for conventional systems of exploitation and consideration of the possibility of application of the modern systems and others. Also, all decisions have to be based on the principles and criteria of sustainable development.This means that they, adequately covers environmental protection, as well as issues of particular national importance and beyond.

Project of organizational restructuring of the underground coal mines (alternative A_2) includes organizational transformation. Organizational structure of JPPEU Resavica is outdated and based on the functional principle. According to the fact that the most of the mine locations are far away from the headquarters in Resavica, the functioning of the whole company is very difficult. So, it is necessary to implement a new model of organization of this company. In accordance with existing state of this company, it is the best to implement the project organizational structure in which each individual mine represents a special project, with headquarters in Resavica, which would unify all the common activities of the mine. Project of managing restructuring of the underground coal mines

(alternative A_3) represents implentation of the Integrated System of Management (ISM), and then a hiring a professional management through a tender process that will lead to the privatization of this company. It should consider the possibility of applying the ISO standards-such as ISO 9001: 2015, which represents the application of process models as the most suitable for operating mines and should be valid from 15 September 2018.

Criteriafor restructuring projectsranking

The criteria represent the most important parameters for the prioritization of restructuring projects of JPPEU Resavica. In order to accomplish quality prioritization of projects, actually their ranking it have to be considered two sets of criteria. Thefirst set of criteria involves the most important characteristics of the projects and the second group expected results. The criteria are defined by authors and management of the company.

The first set of criteria includes costs of the project realization (Criteria C_1), time for the projects realization (Criteria C_2) and the resistance of employees to changes (Criteria C_3). Costs of the project realization indicates the size of investment needed for the realization of restructuring projects. It depends on the types of projects, their scope, required resources, etc.This criteria is very important because the financial resources for the implementation of projects is limited. Time of projects realization indicates the duration of individual projects. Due to the limited time for the realization of the restructuring process, time for the projects realization is an important criteria. Resistance of employees is a criteria that can significantly affect not only the prioritization of restructuring projects, but also on the process of restructuring, given the fact that the JPPEU Resavica is state company where unions of employees have an important role in many processesin the company. Accordingly, it is expected that the employee will provide certain resistance during the implementation of restructuring projects, depending on the type and size of the changes that will accomplish these projects.

Expected results of the project is a significant group of criteria, because it affects the order of realization of projects in terms of the strength and depth of the changes realized in the process of restructuring. These include the following criteria: increasing the efficiency of company (Criteria C_4), reducing the cost of company work (Criteria C_5), achieving positive economic results - profit (Criteria C_6) and the functioning of the

company on the principle of sustainable business and reducing environmental pollution (Criteria C_7). After restructuring, the company JPPEU Resavica needs to function more smoothly, there must be a better organization to perform all processes, quality management and others. Also, restructured company should have a lower cost of business that can be achieved by rationalizations in many areas of functioning, operations and management, applicating of modern techniques and technologies, process management approaches and others. All mentioned above should lead to achieving of positive economic results - profits, which would significantly help in the future privatization of this company. At the end, it should be noted that the goal of restructuring is functioning of the company on the principle of sustainable business and reducing environmental pollution, too.

Methodology of ranking of the restructuring projects AHP-PROMETHEE integrated method

Analytic Hierarchy Process (AHP) is one of the most popular method for decision making, created by Saaty (1980). This is a quantitative method that parses the complex problem of multi-criteria decision-making in a multi-dimensional hierarchical structure of objectives, criteria and alternatives (Lee, 2001).

This process includes the following tasks:

- forming a matrix of comparison of criteria,
- the assessment of the consistency degree in order to check the consistency of the process.

Table 1: *Comparing scale ofdecisionelements*

Dominance	
Description	**Rating**
Equally	1
	3
Strong domination	5
Very strong domination	7
Absolute domination	9
2, 4, 6, 8 areintermediate values	

PROMETHEE is used to obtain a final order of realization of restructuring projects, which uses the coefficient weights of criteria, obtained by AHP procedure. PROMETHEE uses the six preference

functions, which indicate the way of ranking of alternatives.The indifference threshold Q represents the largest deviation that is considered negligible, and the threshold P represents the smallest deviation that is considered as decisive.P cannot be less than Q. The Gaussian threshold (s) is a middle value of P and Q thresholds that is only used with the Gaussian preference function. (Brans, 1982; Brans & Vincke, 1985).

The PROMETHEE method ranks alternatives based on values of positive, input flow (Φ^+) and negative, output flow (Φ^-) for each alternative according to outranking relations.The positive flow of preferency expresses how much each alternative dominatescompared to other alternatives and as its value is higher ($\Phi^+ \rightarrow 1$), alternative is more important. On the other side, negative flow of preferency expresses how much each alternative is preferred compared to other alternatives.As much as the value of the output flow is less ($\Phi^- \rightarrow 0$), an alternative is more important. The final ranking is done by PROMETHEE II on the basis of the value of net flow (Φ), which is the difference between positive and negative flow of preference. The best ranked alternative has the highest value of the net flow (Brans & Mareschal, 1994; Anand & Codali, 2008).

PROMETHEE method has the ability to display graphicly the conflicts among criteria and grouping of alternatives - GAIA plan (Albadvi, 2007). By using the combination of AHP and PROMETHEE method it is possible to minimizethe weaknesses of these methods and enhancingof their preferences.AHP method enables calculation of coefficient weights of the criteria on better way, unlike the PROMETHEE method, which is based on intuition or knowledge of experts (Macharis et al., 2004). Regarding to this, AHP-PROMETHEE integrated method is based on defining the criteria that will be used to rank the prioritisation of restructuring projects of JPPEU Resavica. Then, using the AHP method,coefficient weights of the criteriaare calculated.In this case a software Criterium Decision Plus is used. Subsequently, the implementation of PROMETHEE method follows. The first step is determination of the appropriate function of preference and the corresponding parameters. Then, partly ranking is done by using PROMETHEE I method, and then complete ranking of projects is done by using PROMETHEE II method, and finally, GAIA plan is formed. A Decision Lab software is used for all these calculations.

AHP calculation

Based on above mentioned, a comparison matrix can be formed using the scale given in Table 1.This matrix (dimensions 7x7) is shown in Table 2., that is obtained on the basis of empirical estimates of decision maker in order to determine the importance of each criteria for prioritization of restructuring projects.The obtained results by software Criterium Decision Plus are shown in Table 3. All process of the evaluation is made by the engineers from JPPEU.

Table 2: *Matrix comparison of criteria*

Criteria	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**	**C_7**
C_1	1	3	3	2	2	1	2
C_2		1	1	1/3	1/3	1/3	1
C_3			1	1/3	1/3	1/3	1
C_4				1	1/2	1/3	1
C_5					1	1	3
C_6						1	2
C_7							1

Based on the AHP calculations it can be seen that the most influential criteria for prioritization of restructuring projects of the JPPEU Resavica are: costs of the project realization (Criteria C_1), reducing the cost of company work (Criteria C_5) and achieving positive economic results - profit (Criteria C_6). Consistency degree is 0.030, that is less than 0.1 so, the obtained results (coefficient weights of the criteria), can be used in further process of decision – makin

Table 3: *Results obtained by AHP calculation*

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Weightcoefficients criteria	0.232	0.066	0.066	0.125	0.201	0.222	0.088
Consistency coefficient	0.030						

Therefore two categories of criteria in character are distinguished .

The first category includes criteria costs of the project realization (Criteria C_1), reducing the cost of company work (Criteria C_5) and achieving

positive economic results - profit (Criteria C_6). Criteria - costs of the project realization has the highest value of thecoefficient weights(0.232). It means that it affects with the 23.2% on the result of the ranking of restructurating project. This is because the costs are the most important for the realization of projects and funding is very limited, which is the main reason for the projects ranking. Achieving positive economic results - profit is second criteria by the significance. It represents what is espected by the restructuring process - the company ability to survive in the market.Each project should make a contribution in this direction, but the time needed for this goal depends on the order of projects realization. Reducing the cost of company work is third criteria of significance.This criteria is very important becouse it significantly affects the restructuring process. Those restructuring projects will significantly decrease the cost of business from a different point of view - reducing the cost of labor and the functioning of the company, better cost control, etc. The second category comprises the remaining four criteria: increasing the efficiency of company (Criteria C_4), functioning of the company on the principle of sustainable business and reducing environmental pollution (Criteria C_7), time for the projects realization (Criteria C_2)andthe resistance of employees to changes (Criteria C_3). This group of criteria has a somewhat smaller impact on the prioritization of projects than the first group. Their coefficient weights are in te range from 0.066 to 0.125, which means that they individually affect the order of projets realization from 6.6% to 12.5%.But, all these criteria together affect 34.5% on the result of the ranking, which is very important.

PROMETHEE calculation

Further process of prioritization of restructuring projects relies on the use of PROMETHEE method. In this method the first step is forming of a evaluation matrix and assessment of restructuring projects. It is assumed that all the criteria are of qualitative structure which can be determined by qualitative assessment. In Table 4. is shown a qualitative scale which consists of five levels, and corresponding numerical value for each qualitative evaluation.

Table 4: *Qualitative scale*

Qualitative values	Very poor	Poor	Medium	High	Very high
Numerical values	1	2	3	4	5

Table 5: *Evaluation matrix*

Criteria	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**	**C_7**
Max/min	min	min	min	max	max	max	max
Weight. coefficients	0.232	0.066	0.066	0.125	0.201	0.222	0.088
Preference function	Level	Level	Level	Level	Level	Level	Level
A_1	5	5	1	3	5	5	5
A_2	3	4	3	4	3	3	4
A_3	1	2	4	5	3	4	4

Evaluation of alternatives is presented in Table 5.

Ranking of restructuring projects (alternatives) is carried out based on evaluation matrix. Software package Decision Lab was used for these calculations. Relating to this, values of positive (Φ^+), negative (Φ^-) and net (Φ) flows are given in Table 6.

Complete ranking of alternatives is carried out using PROMETHEE II (Figure 1), wherein the values of the net flows were taken from the last column of Table 6.

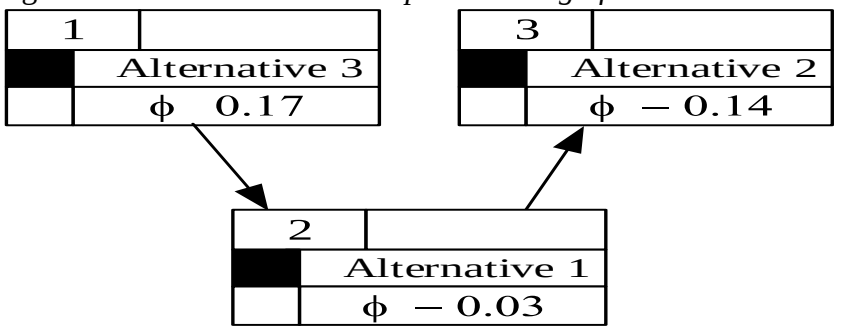
Table 6: *PROMETHEE preferences flows*

Alternative	**Φ^+**	**Φ^-**	**Φ**
A_1	0.2055	0.2383	-0.0328
A_2	0.0580	0.1968	-0.1388
A_3	0.2548	0.0833	0.1715

The best ranking alternative is A_3 (project of managing restructuring of the underground coal mines). In the second place is the alternative A_1

(project of technical-technological restructuring of the underground coal mines), and in the third place is alternative A_2 (project of organizational restructuring of the underground coal mines).

Figure 1: *PROMETHEE II Complete ranking of alternatives*



In this way, a prioritization of restructuring projects of JPPEU Resavica is done, where the optimal order of projects realization is obtained. As it can be seen, project of managing restructuring of the underground coal mines should be realized firstly. This project demands minimum investment and the implementation of the Integrated Management System (ISM) and engaging of professional management creates a precondition for further restructuring.In this way, professional management will actively participate in the implementation of other two projects and have an impact on the process of transformation of the company in order to prepare it for privatization.The professional management can significantly affect the next project of technical - technological restructuring of underground coal mines (alternative A1), which aims to modernization and mechanization of the mine, which is a prerequisite for achieving better business results in JPPEU Resavica.After completion of this project the realization of the last project (organizational restructuring of underground coal mines), should start. After the successful modernization of the mine restructuring process is completed by changing the organizational model of the company, although this process will probably begin before the previous project is completed. The reason is that the technical - technological part of the restructuring inevitably leads to some organizational changes within the company. Finally, organizational restructuring has to be completed, which enables a modern organizational structure of the company.Further, an analysis of the stability interval of the coefficient weights of criteria - a sensitivity analysis is carried out (Table 7).This analysis determines the interval of values of the coefficient

weights of a specific criteria that does not affect the obtained result.In addition, the weight can be changed only for one criteria while weights of other criteria remain the same. Software package Decision Lab enables application of GAIA plan, on the basis of which it is possible to determine the discriminatory power of each criteria, aspects of compliance and non-compliance and the quality of each alternative according each criteria (Figure 2). At GAIA plan, alternatives are presented by triangles and the criteria by axes with square ends. Position of the square of the criteria is the strength of the impact of criteria, while the compliance between certain criteria is defined by approximately the same directional of these criteria axes.

During the ranking, compliance between the criteria C_3, C_5 and C_6, as well as the criteria C_1, C_4 and C_7 is determined while the criteria C_2 is in apparent non-compliance with these criteria. On the other hand, alternative positions (triangles) define their strength or weakness with respect to the criteria. The alternative is better according to certain criteria if it is, (its triangle), closer to the direction of the axes of this criteria.

Alternative A_3 in Figure 2., is the best option, since it is the closest to the direction of axis of those criteria that have the most impact (C_1, C_2, C_4 and C_6), and is the closest to the direction of the decision stick *pi*, which defines a compromise solution according to the given criteria weights.In contrast, alternative A_2 is the worst option as it is located opposite to the direction of the decision stick *pi*.

Table 7: *The sensitivity analysis of criteria*

Criteria	**Weight**	**Min**	**Max**
C1	0.232	0.0958	0.3733
C2	0.066	0.0000	0.4900
C3	0.066	0.0000	0.2294
C4	0.125	0.0000	0.5490
C5	0.201	0.0597	0.4733
C6	0.222	0.0100	1.0390
C7	0.088	0.0000	Infinity

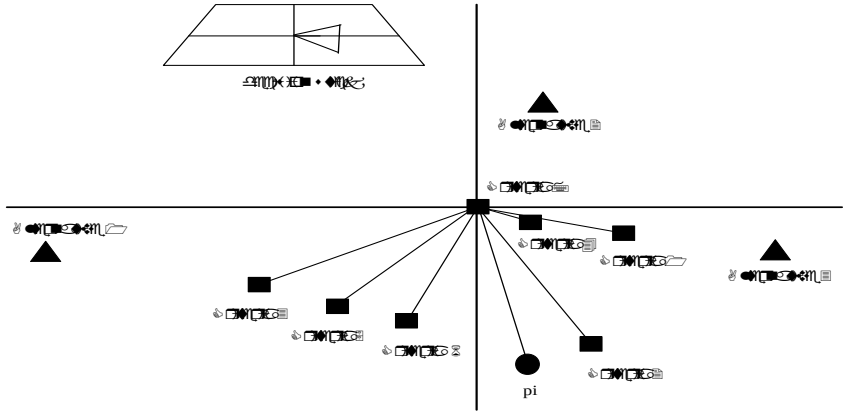
One of the ideas of this work is the analysis of the impact of the most important criteria C_1 - costs of the projects realization on the ranking result of restructuring projects. The analysis is performed by the changing

value of the coefficient weights of this criteria in the range of 0 (criteria C_1 has no effect on the result of ranking) to 1 (only criteria C_1 has effect on the result of ranking). Interval of the changes of coefficient weights value was 0.05. Any change in the value of the coefficient weight of this criteria affect the value of the other coefficients weights of criteria. These changes can be calculated using following formula:

$$W_i = w_i \cdot (1 - w_1), i = 1, \dots, 7 \quad (1)$$

where: W_i – changed value of coefficient weight of the i[th] criteria, w_i– previous value of the coefficient weight of the i[th] criteria , and w_1 – value of coefficient weight of the criteria C_1.

Figure 2: *GAIA plane*



Analysis of the influence of the criteria C_1 – costs of the projects realization

Table8.,shows completeranking for alternativesdepending on coefficient weight value of the criteria C_1, done by PROMETHEE II method. Used software packageis Decision Lab 2000.

Changes of the locations of ranking for each alternative depend on the size of the coefficient weight of criteria C_1. This is graphically presented in Figure 3., based on Table 8.A figure 3 show that changes the value of the coefficient weight of criteria C_1 affects the ranking result. Lower values of this criteria coefficient weight (up to 0.3), have the greatest influence on the change of ranking result and inversely, higher values

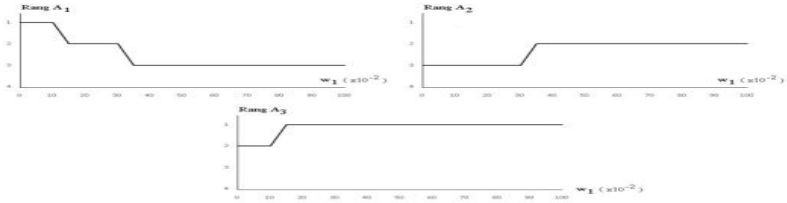
indicating its less impact on the result of ranking, as the stabilizing the order of alternatives.

Table 8: *Complete ranking for alternatives*

Weight coefficient of the criteria C_1	Projects of restructing (alternatives)
0.00	A_1 /A_3 /A_2
0.05	A_1 /A_3 /A_2
0.10	A_1 /A_3 /A_2
0.15	A_3 /A_1 /A_2
0.20	A_3 /A_1 /A_2
0.25	A_3 /A_1 /A_2
0.30	A_3 /A_1 /A_2
0.35	A_3 /A_2 /A_1
0.40	A_3 /A_2 /A_1
0.45	A_3 /A_2 /A_1
0.50	A_3 /A_2 /A_1
0.55	A_3 /A_2 /A_1
0.60	A_3 /A_2 /A_1
0.65	A_3 /A_2 /A_1
0.70	A_3 /A_2 /A_1
0.75	A_3 /A_2 /A_1
0.80	A_3 /A_2 /A_1
0.85	A_3 /A_2 /A_1
0.90	A_3 /A_2 /A_1
0.95	A_3 /A_2 /A_1

In fact, with the rise in the value of coefficient weight of the criteria C_1, alternative A_1 is moved down, and has been ranked lower. The reason is that this alternative (project), requires the biggest investments, and the highest costs of implementation. Also, a greater impact of criteria C_1 leads to the first two places Alternatives A_3 and A_2. These are projects that require less investment and less costs of their implementation.

Figure 3: *Changes of ranking depending on the weight of the criteria C_1.*



Conclusion

A multi-criteria decision-making method is applied in prioritization of restructuring project of JPPEU Resavica. Projects include the whole process of restructuring this company, which is property of the state, in order to make it more efficient organization, and then to solve its proprietary status and to privatize it. The restructuring process consists of three projects, containing the technical-technological, organizational and managing aspects of this process. The order of realization of restructuring projects of JPPEU Resavica is defined due to limited resources for the restructuring and it should be in accordance with the schedule of investments that is determined by the Government of Serbia, so that it is possible to realize only one project at a time. The selection of the optimal order of projects realization is an important decision that has great influence on the whole process of restructuring.Selection of optimal order of project realization is performed in accordance to the criteria, which can be divided into two groups. The first set of criteria comprises the most important characteristics of the projects, and the second group the expected results. Prioritisation is performed by combined AHP and PROMETHEE methods. AHP method is used to determine the coefficient weights of the criteria for ranking projects and PROMETHEE method is used for complete ranking of alternatives. The most influential criteria C_1 - costs of the restructuring projects, shows the importance of the coefficient weights calculation of criteria for ranking or implementation of PROMETHEE method. GAIA plan that represens powerful tool for differentiating strength of criteria and determination similar, independent and conflicting criteria is presented, too. Finally, sensitivity analysis of results is carried out by the PROMETHEE method. Based on integrated AHP and PROMETHEE methods the following results are obtained: the best ranked alternative is A_3 (project of managing restructuring of the underground coal mines), the second is alternative A_1 (project of technical-technological restructuring of the underground coal mines) and the third is the alternative A_2 (project of organizational restructuring of

the underground coal mines). This way of restructuring, with the obtained order of its realization, represents a completely new approach.

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DYNAMICS OF THE NUMBER OF FOREIGN TOURISTS IN ROMANIA

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Abstract

Tourism as a branch of a country's economy contributes to its well-being. The arrivals of foreign tourists are particularly important being associated with the export from this field.Romania is a European Balkan country with valuable natural and anthropogenic tourist resources, with areas where rural culture is still alive. It can be an attractive tourist destination for Romanian and foreign tourists, offering the possibility of practicing several types and forms of tourism.Foreign tourists prefer to visit the capital city and the big cities, as well as the central area of the country. The number of foreigners attracted by these destinations is rising, but we cannot speak of remarkable results.

Keywords*: tourists, arrivals, tourist destination*
JEL classification: L83, O1

Introduction

Tourism is an economic activity that most often involves the stay of people outside of the place of residence for the purpose of relaxation, recreation and entertainment (Maksimović et al., 2015; Sava, 2010a, b). Urošević et al. (2017) point out that tourism as an industry is an extremely complex phenomenon that plays an important role in the process of strong and continuous changes. Also, Urošević et al. (2018) emphasizes that "development of tourism and the increased participation of tourists in this kind of activities on the global level also enlarged the number of tourist destinations, which created a high level of competition in the world market".

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Worldwide, the Madrid-based World Tourism Organization, which is part of intergovernmental organizations and is the only organization of this type with general tourist attributions at global scale, has been set up to monitor and promote the development of responsible, sustainable and accessible tourism.

The organization has the role of a world tourist information centre, by exchanging data on national and international tourism, information on current legislation and regulations, and tourism events.

At present, this organization numbers 158 states as members, including, ever since its founding under this name (1975), Romania as a founding member as well. Traveling for tourism purposes is promoted being viewed as a means of stimulating global economic growth.

Tourism has seen substantial annual growth, the number of people who have chosen to spend their leisure time in a tourist destination reached 1.323 million in 2017, with 84 million more tourists than in 2016, thus a 7% growth.

Europe attracted 671 million tourists, Asia and the Pacific 324 million tourists, America (North, Centre and South) 207 million tourists, Africa 63 million tourists and the Middle East 58 million tourists.

For Europe, growth in 2017 as compared to 2016 was driven by good results in Southern Europe and the Mediterranean Sea (+ 13%), as well as positive results in Western Europe (+ 7%), North and Central and Eastern Europe (both + 5%).

Much of the tourists preferred Europe, as is always the case with the World Tourism Organization's forecasts.

Aspects that could influence European tourism:

- Intensive promotion of tourism by each country;
- The emergence and increase of competition between different tourist destinations;
- The emergence of amusement parks with various themes;
- Increase in "low cost" flights' number and routes;
- Increase of the market share of large European tour operators;
- Desire to return to nature;
- European culture;

- Increase in the number of single people;
- High share of third-age population;
- Increase in the number of internet users;
- Existence of tourism sites.

The WTO predicted a world record of 1.4 million tourists for 2020 and 1.8 million tourists for 2030.

The motivations of the people that will contribute to reaching this number of tourists would be:

- satisfaction of hobbies (generally sports);
- enriching the knowledge in a field;
- discovering the ancestral birthplaces;
- faith and desire to see holy places;
- the attention paid to the state of health, to its maintenance or improvement;
- short-term relaxation, especially during the weekend;
- participation in various cultural events, congresses and sports events;
- the discovery of other until recently inaccessible destinations;
- the growing appreciation of the beauty of unpolluted nature;
- more frequent business trips;
- appreciation for traditional and specific gastronomy services.

Support for tourism development is provided by population incomes, leisure time, culture, high-performance means of transportation, technological performance of communication, general and specific infrastructure, legislation and policy in the countries of the world, safety and security of travel, and last but not least natural and anthropogenic tourist resources.

Romania - general tourist aspects

Romania is located in the south-eastern part of Central Europe, being one of the countries bordering the Black Sea, situated on its north-west shore. Its total area is 238.391 km², plus 23.700 km² of the Black Sea platform. Almost the entire Danube Delta reservation as well as the southern and central part of the Carpathian Mountains are located on the territory of the country.

Accessibility is provided by road, rail, sea, river and air. In 2017, the road network was 16062 km long, out of which 748 km of highway and 3374 bridges. The railway network consists of nine main trunk lines from which several secondary lines start. It has a total length of 20.077 km of lines, being the seventh largest network in the European Union. The Danube is the navigable waterway with a length of 1075 km and many harbours. Sea accessibility is due to the Black Sea, and the main port is Constanța. Existing airports provide passenger and freight transportation throughout the country. Airports in the following cities are currently operational:

- Bucharest - Henri Coandă International Airport and Băneasa - "AurelVlaicu" International Airport;
- Cluj-Napoca - Cluj International Airport;
- Timișoara - "TraianVuia" International Airport;
- Iași - Iași International Airport;
- Sibiu - Sibiu International Airport;
- Bacău - "George Enescu" International Airport;
- Craiova - Craiova International Airport;
- Constanța - "MihailKogălniceanu" International Airport;
- Suceava - "Ștefancel Mare" International Airport;
- Arad - Arad International Airport;
- Satu Mare - Satu Mare International Airport;
- Baia Mare - Baia Mare International Airport;
- Oradea - Oradea Airport;
- Tulcea - "Danube Delta" Airport.

On the Romanian territory, there is a valuable natural and anthropogenic tourist potential that can support a varied tourism.

Natural resources are diverse and even spectacular. The Carpathian Mountains account for about 35% of the country's territory,having some peculiarities that distinguish them from the other mountains of Europe, namely:

- Landscape diversity;
- Complexity;
- Accessibility;
- Remarkable speleological resources - over 10,000 caves

Also in the category of natural resources, we include the other forms of relief: hills, plateaus, plains, seashore, and delta.

The Romanian seaside has 245 km of beaches, and a series of features makes it attractive:

- East and Southeast orientation;
- smooth descent into the sea;
- fine sand;
- the width of the beach.

The Danube Delta is one of the most important attractions of the country due to its uniqueness in the European area, which has been a UNESCO heritage site ever since 1991.

The hydrographic network is rich and varied including rivers, lakes, springs, underground mineral and thermal waters.

The climate of Romania is a temperate continental transition because it makes the transition from the oceanic climate in the west to the excessive continental in the east and sub-Mediterranean in the south-west.

The vegetation presents variety, with 3.700 plant species identified, of which 23 have been declared monuments of nature until now.

The fauna is one of the richest and most diverse in Europe, with about 3.600 rare or even unique species on the continent.

Therefore, the tourist impact of Romania's geopolitical position in Europe must be seen in terms of the three basic natural elements - the Carpathian Mountains, the Danube and the Black Sea.

The anthropogenic potential is a diverse one, influenced by the geographical position and the historical realities.

There are many historical vestiges around the country, some of them of great importance, such as the Dacian fortresses (Costeşti, Sarmizegetuza, PiatraRoşie), Roman fortresses (Potaissa, Apulum, Morisena, Capidava), Greek fortresses (Histria, Tomis) and medieval fortresses(Sighişoara, Alba-Iulia, Râşnov, Deva, Făgăraş), the castles (Peles, Bran, Hunedoara) and the fortified peasant fortresses from Transylvania (Răşinari, Biertan).
Religious edifices are present throughout Romania, some of them being recognized by UNESCO. At the same time, it is underlined that there are religious edifices belonging to several religious cults. Among the most appreciated religious buildings are the wooden churches of Maramures

(Ieud, Bogdan Vodă), the monasteries of Bucovina (Putna, Voroneţ, Humor, Sucevita, Dragomirna), Curtea de Argeş Monastery, Cozia Monastery, Maria Radna Monastery, the Viscri Fortified Church, the Constanţa mosque, the synagogue in Satu Mare.

The cultural artistic heritage of the country is well represented, including a series of works of art (Sculptural Ensemble Constantin Brâncuşi from Târgu Jiu), memorial houses (Ciprian Porumbescu from Suceava, Mihai Eminescu from Ipoteşti, George Enescu from Sinaia, Vasile Alecsandri from Mirceşti), museums (Grigore Antipa Museum, Romanian Peasant Museum, Brukenthal National Museum, Museum of Gold), cultural institutions (Romanian Athenaeum, Palace of Culture-Iasi), and folk art.

Romania's tourist resources are numerous and diverse, natural and anthropic, stretched on all its territory. This has led to the appearance and development of several types and forms of tourism.

Figure 1: *Romania Map – historical regions*

Source:*http://dan-blog.ro/*

Every historical region of the country presents certain types and forms of tourism according to the tourist resources it has.

Table 1: *Types of tourism practiced in Romania*

Romania's historical regions	Representative types of tourism
Maramureş	Cultural, sport (winter sports), mountain, rural;
Bukovina	Religious, culinary, rural, cultural, leisure
Moldavia	Mountain, wellness, religious, cultural, scientific, rural
Dobruja	Seaside, cultural, fishing, ecotourism
Muntenia	Mountain, sport, business, rural, culinary, cultural, scientific, wellness;
Oltenia	Cultural, religious, fishing, leisure
Transylvania	Wellness, mountain, cultural, sport, leisure, rural, religious, scientific, business, culinary, ecotourism
Banat	Wellness, cultural, scientific, mountain, sport, business, fishing
Crişana	Wellness, mountain, hunting

As seen from table 1, the tourists that arrive in any of the historical regions can choose a tourist destination and a type of tourism (Sava, 2015)".

In support of these natural and anthropogenic tourist resources come a series of artistic events, cultural and scientific events that take place annually throughout the country.

The accommodation facilities are also alongside the important tourist resources in tourism development.

Classification of accommodation facilities in Romania is done by the National Authority for Tourism, in accordance with HG no.1.267 / 2010 regarding the classification certificates, licenses and patents for tourism, as amended by HG no.121 / 2013.

Currently, there are criteria aiming at:

- constructions and installations;
- provision of furniture, linen and other items;

- the minimum services offered to tourists;
- other criteria.

The classification system includes a series of minimum technical criteria, but unfortunately, there is very few qualitative criteria.

The types of accommodation facilities are classified either on stars or on flowers (daisies), depending on the type of accommodation, existing facilities, location and offered services.

Table 2: *Classification of accommodation facilities in Romania*

Type of accommodation facility	Classification	1	2	3	4	5
Hotel	stars	x	x	x	x	x
Hostel	stars	x	x	x	-	-
Apartament hotel	stars	-	x	x	x	x
Motel	stars	x	x	x	-	-
Inn	stars	x	x	x	-	-
Villa	stars	x	x	x	x	x
Chalet	stars	x	x	x	-	-
Bungalow	stars	x	x	x	-	-
Holiday village	stars	-	x	x	-	-
Camping	stars	x	x	x	x	-
Tourist stop	stars	x	x	x	x	-
Tourist houses	stars	x	x	x	x	-
Camps for pupils and children	stars	x	x	x	-	-
Guesthouses	stars	x	x	x	x	x
Agrotourist pension	Flowers (daisies)	x	x	x	x	x
Accommodation on river and sea vessels	stars	x	x	x	x	x

Source: *HG no.1.267 / 2010*

This classification provides a guarantee of comfort and services offered to the tourist. Some types of accommodation facilities cannot be classified to

a higher category (4-5 stars), others cannot be classified in category 1 star. It is important that the minimum criteria stipulated by Romanian laws are always met.

The specialized bodies periodically evaluate the condition and operation of facilities, quality of services, compliance with hygiene and other criteria necessary for the classification of the accommodation facility" (Sava, 2016a).

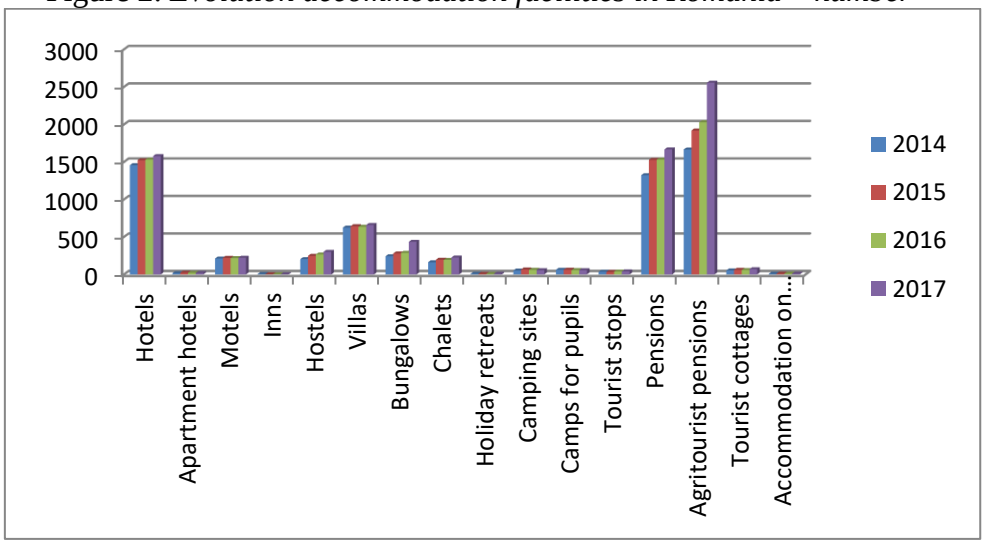
In Romania (Table 3 and Figure 2), their overall evolution was an increasing one, with the highest increases being recorded in accommodation facilities such as tourist and agritouristpensions. Decreases were recorded in camps for pupils, camping sites, due to low demand and conditions that did not rise to mandatory minimum standards for their classification.

Table 3: *Accommodation facilities in Romania - number*

Type of accommodation facility	Year 2014	Year 2015	Year 2016	Year 2017
TOTAL	6130	6821	6946	7905
Hotels	1456	1522	1530	1577
Apartment hotels	17	23	21	20
Motels	212	221	218	222
Inns	5	3	3	3
Hostels	204	248	266	300
Villas	624	643	635	659
Bungalows	242	280	288	434
Chalets	162	196	194	225
Holiday retreats	9	7	7	9
Camping sites	52	66	61	57
Camps for pupils	62	63	58	57
Tourist stops	35	33	38	40
Pensions	1323	1527	1530	1666
Agritourist pensions	1665	1918	2028	2556
Tourist cottages	53	61	59	70
Accommodation on vessels	9	10	10	10

Source: *www.insse.ro, TUR 101A*

Figure 2: *Evolution accommodation facilities in Romania – number*



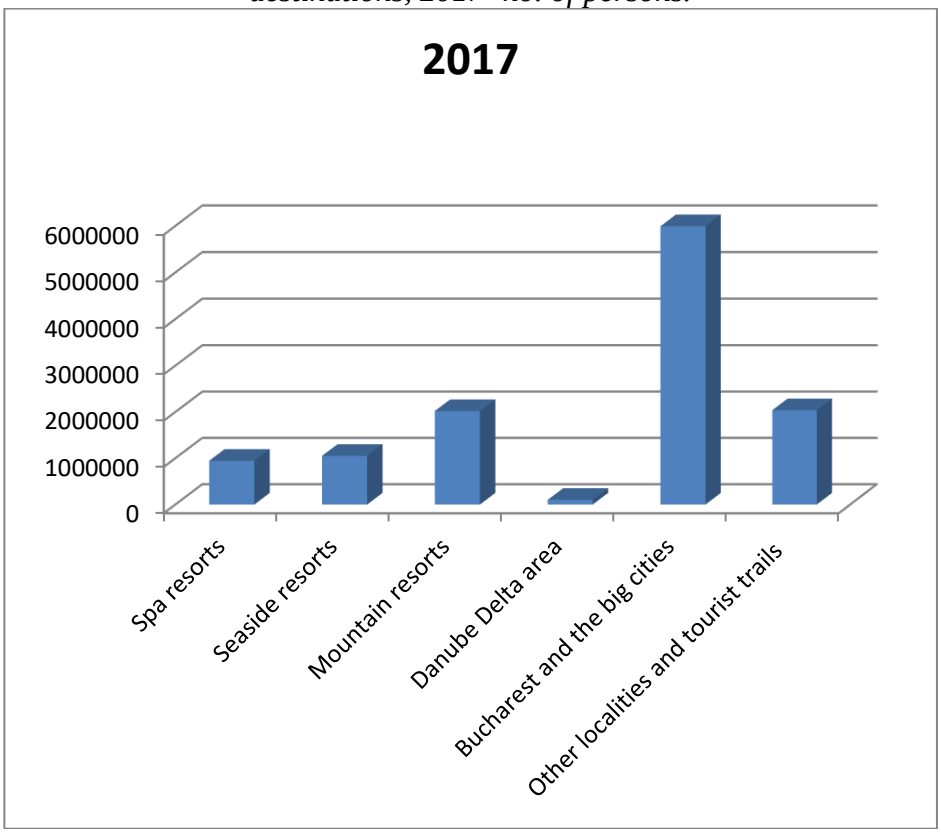
The evolution of the number of tourists staying in Romania in recent years has been increasing, oscillating only between the chosen destinations (Table 4 and Figure 3).

Table 4: *Evolution of the number of tourists accommodated in tourist destinations - no. of persons.*

Tourist destination	Year 2014	Year 2015	Year 2016	Year 2017
Spa resorts	655565	**779325**	851040	945257
Seaside resorts	747103	821659	977386	1049970
Mountain resorts	1291013	1528583	1748157	2019142
Danube Delta area	65604	69076	73114	100423
Bucharest and the big cities	4308117	5088334	5562743	5992403
Other localities and tourist trails	1398507	1634897	1790082	2036151
TOTAL	8465909	**9921874**	11002522	12143346

Source: *www.insse.ro, Time series online, TUR 104A*

Figure 3: *Evolution of the number of tourists accommodated in tourist destinations, 2017- no. of persons.*



It is noticed that the number of tourists increased annually in all tourist destinations, but especially in the mountain resorts (new resorts were opened and the existing facilities were modernized), the capital city and the big cities (promotion of city breaks, organizing various events), as well as in other localities and tourist routes.

"Tourists' motivations are varied and depend on each individual, from the need to escape the crowded stressful urban environment to relaxation, to complete nature, to maintain or recover health, to practice sports, the need to know and get entertainment" (Sava, 2016b).

Dynamics of foreign tourists in Romania

Every year a number of foreigners arrive in Romania for tourist purposes, a number that has been growing in recent years.

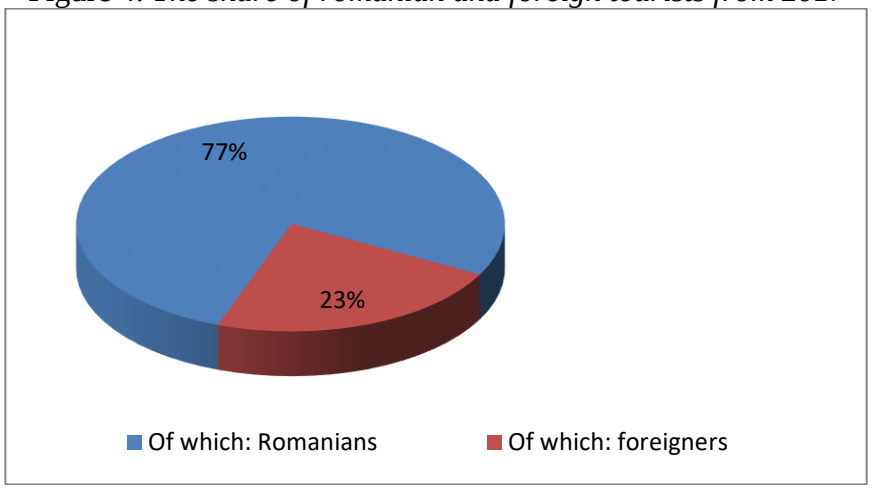
Table 5: *Number of foreign tourists arriving in Romania (no.of persons)*

Indicator	Year 2014	Year 2015	Year 2016	Year 2017
Total tourists	8465909	**9921874**	11002522	12143346
Of which: Romanians	6551339	**7681896**	8521698	9383266
Of which: foreigners	1914570	2239978	2480824	2760080

Source: *www.insse.ro, TUR101A*

The share of foreign tourists arrived in the country in 2014 was 22.61% of the total number of accommodated tourists, varying very poorly in the analysed years, reaching 22.73% of the total number of tourists accommodated in 2017.

Figure 4: *The share of romanian and foreign tourists from 2017*



The absolute increase with the 2014 fixed base of foreign tourists arriving in Romania or the absolute change actually shows how many persons were registered in addition, every year, compared to the reference year, so we can see better the growth that took place (Table 6).

Table 6: *Absolute change with the 2014 fixed base of foreign tourists arriving in Romania*

Absolute change	2014	2015	2016	2017
Number of persons	1914570	325408	566254	845510

The dynamics indicator calculated with the base year 2014 shows the existing proportion between the level of the number of foreign tourists arriving in the country in the last three years and the number of foreign tourists in the base period (table 7)

Table 7: *The annual growth indicator of the number of foreign tourists arriving in Romania*

Annual growth indicator	2014	2015	2016	2017
-	1	1,17	1,30	1,44

The pace of dynamics reflects the increase in the number of foreign tourists arriving in Romania every year compared to the year of comparison. The pace of growth is obvious (Table 8) but still not enough to count in Romanian tourism.

Table 8: *Growth rate with fixed base of foreign tourists arriving in Romania*

Growth rate with fixed base	2014	2015	2016	2017
%	0	17%	29,6%	44,16%

The grouping of Romanian tourist destinations allows a visualization of the foreign tourists' preferences and an awareness of the quality of the Romanian tourist offer.

Table 9: *Distribution of foreign tourists arriving in Romanian tourist destinations (no.of persons)*

Tourist destination	Year 2014	Year 2015	Year 2016	Year 2017
Spa resorts	33599	**43456**	46085	**48742**
Seaside resorts	31325	**29620**	34399	**33683**
Mountain resorts	132271	**172179**	182595	**219002**
Danube Delta area	13482	**15692**	17367	**24142**
Bucharest and the big cities	1486136	**1719087**	1930628	**2132377**
Other localities and tourist trails	217757	**259944**	269750	**302134**
TOTAL	1914570	**2239978**	2480824	**2760080**

Source: *www.insse.ro*, *TUR104C*

It can be said that Bucharest and other big cities of Romania managed to attract the most foreign tourists in all the analysed years (Table 9), being more accessible due to the airports and offering more opportunities for leisure. In 2017, the share of foreign tourists in Romanian tourist destinations highlighted this fact (Table 10).

Table 10: *Share of foreign tourists arriving in Romania according to tourist destinations in 2017*

Year 2017	Spa resorts	Seaside resorts	Mountain resorts	Danube Delta area	Bucharestand the big cities	Other localities and tourist trails
Share of foreign tourists arrival in Romania (%)	1,8	1,2	8	1	77	11

Figure 5: *Share of foreign tourists arrived in Romania according to tourist destinations*

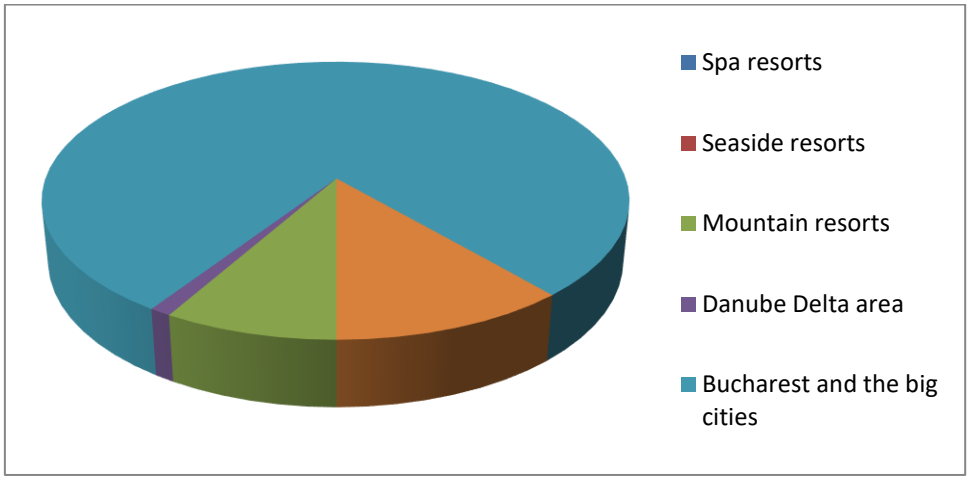


Table 11: *Evolution of foreign tourists arrived in Romania according to development regions (no.of persons)*

Region	Year2014	Year2015	Year2016	Year2017
North-West	169781	**208767**	238575	**271180**
Centre	359337	**430476**	490995	**549421**
North-East	98972	**117224**	135119	**153272**
South - East	86769	**96147**	102520	**114931**
South	92641	**122161**	128493	**149220**
Bucharest-Ilfov	921131	**1052341**	1163281	**1265315**
South-West	40734	**50841**	48023	**54612**
West	145205	**162021**	173818	**202129**

Source: *www.insse.ro,TUR 104B*

The capital of the country - the Ilfov area attracts most of the foreign tourists annually, followed by the Central Region, a highly publicized area, promoted abroad by Prince Charles of Wales, a fact found in all the analysed years (Table 11).

Table 12: *Evolution of foreign tourists according to types of accommodation facilities (no.of persons)*

Type of accommodation structure	Year2014	Year2015	Year2016	Year2017
Hotels	1722975	**1971500**	2163174	**2370178**
Hostels	26505	**40168**	56130	**81213**
Apartment hotels	3332	**18998**	19867	**24246**
Motels	15672	**16262**	17939	**14459**
Inns	:	**189**	182	**550**
Villas	23958	**29709**	29796	**34720**
Chalets	5338	**7473**	8254	**9482**
Bungalows	750	**1518**	1667	**2300**
Holiday retreats	169	**815**	701	**589**
Camping sites	3936	**7644**	7502	**9973**
Tourist stops	547	**182**	593	**987**
Tourist cottages	224	**548**	480	**563**
Camps for pupils	749	**1605**	1763	**475**
Pensions	68947	**92798**	107624	**122451**
Agritourist pensions	41434	**50569**	65134	**87187**
Accommodation on vessels	34	-	18	**707**

Source: *www.insse.ro, TUR 104B*

It is obvious (Table 12) that foreign tourists who prefer to visit Romania choose, especially for accommodation, hotels and then tourist pensions. The agro-tourist pensions attract more and more foreigners eager to get to know the gastronomy, crafts and traditions of the Romanian rural environment.

Conclusions

On the territory of Romania there is the possibility of practicing the seaside, mountain, spa, cultural tourism.The country has special tourist resources, but insufficiently well valued and a basic technical and material base, which is often a barrier for foreign tourists. The tariffs applied by tourism providers are a criterion in the choice of the tourist destination, along with the quality of the services offered, the diversity of services, and the accessibility of the tourist destinations.The recent evolution of the number of foreign tourists visiting Romania is rising, and

it gives hope to Romanian tourism as a branch of economy.Worldwide, our country is not in the top tourist destinations, tourists' preferences are still related to countries with a tradition in this economic sector.However, with some investments in infrastructure and human resources, with a better management of what already exists, the number of foreign tourists in Romania can be increased, especially as Europe remains at the top of holiday destinations.

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THE INFLUENCE OF THE CAR INDUSTRY INNOVATIONS TO THE REDUCTION OF AIR POLLUTION

Verica Jovanović[1], *Pavle Radanov*[2]

Abstract

In this paper we will analyze the effects of increasing and numerous innovative solutions in the car industry to the air pollution reduction. For the subject of this paper, we have chosen the characteristics of several main trends that will have a significant impact on the design and direction of vehicle production in the world in the near future. Important factors in improving environmental protection within car production are the growth in the production of electric and hybrid vehicles, technological improvements made to conventional vehicles and shared driving. The research was carried out by a comparison method; we have compared the results from several relevant scientific studies, which are often contradictory about the importance that the observed changes in the car industry will have on reducing air pollution. The basic conclusions drawn from the research are that the implementation of innovative solutions to new types of vehicles in the next two decades will definitely reduce the current level of air pollution, but also that it will take a long time for ecological cars to become the majority on the roads.

Key words:*innovation, car industry, air pollution*
JEL classification*: O31, O33*

Introduction

All the countries want to develop ICT sector due to its characteristic of so called cascading effect, i. e. adding the value for both firms in other sectors and for consumers (Grandov & Jovanović, 2017). Technological innovations that have been rapidly conquering all spheres of human activity in the last years are particularly obvious in the car industry. Vehicle production today is experiencing almost revolutionary changes, and cars are turning more and more from conventional transport vehicles

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into computers on wheels. Large companies, such as Google, Intel, Apple and others are involved in the development of new innovations that speed up the cars' performances. Therefore, cars today represent the largest innovation platforms (Illonin, 2018). Autonomous vehicles, mobile connectivity, electric vehicles and shared driving (CAR, 2017) are the most affected by the innovative solutions and they have already received a special common name ACES (autonomous, connectivity, electricity, share).

The reasons that put car industry at the top of the innovative activities are multiple and one of them is certainly the more serious legal obligation to reduce emissions of harmful gases, mostly emanated by car and truck engines with internal combustion. Therefore, the main goal of this paper will be to find the answer to the question whether new revolutionary solutions, which design the vehicles we have known so far in a completely different way, can significantly contribute to the much cleaner air in the urban environment.

Car pollution

Many studies confirm that air pollution is one of the most common causes of health problems (Radanov, 2016). Cars were recognized as the source of pollution long time ago, and the first standards for new car emissions were established in California in the 1960s (Johnson, 1988, p.40). Legislation has been further aggravated, but the car industry is still considered one of the largest air pollutants. According to the World Health Organization's (WHO) study, 9 out of 10 people in the world today live in cities with polluted air. Such a condition causes more than 7 million deaths a year. The highest percentage of deaths caused by air pollution is in developing countries located in the Southeast Asia and the Western Pacific region, but it has also been found that in European Union cities with a pollution rate below the prescribed lifetime is 8.6 months shorter, due to exposure to harmful substances from the air (WHO/EU Commission, 2013).

Even though it is difficult to determine the percentage of the car engines pollutants and those from other sources, it is considered that the share of car industry in total pollution, especially in densely populated areas, is between 50% and 90% (Megan, 2010). Cars and trucks have indisputable negative effect on the air. The pollution caused by vehicles is divided into primary and secondary. Primary pollution is emitted directly into the

atmosphere, while secondary is created by subsequent chemical reactions between harmful substances in the atmosphere. The main pollutants resulting from combustion of fuel in vehicles are: Particulate matter (PM), Hydrocarbons (HC), Carbon monoxide (CO), Hazardous air pollutants (toxics) and Greenhouse gases.

PM particles are the most harmful for health, and their main components are sulphates, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. Particularly dangerous are the smallest PM particles, which are smaller than one tenth of the diameter of human hair (PM 2.5). They can get deep into the respiratory organs causing them to swell and enter the blood system. Long exposure to these particles leads to diseases of the cardiovascular system and lung cancer.

Secondary air pollution is caused by hydrocarbons reacting with nitrogen dioxide emitted by cars, and in the presence of sunlight it is created triplet oxygen – ozone, which is the basic component of smog. Although the ozone layer is useful as a protective layer of the atmosphere, its presence in the lower layers is dangerous, because it irritates the respiratory system and causes a decrease in lung capacity (Union of Concerned Scientists, 2013). Carbon monoxide is a poisonous gas created during combustion of fossil fuels; it is mostly created due to the combustion of fuel in the cars and trucks engines. The negative effects of inhalation of this gas has been proven long time ago and it is manifested by oxygen blocking in the brain, heart and other organs in the body.

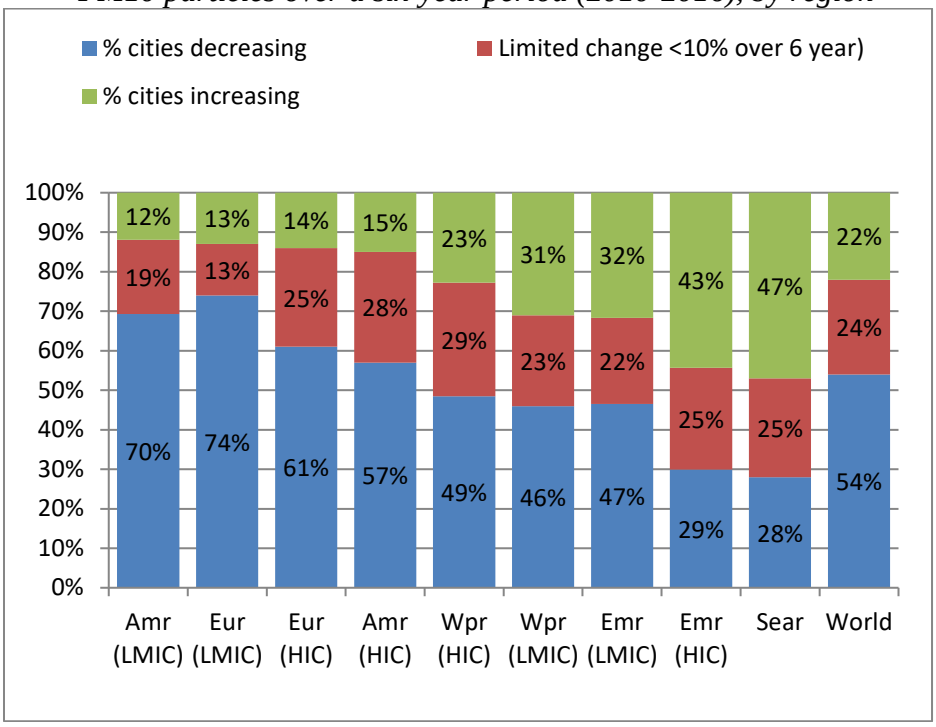
Alongside of carbon monoxide, motor vehicles, in the fuel combustion process, also cause the creation of sulphur dioxide in the air, which is particularly harmful for small children and asthmatics (Washington State Department of Ecology).

A particular danger is hazardous air pollutant, toxic substances, such as benzene, acetaldehyde and butadiene, which are considered the cause of half of all cancers resulting from air pollution. The emission of these particles, as well as particles of carbon monoxide, increases with vehicle age and mileage (Wenzel et al., 2017).In addition to the mentioned substances, motor vehicles produce carbon dioxide, which contributes most to the greenhouse effect, and thus also increases the warming and climate change.

PM particles are the main indicator that WHO uses for measuring air pollution and they can seriously endanger people's health. Guideline values for particulate matter are 20 μg/m3 for PM10 and 10 μg/m3 for PM2.5. However, even though there are guidelines for allowed level of these particles, it has to be said that every concentration, even the smallest, of PM particles is harmful to health.

The importance of clean air for human health and the environment is recognized all over the world (Radanov & Brzaković, 2017) and the standards of the allowed emission level of harmful particles are constantly becoming more strict. Nevertheless, the overall level of air pollution in cities in the world continues to grow. The latest WHO study (indicators for PM10 and PM are 2.5), during which it was monitored air pollution in 795 cities from 67 countries over a period of 5 years or more, showed that the pollution level globally increased by 8%. Some regions, such as America and Europe, recorded a reduction in pollution, but the increase in Southeast Asia and in the low-developed and moderately developed countries of the Western Pacific was quite high, so the overall picture of the percentage of air pollution is negative.

Figure 1: *Percentage of cities with increasing and decreasing PM2.5 or PM10 particles over a six-year period (2010-2016), by region*



Source: WHO's Urban Ambient Air Pollution database – Update 2016, version 0.2, Amr: America; Emr: Eastern Mediterranean; Eur: Europe; Sear: South-East Asia, Wpr: Western Pacific; LMI: Low and middle-income; HI: high-income.

Air pollution is affecting the quality of life, but also has a large negative impact on the economies of different countries due to the high costs of treating the patients and their premature mortality. It is encouraging that many cities are trying to improve air quality. Thus, according to WHO records, in the period from 2012 to 2016 more than half of the monitored cities in highly developed countries and more than one third in low and middle-developed countries have reduced the level of air pollution by more than 5%.

Car industry today

Car industry is a business that has had for over a century, since the first mass production of the famous Ford's model T, a great impact on the

economic development of many, especially economically developed countries. The contribution of this industry in the gross domestic product of high-income countries is up to 6.8%, which is the percentage of this sector's share in the European Union's economy (ACEA, 2016). In the countries of intensive development, this contribution is even higher and constantly increasing. It is estimated that in the next decade in India the share of car industry in total GDP will reach 12%, which will represent almost a quarter of the total industrial production in this country (Pawan & Goenka, 2016).

According to World Top Export figures, the car industry has made a major contribution to the international trade in 2016, when took over the title of the world's largest exporter from oil industry, earning $ 698.2 billion in revenue (Workman, 2018). In addition, more than 50 million people are directly and indirectly employed in the car industry around the world (OICA, 2006). Despite the increasing automation of factories, the number of employees will continue to increase due to the steady increase of production. But, gender diversity in top management structure in automotive industry is still a problem. (Grandov & Jovanović, 2016). So far, Mary Barra in General Motors is the first and so far only female car chief.

Every country feels benefits from the car industry, because large amounts of money are levied in their budget from various taxes paid by vehicle owners. These revenues include fees on import of cars, taxes for sales of vehicles, excise taxes and taxes on fuels, as well as various fees for registration and vehicle insurance. The amount of fiscal revenue from car industry of each country is on average estimated at around 13% (Creger et al., 2012).

The car industry is a highly concentrated industry, both regarding the number of manufacturers and the size of market for the sale of vehicles. The top twenty biggest car companies have more than 50% of market share, and for years the revenue generated by the 15 largest car companies has exceeded the cumulative amount of gross domestic product of two-thirds of the world's countries. According to the Forbes list of 2000 largest companies, the revenue earned by the fifteen largest carmakers in 2017 was $ 1,820 billion, profits was $ 83.9 billion and the market value was just over $ 750 billion (Table 2).

Table 2: *Main business results of 15 biggest car companies in 2017*

	Company	Sales revenue	Profit	Value of assets	Market value
1	Toyota Motors	249.9	17.1	412.5	171.9
2	Daimler	169.5	9.4	256.3	76.1
3	Volkswagen Group	240.3	5.7	458.7	72.9
4	General Motors	166.4	9.4	221.7	50.8
5	BMW Group	104.2	7.6	210.3	57.7
6	Ford Motors	151.8	4.6	238	44.7
7	Honda Motors	127.9	3.9	161.8	51.4
8	Nisan Motors	105.9	4.5	157.3	38.4
9	Hyundai Motors	80.7	4.7	148.1	34.2
10	SAIK Motors	112.7	4.8	85	43.5
11	Reno	56.7	3.8	107.7	24.6
12	Fiat Kreisler	122.8	2	110.1	15.5
13	Peugeot	59.8	1.9	48.2	16.9
14	Tata motors	41.2	1.7	39.5	24.9
15	Subaru	29.8	2.8	22.7	27.3

Source:
https://www.forbes.com/global2000/list/#industry:Auto%20%26% 20 Truck%20Manufacture, Accessed on May 4th, 2018

Geographic market concentration is even more pronounced, so China and the United States represent countries that sell more than 48% of all vehicles (Focus 2 move) – Table 3.

Table 3: *World car market - Top 15 Countries in 2017*

Rank 2017	Country	Sale 2017	Sale 2016	Variation 2017%	Share 2017%.
1	China	28,271,791	27,649,428	2.3	30.2
2	USA	17,237,702	17,558,919	-1.8	18.4
3	Japan	5,090,408	4,827,456	5.4	5.4
4	Germany	3,700,758	3,556,264	4.1	4.0
5	India	3,223,429	2,964,282	8.7	3.4
6	UK	2,903,058	3,065,537	-5.4	3.1
7	France	2,541,321	2,422,685	4.9	2.7
8	Brazil	2,172,452	1,990,188	9.2	2.3
9	Italy	2,140,248	1,963,422	9.0	2.3
10	Canada	2,043,615	1,951,658	4.7	2.2
11	South Korea	1,748,399	1,834,784	-2.7	1.9
12	Russia	1,595,667	1,425,791	11.9	1.7
13	Iran	1,553,330	1,347,102	15.3	1.7
14	Mexico	153,624	1,604,148	-4.6	1.6
15	Spain	142,671	1,304,329	8.9	1.5

Source: *Focus 2 move, World car market, Top 100 countries ranking in 2017, available on https://focus2move.com/world-car-market/, Accessed on May 3rd, 2018*

From the first mass production at the beginning of the last century to the present day, the number of cars sold at the global level has steadily grown. This growth was particularly pronounced after 2000, when production, excluding a slight decrease in 2008 and 2009, totalled around 60% (Statistic, 2017). The volume of sold passenger and light vehicles today, although slightly varying depending on the coverage of countries whose production is monitored statistically, already exceeds the figure of 90 million annually. Considering that the average lifetime of cars is about fifteen years, it is estimated that more than 1.5 billion vehicles are currently on the world's roads (Smith, 2016). Most of these four-wheelers are vehicles fuelled by petrol and diesel and represent a real danger to the environment

Analysis of the car innovations' contributions to the air pollution

Innovations in the car industry happen so fast, which has recently been almost impossible to imagine. The future ahead brings us even more significant changes and the main technologies that will further alter the world of cars we now know are: autonomous driving, mobile connectivity, electric vehicles and shared driving. In line with the increased demands for more efficient environmental aspects, these new technologies are expected to significantly reduce the current level of negative effects of the car industry. In order to find the answer to the question of whether and to what extent innovations can contribute to cleaner air in cities, this paper analyzes the results of several studies of renowned research organizations related to the car industry. These are studies conducted by IHS Markit, the United States Department of Energy(DOE), EIA and Accenture Mobility, as well as a joint study of the University of Michigan and Ford. In addition, in order to prove or refuse the conclusions, there were analyzed the results of several other scientific papers regarding the issue of the influence of new innovative technologies in the car industry on the reduction of air pollution.

When it comes to autonomous driving, it should be pointed out that some of its innovative forms have already become an integral part of the new car model range. Vehicles with systems for auto-brakes functions, automatic parking, driving control based on road conditions, automatic accident avoidance, etc. are already available to customers. Also, some cars have an automatic steering wheel, electric parking brakes, electronic regulation and engine control (Jovanović & Radanov, 2017, p. 217). However, the main goal is a completely autonomous and completely safe ride without a driver. The leading car companies are fighting who will be the first to offer a completely autonomous and fully secure car to the market (Rowell, 2017). Almost all major car manufacturers are involved in this race, but also leading technologic companies that independently, or in cooperation with car makers, are developing advanced autonomous driving software. Leaders in the development of autonomous driving are Tesla, Mercedes, BMW, General Motors, Volvo, Nisan and Toyota, but also Uber, Google, Apple and others. They are already heavily testing their pilot versions for a completely autonomous ride. Even though most of the average people today are scared of autonomous drive (Sapienza, 2018), it will soon become a reality. According to Business Insider research, the younger generation, ages 18 to 29, is particularly interested in this type of vehicle (Elner & Galsher, 2017).

For this paper the important question is: can autonomous driving contribute to the reducing of air pollution? There are numerous studies proving the positive impact of autonomous driving on the environment. Nevertheless, most of them point to the fact that this effect has a number of negative consequences, which, if autonomous driving is not implemented strategically, can even aggravate environmental pollution. According to the study conducted jointly by the University of Michigan and Ford, the main factor that can endanger the positive effect of autonomous driving is the increase in vehicle weight caused by the installation of software and other technical aids (navigation systems, camera, sensors), as well as increased fuel consumption in the process of creating a mapping system. Autonomous vehicles have been found to increase the emissions of greenhouse gases by 20% in relation to standard vehicles (Clerkin & Bridget, 2018) due to the installation of this equipment. The increase in the weight of the car happens mostly because of the computer software (45%), which has a share in the total increase in the emissions of harmful gases of 43%.

Other studies also highlight controversies about autonomous driving. A study conducted by the US Department of Energy (DOE) in 2016 showed that self-driving vehicles can reduce emissions by 90% or increase by 200%, depending on how technologically and politically they are monitored. According to this study, the greatest danger is the significant increase in mileage due to the greater accessibility of autonomous vehicles. In a survey conducted in five different laboratories of the Department of Energy, it has been estimated that some, according to the general criteria, significantly positive characteristics of this type of driving can increase air pollution. This primarily relates to the fact that autonomous driving allows independent travel to cars and to many people with disabilities who would otherwise not be able to drive. Also, there is a realistic estimate that many people, because they would not be burdened by long-term driving, would want to move to the suburbs, which will significantly increase the mileage that cars will cross and thus pollution. Some analyzes even prove that many employees working in city centres, where the parking lots are expensive and inaccessible, choose to send their vehicles to circulate around the city blocks while they are at work, because this will represent a lower cost in their budget (Worland & Justin, 2018).

However, the same study has proven that better planned and more efficient roads, regulated by embedded computers, make a significant contribution to reducing overall fuel consumption. Embedded systems, in particular those related to mobile connectivity, can identify and avoid sites of traffic jam, which can significantly reduce pollution. Also, autonomous vehicles will be the base of the car fleet for shared driving, which will indirectly contribute to reducing the total number of vehicles on the roads. The ultimate conclusion is that autonomous driving, with the widespread use of shared driving, can lead to reduced consumption of net energy and greenhouse gas emissions up to 9% (Clerkin, 2018). In the case that there is majority of autonomous vehicles on the road that communicate with one another, driving can be even more economical and then the reduction in gases emissions would be about 14% (2016).

An important conclusion from the aforementioned study conducted by the University of Michigan and Ford is that the choice of fuel to be used in autonomous driving is the most important factor in reducing emissions of harmful particles. Experimentally, Ford's vehicles have proven that the choice of electric power instead of gasoline engine reduces greenhouse gases from 20% to 80%, depending on which type of energy is used for the production of electricity (Reichmut & David, 2018). For this reason, more and more companies are using electric vehicles to develop their autonomous driving models.

Mobile connectivity is an innovative technology that will largely determine the future of demand for cars. It is believed that customers in the near future will not choose a car according to its technical characteristics, but by mobile performances that will provide them with the same or better opportunities they already have on their other mobile devices. In addition, car connectivity plays a major role in the functioning of other important innovative technologies in the car industry, above all in the autonomous and shared driving. Without a high level of IT connection, it would not be possible to achieve essential autonomous driving functions that contribute to the air pollution reducing. Since this connection is becoming more important end evident, connectivity and automation are expressed in the car industry with the common name – Connected and Automated Vehicles (CAV). CAV technology implies a certain level of vehicle equipping with a unified system of cameras and sensors (e.g. radar, LiDAR and sonar), communication technologies (e.g. 5.9 gigahertz short-range radio), automotive technology (e.g., drive-by-wire systems), controllers and advanced information capabilities (e.g.

neural networks, machine learning and artificial intelligence) – (EIA, 2017).

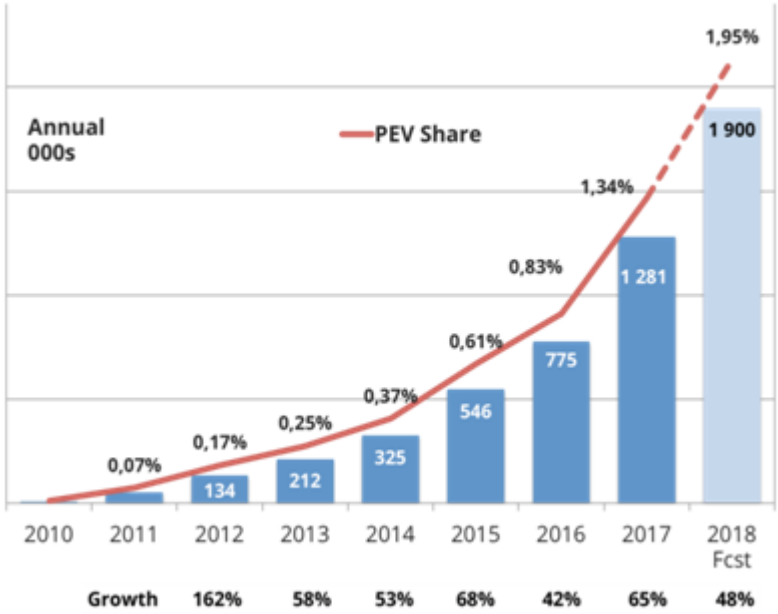
This technology of autonomous driving can significantly and positively affect air pollution reduction. According to the IHIS Markit's study, the vehicle's connection allows autopilots to predict speed changes in traffic, as well as to communicate with the infrastructure, such as traffic signs, to reduce idling and unnecessary vehicle stopping. Similar results were found in the EIA's study: the positive effects of CAV on reducing fuel consumption are manifested through: 1) vehicle light weighting and rightsizing, 2) power train electrification, 3) platooning, and 4) eco-driving (EIA, 2018).

Unlike autonomous driving that can have both positive and negative consequences for polluted air, shared ride can certainly bring many benefits to the environment. The key reason for this is the fact that more people drive one car, so the number of vehicles on the roads will be smaller. This technology has already been widely accepted in the major cities of the developed countries and its implementation is dominated by Uber, whose number of users reached the level of 75 million users per month at the end of 2017 (Buhyan & Joana, 2018). Companies that provide their customers with shared-use services are mainly located in densely populated urban areas where infrastructure has the conditions for mobile connectivity, making use of self-driving vehicles much easier and more efficient. This can additionally help harmful emissions, but under the condition that self-driving vehicles used in shared driving use cleaner energy.

For this reason, the final part of this paper includes an analysis of the growth in production and sales of vehicles that do not run on oil and gasoline, but use electric and hybrid engines.

Statically, the share of plug-in vehicles in the total sales volume in the world now stands at just slightly more than 1.34%. However, according to EVS data, the market for these vehicles is growing rapidly, so it is estimated that by 2027 it will represent half of all new vehicles. This forecast is based on data on sales of these vehicles in the period from 2010 to 2017 (Figure 2).

Figure 2: *Global Plug-In Vehicle Sale & Share*



Source: *EV volumes.com: Global Plug-in Vehicle Sales for 2017 – Final Results, available at: http://www.ev-volumes.com/country/total-world-plug-in-vehicle-volumes/* (March 5th, 2018)

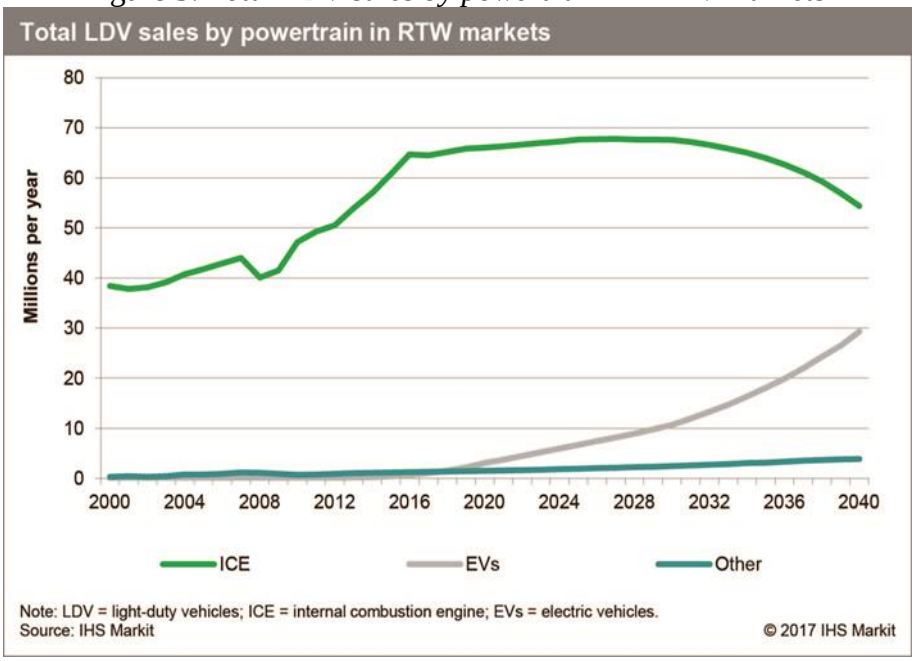
For this analysis, particularly interesting is the period from 2014 to 2017, when the growth in sales of plug-in vehicles quadrupled. Namely, in 2014, there were only 325,000 vehicles and in 2017 there were 1.28 million cars sold, which is four times more. Considering that at the end of 2017 the total number of plug-in vehicles was 3.2 million, if the forecast of 1,900 new units in 2018 comes true, then their number would be 5 million. This is an increase of almost 600% compared to 2014.

Optimistic forecasts of the ever-accelerating growth of electric and hybrid vehicles are supported by data that the number of public locations for their charging has doubled in the last two years, and that battery costs have decreased by 50% compared to three years earlier. Important decisions are also made by the governments of certain countries regarding the prohibition of the production of diesel-powered vehicles, as well as the incentives for the production of zero-emission vehicles.

However, not everyone share this optimistic view on the accelerated disappearance of conventional vehicles on the world's roads. According

to the study made by Reinventing the Wheel, a market share of cars running on gasoline and diesel in 2040 will be 62%, but this percentage also includes partial and fully hybrid vehicles that are still based on internal combustion engines. Cars that use purely gasoline and diesel will fall to a fraction below 50% by 2031 (Figure 3), which is four years later than Electric Volume predicted.

Figure 3: *Total LDV sales by powertranin in RTV markets*



Source: *IHS Markit, https://ihsmarkit.com/products/reinventing-wheel-multiclient-study.html, accessedon April 14th, 2018.*

Differences come from the approach on which the assessment was based. Namely, the Electric Volume data are based on mathematical projections of trends and the assumption that new technologies are adopted not in a linear model, but that they follow the shape of the S curve. For this reason, this company is expecting a significant leap in sales of electric vehicles in the years to come. On the other hand, the IHS Markit's study included the influence of the broader environmental factors and the effects that new technologies have on other industries. Reasons of slower withdrawal of petrol vehicles are the oil monopole, as well as the high costs of batteries, whose reduction is expected only around 2030, which coincides with the estimated growth period of electric vehicles. In addition, under the pressure of state regulations, but also because of the

growing customer expectations for the vehicles to become more economical, conventional vehicles will have to reduce their emissions of harmful gases in the years to come, which will help to reduce air pollution altogether.

Conclusion

The analysis made in the paper aimed to determine the impact that four key innovation technologies, which are rapidly transforming the car industry, will have to the reduction of air pollution. A research conducted by the case study methodology included the analysis of the results of several major studies regarding the impact of autonomous driving, mobile car connectivity and the growth of electric vehicle production and shared driving. The general conclusion is that these technologies, when relying on one another, can significantly contribute to the air pollution reduction, but this depends on the way and the dynamics customers will be able to accept it. Several studies have shown that the younger generations, aged 18 to 29, are much more inclined towards autonomous and shared driving, so it is therefore expected that the use of these technologies will grow rapidly with new generations.

On the other hand, the number of vehicles with gasoline and diesel engines around the world is currently 1.5 billion, so it will definitely take a long time to replace them with more environmentally friendly models. Whether this will happen in 10 years, as the results of some research studies show, or in 30 years, as other researchers convince us, is still unclear. The fact is that the next few years will represent a real innovative revolution in the car industry and that the trends than will be much clearer about the future of further movements. It is important to point out that this car revolution will not show its full capacity, if governments do not actively direct their national policies toward more strict regulations on car gas emissions and greater incentives for production and purchase of cleaner vehicles.

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GOALS OF SUSTAINABLE DEVELOPMENT

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Abstract

This paper presents the concept of sustainability and sustainable development, citing and analyzing 17 goals of sustainable development. Sustainability is a process characteristic or a state that can be maintained at a certain level without limitation period, whose efforts are to create and maintain the conditions under which people and nature can exist in a productive harmony to support current and future generations. Sustainable development promotes economic growth, environmental sustainability and social development in a developed and developing world.Sustainable development emphasizes the need to achieve further economic growth in an environmentally sound manner, given that former patterns of economic development have serious implications for the global environment. The aim of the paper is to demonstrate on a scientific basis that, in order to achieve sustainable development, it is necessary to create a sustainable and more economical economy that respects the ecological principles and the natural environment and to achieve sustainable development goals that recognize that extreme poverty must go hand in hand with strategies that increase economic growth and address a range of social needs, including education, health, social protection and employment opportunities, while fighting against climate change and for environmental protection.

Key words: *sustainability, sustainable development, sustainable development goals, green economy, environmental protection.*
JEL classification: Q01

Introduction

Adequate and timely response in terms of permanent changes is essential for the survival of any company (Gavrić et al., 2017). In this sense, the

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concept of sustainable development is especially important for the business of today's organizations (Maksimović et al., 2017). One of the basic concepts of economics of natural resources and the environment is the concept of sustainability or sustainable development. Despite the various interpretations that can be found in the literature, this concept today has a central place in the consideration of the long-term perspectives of the survival and progress of mankind (Gašić & Ivanović, 2018).

Sustainability or sustainable development appears as an essential prerequisite, and as the ultimate goal of effectiveorganization of numerous human activities on Earth.The concept of sustainability has become significant in making decisions at different levels of society, considering that we are facing environmental problems such as climate change and loss of biodiversity, but also problems such as poverty, health, etc. (Finnveden & Gunnarsson-Östling, 2016). In times of crisis it is important to provide timely information in order to overcome the given situation and to establish main function of the sustainable development system.

The word "sustainable" was derived from the Latin term "sustenere", which means "keep upright" (Daly, 1996). In English, this word (sustainable) has been used since 1290, but the etymological significance of the word itself is related to interesting, as much as importantimplicationsrelated to its use.According to De Vries, "maintaining" can mean "supporting the desired state of something," but also "to stand an unwanted condition" (De Vries, 1989; Milutinović, 2012). The verb "maintain" carries with it the connotation of the passive, unlike the adjective "sustainable", which implies the active connotation. "Sustainability" is a term that emerged within the ecology, signifying the ecosystem's ability to maintain a certain population over time, so that only later, by adding the context of "development" and forming the syntagm "sustainable development", the focus of environmental analysis is transferred to society.

The word ‘sustainable’ implies a steady state dynamic and limitations which, it is argued, supports environmental ideals, while the term ‘development’ implies growth which supports those who believe technology can solve all problems (Weaver & Lawton, 1999; McDonald, 2006). Grant (1999) believes there needs to be a separation between the

terms ‘development’ and ‘growth’ in the whole sustainability debate. The term ‘growing’ is deemed as a quantitative change whereas development relates to a qualitative change in a system (Grant, 1999; McDonald, 2006).

Sustainability is based on a simple principle: All we need for survival and prosperity depends, either directly or indirectly, on our natural environment (Madžgalj et al., 2018). Sustainable development is impossible without social justice - there is no growth without good management of natural resources, of which our economy lives (Ivanović & Madžgalj, 2018). Sustainability effort is to create and maintain conditions under which humans and nature can exist in productive harmony to support current and future generations (Ivanović et al., 2015).

Economic Commission for Latin America and the Caribbean (*ECLAC*, 2001), claims “what is sustained, or has to be made sustainable, is the process of improvement of the human condition (or better, of the socio-ecological system to which humans pertain), a process that does not necessarily require indefinite growth in the consumption of energy and materials.”

The history of the sustainable development concept is closely related to the changing perceptions of environmental intervention, preservation of natureand development during the last century. Due to climate and technological changes that have led to problems, society is facing the need for radical changes as a result of increasing technological progress and increasing environmental impacts. Therefore, environmental issues need to be systematically addressed in order to find harmony between all subsystems of the economy. Sustainable economic development requires the provision of economic growth and development in terms of environmental protection by providing a bridge between sustainable economic growth, improving human health, social justice, employment and environmental protection.

Understanding of sustainable development has changed over time due to the evolution of ecological and developmental studies that culminate in widespread recognition that economic and social development must be achieved in an environmentally sound manner.

Agger & Jelsoe (2010) further argue that sustainable development is unthinkable without ethics as it is clear in this quotation: “without ethics, the demand for sustainable development becomes an unfounded claim. And although there often are arguments for a sustainable development without mentioning ethics, it will stay as a tacit precondition, attracting meaning to the argumentation from the beginning to the end.” Sustainable development is an ethical idea based on four ideas. Apart from meeting the needs of the poor and future generation and the maintenance of natural resources and nature, it should strive for social fairness by working for a fair distribution of resources within global population (social fairness), revitalize economic growth by producing more with less, fighting poverty and environmental degradation (sustainable economy) (Noubissié, 2014).

Sustainable development concept is sometimes described as a political project aimed at developing an integrated decision-making process, which is capable of balancing economic and social needs of the people with the regenerative capacity of the environment .They argue that the problem with sustainable development lie in the fact that it is sometimes understood as system stability and as part of the dynamics of nature and society, by analyzing how stability can be connected to development in its varied forms in space and time. It requires that we understand that the world develops at many different levels and rhythms and humans understand nature functions only within timescale and develop strategies to adapt themselves to their environment. In this regard therefore, sustainable development offers “a relevant framing of the debate on broad and farsighted issues. It is a normative way to organize politics at a higher level, a frame or strategy, a planning of planning that helps us to organize our comprehension of complex systems across scales of time and space” (Agger & Jelsoe, 2010; Noubissié, 2014).

Concept and definition of sustainability

The basic significance of sustainability is the possibility of something extending more - less infinitely in the future. Sustainability is, therefore, a process characteristic or a state that can be maintained at a certain level without limitation of time (Milutinović, 2012).

Sustainability can be (Vukićević & Milošević, 2012): Poor sustainability and Strong sustainability. *Poor sustainability*, sustainable is the growth that will, sooner or later, lead to the final exhaustion of non-renewable

resources, but their transformation into other forms of capital, primarily in human capital (knowledge), will enable further, sustainable growth to continue through efficient exploitation of renewable resources.Poor sustainability suggests that general welfare can not be diminished, which means that for example, any use of natural resources is not wrong if it works well for people. *Strong sustainability* on the other hand implies marginal levels of some forms of capital (physical, human, social and natural) that are stored in the physical sense, so that growth can not be achieved at the cost of exhausting non-renewable resources.. Strong sustainability separates resources that are naturally created from those created by the human hand. This means that natural resources are limited and, if man transforms them, their value can not be reused.

In addition to the previous points of view, sustainability can be viewed from other perspectives (Mladenović, 2017) such as:

- A technocentric view is similar to strong sustainability. According to this view, natural resources can be extracted without special restrictions, people are superior to nature, the economy is isolated in relation to nature and encourages global growth.
- The ecocentric view is more similar to its poor sustainability. The values of this view point the earth as lively, fragile and sensitive to human actions, where the human population has already reached its maximum.
- Sustainable-centric view attempts to reconcile the previous two. Its basic characteristics are that the earth and people are connected in one system, the population has to be stabilized, the economy and the ecological system are supported.

Concept of sustainable development

The blossoming of the concept of sustainable development and its emergence as a new paradigm of development can be explained by the growth of international studies on environmental protection and development in the mid-20th century (Elliott, 2008; Harrington, 2013).

Sustainable Development first appeared in the Environmental Strategy, presented by the International Union for Conservation of Nature (IUCN) in 1980, where economic growth was seen as an enemy of the environment (Stern et al., 2017). However, the emphasis on sustainable development is the Brundtland Report (WCED, 1987) in which

sustainable development is defined as "a development that meets the needs of the present generation while allowing future generations to meet their needs." Since then, the concept of sustainable development has been used in major international agreements, where four recurring principles are considered to be associated with the concept (Sands & Jacqueline, 2012):

1. The principle of intergenerational equity: the need to preserve natural resources for future generations.
2. Sustainable use principle: exploitation of natural resources aimed at long-term availability and taking into account the environmental impact.
3. The principle of capital intergeneration: countries should use natural resources according to the needs of other countries.
4. Principle of integration: development plans and projects should integrate environmental issues.

One aspect of the Brundtland report was the use of a sustainable development concept that would call into question a development model based on a high rate of resource reduction for the continuation of economic growth. However, he also supported rapid economic growth, resulting in an ambiguity that allowed governments, corporations and organizations to have different interpretations of the concept. Therefore, sustainable development is also called environmental protection, social equity and economic growth as an equal sphere, or - depending on interest. Thus, the concept of sustainable development and sustainability is used to describe many types of policies from the expansion of the coal industry to the protection of natural areas (eco-union, MIO-ECSDE, GEC, 2016).

In the past few years, economists have made progress in articulating the concept of sustainable development. Of crucial importance is the fact that scientists synthesized sustainable development on three pillars; economic development, social equity and environmental protection (United Nations, 2007; Oladeji, 2014; Ekperiware et al., 2017).

From Brundtland's definition of sustainable development, Figueroa et al. (2010) argue that this idea is based on two main ideas: to give priority to the needs of the world's poor and to limit the ability of the environment to meet current and future needs. That definition is comprised of two key concepts (World Commission on Environment and Development, 1987):

- The concept of "needs", especially the essential needs of the poor in the world, which should be given the overriding priority;
- The concept of "idea" of constraints that state and technology put on the ability of the environment to meet current and future needs.

But despite the universal approval of the WCED definition of sustainability, opinions still diverge on how this goal can be attained. One of the first attempts in economics was the *systems approach*, which characterizes sustainability as the maximization of goals across environmental, economic and social systems (Barbier 1987; Barbier & Markandya, 2012; Costanza et al., 2016; Ekins, 1994; Elliott, 2006; Holmberg & Sandbrook, 1992; Pezzey & Toman, 2002; Barbier & Burgess, 2017). This approach is attributed to Barbier (1987), who first identifies three systems as basic to any process of development: the environmental or ecological system, the economic system and the social system. He then argues that "the general objective of sustainable economic development, then, is to maximize the goals all these systems through an adaptive process of trade-offs" (Barbier, 1987; Barbier & Burgess, 2017).

There are various interpretations of sustainable development. The most popular describes this term on the basis of three basic components - economic, social and environmental component - which form the basis of sustainable development (Crespo et al., 2017).

There are different definitions aimed at describing "sustainable development", some of which are shown in Table 1.

Table 1: *Overview of Sustainable Development Definitions*

Author, source	Definition
Our Common Future, Report of the World Commission on Environment and Development, 1987)	"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
UNESCO, 2005	„A vision of development that encompasses populations, animal and plant species, ecosystems,

	natural resources – water, air, energy – and that integrates concerns such as the fight against poverty, gender equality, human rights, education for all, health, human security, intercultural dialogue, etc.
Pawłowski, 2006	"Programme integrating various aspects (moral, ecological,technical, economic, legal, social and political) of human activity based on a moral reflection referring to man's responsibility for nature"
Stappen, R. K., 2008	"Development that meets the basic needs of all human beings and which conserve, protect and restore the health and integrity of the Earth's ecosystem, without compromising the ability of future generations to meet their own needs and without going over the limits of long term capacity of the earth´s ecosystem"
Forum for the future (2011)	"A dynamic process which enables all people to realize their potential and improve their quality of life in ways which simultaneously protect and enhance the Earth's life support systems"
Battaglia et al, 2010	"Development that looks at the long-term perspectives of the socio-economic system, to ensure that improvements that occur in the short term will not be detrimental to the future status or development potential of the system, ie development will be "sustainable" to the environment, social, financial and other bases."
DECLG, 2012	"Sustainable development' can be defined as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs.' Sustainable development is characterised as a continuous, guided process of economic, environmental and social change aimed at promoting wellbeing of citizens now and into the future. To realise development of this nature requires creating a sustainable and resourceefficient economy

	founded on a fair and just society, which respects the ecological limits and carrying capacity of the natural environment.”

It can be said that the basic focus of sustainable development is the society and its need to include environmental concerns in the consideration of social changes, primarily through changes related to economic functions (Baker, 2006).

Depending on the ways it is looked at, sustainable development may have many meanings (Leal Filho, 2011), such as:

- the systematic, long-term use of natural resources — as defined in the
  Brundtland Report — so that these are available for future generations (herethe concept refers to country and local policies);
- the modality of development that enable countries to progress, economically and socially, without destroying their environmental resources (with reference to country policies);
- a development which is socially just, ethically acceptable, morally fair and economically sound (referring to the social ramifications of development);
- a development where environmental indicators are as important as economic indicators (here referring to the close links it bears with economic growth).

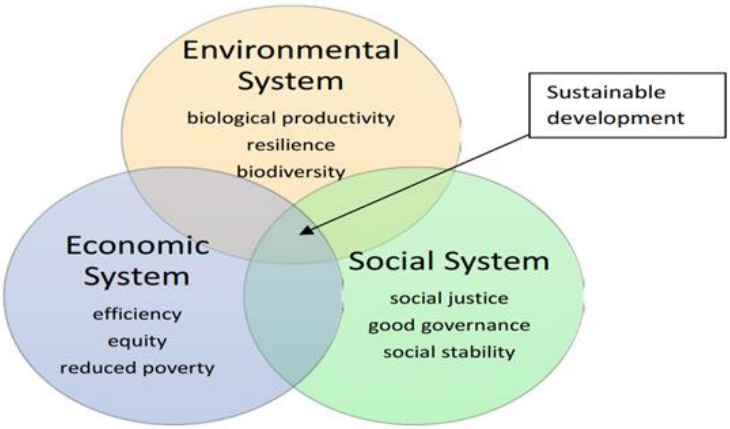
The definition of sustainable development is a normative concept that includes behavioral standards to be respected if the human community seeks to meet its own survival and well-being needs. The definition includes three basic components - economic, social and environmental component - which form the basis of sustainable development. There has been a growing recognition of three principal aspects of the sustainable development concept (Harris et al., 2001; Harris, 2003):

- economic: an economically sustainable system should be able to deliver goods and services on a continuing basis, to maintain manageable levels of government and external debt, and to avoid extreme sectoral imbalances,
- environmental: an environmentally sustainable system ought to maintain a stable resource background, avoiding over-exploitation of renewable resource or environmental sink functions, and

depleting non-renewable resources only to the extent that investment is made in adequate substitutes,

- social: a socially sustainable system should achieve fairness in distribution and opportunity, adequate provision of social services including: health, education, gender equity, political accountability and participation.

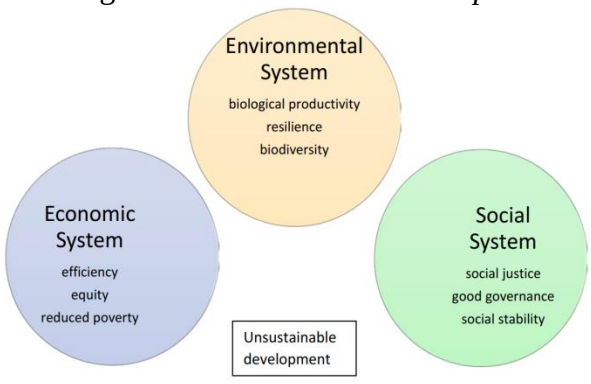
Figure 1: *Sustainable Development*



Source: *Barbier & Burgess, 2017.*

Sustainable development is based on three pillars: economic development, environmental protection and social development. Unlike Figure 1, which shows sustainable development, Figure 2 shows unsustainable development.

Figure 2: *Unsustainable development*



Source: *Barbier & Burgess, 2017.*

From the previous picture, it can be seen that the attempt to maximize the goals of only one system does not achieve sustainability, as the impacts on other systems are ignored. For example, achieving greater efficiency, equity and reduced poverty in economic systems can still cause unwanted environmental and social impacts that undermine ecological and social systems. The approach to development in Figure 3 does not recognize that environmental, economic and social systems are interconnected, and that progress that is only focused on the goals of a system could have implications for other systems (Barbier & Burgess, 2017).

The goals of sustainable development

The Sustainable Development Goals (SDGs) of the "2030 Agenda for Sustainable Development" are a United Nations initiative that builds on the partially achieved Millennium Development Goals (MDGs). While the 2012 Rio+20 Summit embraced the concept of Green Economy as one of the important tools to achieve sustainable development, it also agreed that specifc goals and targets for all countries should be developed in order to achieve Sustainable Development (eco-union, MIO-ECSDE, GEC, 2016).

On 25 September 2015, the entire UN General Assembly adopted the 17 goals and 169 targets that comprise the SDGs to be achieved by 2030. The SDGs "recognize that ending poverty must go hand-in-hand with strategies that build economic growth and addresses a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection." The SDGs are to be achieved by the adoption of Green Economy policies at national level and the active participation of the private sector in supporting Green Economy (eco-union, MIO-ECSDE, GEC, 2016).

17 Sustainable Development Goals (UN, 2015) [*]:

SDG 1 – End poverty in all its forms everywhere

SDG 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG 3 - Ensure healthy lives and promote well-being for all at all ages

SDG 4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 5 - Achieve gender equality and empower all women and girls

SDG 6 - Ensure availability and sustainable management of water and sanitation for all

SDG 7 - Ensure access to affordable, reliable, sustainable and modern energy for all

SDG 8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG 9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

[*] United Nations (UN) (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development.*United Nations, New York, стр. 18. Available at: https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf.

SDG 10 - Reduce inequality within and among countries

SDG 11 – Make cities and human settlements inclusive, safe, resilient and sustainable

SDG 12 - Ensure sustainable consumption and production patterns

SDG 13 - Take urgent action to combat climate change and its impacts

SDG 14 - Conserve and sustainably use the oceans, seas and marine resources for sustainable development

SDG 15 - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

SDG 16 - Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

SDG 17 - Strengthen the means of implementation and revitalize the global partnership for sustainable development

These goals will end poverty and hunger, achieve the human rights of all, achieve gender equality and empower all women and girls and ensure the permanent protection of the planet and its natural resources. They are integrated and indivisible and balanced three dimensions of sustainable development: economic, social and environmental.

On January 1, 2016, officially announced the 17 goals of the sustainable development of Agenda in 2030 officially came into force. Over the next

15 years, these goals will rely on previous MDGs and complete what they have not achieved.

In Agenda 21, one of the activities in the chapter Scientific and Technological Community points to the need for the development and application of information technology in order to increase the dissemination of information for sustainable development.

Conclusion

Sustainable development promotes economic growth, environmental sustainability and social development in a developed and developing world.

As the current dominant paradigm of development, the principles of sustainable development have been adopted around the world and have a significant impact on international agreements and national policies and strategies. Sustainable development highlights the need to achieve further economic growth in an environmentally sound manner, given that former patterns of economic development have serious implications for the global environment.

Sustainable development is the economic development of a region that is implemented without reducing natural resources. The need is to ensure a better quality of life for all, now and in the future, in a fair way within the limits of support for ecosystems.

Sustainable development is the normative outlook of the world, which means it recommends a gathering to which the world should strive. In this normative (or ethical) sense, sustainable development requires a world in which economic progress is widespread; extreme poverty has been eliminated; Social trust is spurred by policies that strengthen the community; and the environment is protected from man-caused degradation. Sustainable development recommends a holistic framework in which society aims at economic, social and environmental goals. Sometimes the following abbreviations are used: sustainable development of calls for socially inclusive and environmentally sustainable economic growth.

Goals of sustainable development represent a unique political commitment while urging the action of all countries to promote prosperity

while protecting the planet. They acknowledge that eradicating poverty is the greatest global challenge and an important condition for sustainable development. To this end, all countries are invited to develop strategies that increase economic growth and address a range of social needs, including education, health, social protection and employment opportunities, while dealing with climate change and environmental protection.

Goals of sustainable development have a non-binding nature, but symbolize an unprecedented opportunity to set the world on a sustainable course and ensure a dignified life for all. Goals of sustainable development are universal and provide a clear political framework for regulatory actions at the national and international levels. It is expected that national governments will establish political plans that are in line with the goals of the Agenda in 2030. In that sense, countries retain a primary duty to monitor and analyze the progress made in implementing the objectives, which will require quality, accessible and timely data collection.

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ECOLOGICAL TENDENCIES AND TRENDS IN TOURISM

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Abstract

The subject of this paper is ecological trends and tendencies in tourism, actually greening the tourism sector, the path of tourism to the transition known as the green economy, which actually refers to the sustainable development of tourism. Tourism is usually seen as a local and regional driver of development, but its growth may involve excessive pressure on the environment or cultural heritage of the destination, changing social and economic conditions, and modifying the quality of life of the local population. Moreover, the negative impacts of tourism could have an impact on the attractiveness and competitiveness of the destination. Consequently, the aim of the paper is to scientifically prove that sustainable forms of tourism are becoming more and more popular for tourism countries that want to develop their tourism in a good way and ensure sustainability in the future, because if we want a sustainable future in which tourism will always be used for the local economy, for improvement rather than damage to the natural environment, for the preservation of ecosystems, then we have to turn to sustainable development of tourism. Increasing the sustainability of tourism enterprises will stimulate industry growth, create better and more jobs, consolidate more investment, contribute to local development and contribute to poverty reduction, and raise awareness and support for the sustainable use of natural resources.

Key words: *ecological innovations in tourism, green economy tourism, sustainable tourism development, sustainable forms of tourism.*
JEL classification: O00, Z32, Q01.

Introduction

Tourism has undergone several changes in the last few decades, which are designated as turbulent. Contemporary literature points to numerous and varied changes, tendencies and trends both on the side of tourist demand

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and on the side of the tourist offer, which have significant impacton the behavior of different subjects in tourism. The impact is primarily on the behavior of companies whose activity is tourism, where hotel companies and travel agencies are especially important and focusing attention.

The subject of this paper is the ecological trends in tourism, namely the greening of the tourism sector, the path to a transition known as the green economy, which relates to the sustainable development of tourism.

Tourism is usually seen as a local and regional driver of development, but if it is not well managed, its growth may involve excessive pressure on the environment or cultural heritage of a destination, changing social and economic conditions, and modifying the quality of life of the local population. Moreover, the negative impacts of tourism could have an impact on the attractiveness and competitiveness of the destination (Massiani & Santoro, 2012).

Unambiguously, tourism brings and maintains employment and economic values for society. However, tourism activities also have a negative impact on the environment, where solid waste is one of the most significant impacts (Ezio et al., 2014; Kaseva & Moirana, 2010; Mateu-Sbert et al., 2013; Mihalič, 2000; Schianetz et al., 2007; Teh & Cabanban, 2007; Zaei & Zaei, 2013; Pham Phu et al., 2018; Urošević et al., 2018).

It is believed that the negative impacts of tourism on the environment begin when more than 30% of operating income comes from the community (Williams, 2006).

Due to the non-selective and unplanned growth of tourism infrastructure in many countries, negative effects on the environment began to appear, and therefore mass tourism is the past for tourism countries that want to develop their tourism in a good way and ensure sustainability in the future. If we want a sustainable future in which tourism will always be used for the local economy, for improvement rather than damage to the natural environment, for the preservation of ecosystems, then we have to turn to sustainable development of tourism (Ivanović & Madžgalj, 2018).

Tourists tend to have a great impact on the environment by spending significant amounts of water, energy and other resources. As the main supplier of these products, tourist accommodation facilities have the greatest potential to mitigate the negative effects on the environment. Catering companies are becoming more and more popular in the world,

and due to the small and large content of capital costs, they serve as an ideal starting point for green initiatives, with the goal of raising awareness about the impact of tourism on the environment and mitigating the damage. Attempts to implement eco-innovations in tourism, the development of green tourism are increasingly common, but progress in achieving mitigation of environmental damage is rather slow (Ivanović et al., 2015). More academic attention is needed to understand initiatives to encourage greenery in the tourism sector.

The tourism industry has a number of effects on the environment. Thus, in some countries today, legislation promotes the necessity of assessing environmental impacts for any new tourism development project. The negative effects of tourism come from the tourists themselves, as well as from the infrastructure and accommodation capacities. Although these effects can not be eliminated, by establishing a framework that emphasizes proper planning and monitoring, they can be managed properly and minimized. In order to mitigate or avoid negative impacts, often part of the eco-tourism planning strategy is to restore the affected land and the affected resources and actively publish such efforts. The tourism industry's economy tends to be positive in places where tourism develops in a sustainable, ecological, green way.

Tourism to the green economy

The green economy is characterized by a significant increase in investments in the sectors of the economy, creating both the strengthening of the country's natural capital or contributing to the reduction of environmental disadvantages and ecological threats. These sectors include, in particular, renewable energy, low emissions, energy efficient construction, clean technology, waste management improvement, sustainable agriculture and forest management and sustainable fishing (Hamdouch & Depret, 2010; UNEP, 2010a; Kasztelan, 2017).

Critically, the concept of a green economy is more than just "greening" the economic sectors, this is a means of achieving the imperative of sustainable development (Brink et al., 2012):

- Improving human well-being: providing better health, education and job security;

- Increasing social equity: poverty reduction, economic and financial inclusion;
- Reduction of environmental risks: fight against climate change, acidity, release from hazardous chemicals and pollutants, and excessive amounts of waste; and
- Reducing environmental scarcity: ensuring access to clean water, natural resources and improving soil fertility.

All sectors are important for the transition towards a green economy, where the sustainable use of natural capital key driver of that transition (Brink et al., 2012).

The tourism industry has a significant negative impact on the resources of the country, the environment, the economy, people and society, especially in small countries. The main influences are pollution, exhaustion of natural resources, corrosion, population displacement, inflation, over-foreign ownership followed by foreign currency leakage, loss of culture, cultural commodification and major changes in social norms.

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The use of water in the housing sector is also very significant in relation to the amount of wastewater it produces. The development of tourism is concentrated in coastal areas and on small islands, where drinking water is usually scarce. This deficiency can be caused by the physical absence of freshwater or due to the lack of necessary infrastructure or resources. Water demand in tourism can even lead to the takeover of the supply to the detriment of local domestic and agricultural needs, caused by excessive utilization of reservoirs and lowering the table of groundwater.Nevertheless, it has also been shown that factors such as the level of staff awareness and management of resource management and efficiency of use are important for reducing losses, in general. Hotels are

significant producers of solid waste and, as a consequence, require regular municipal waste management. Part of the waste is organic, and other parts can be recycled or can be renewable (OECD, 2013).

UNEP's Green Economy Report identifies tourism as one of the ten economic sectors that are key to moving defined transition economies to the green economy, including increasing wealth and social equity, and reducing environmental risks and environmental scarcity. Tourism is one of the most promising drivers of the growth of the world economy and the key to starting defined transition to the green economy. By closely linking tourism with many sectors at the destination and international level, even small improvements towards greater sustainability will have significant impacts (OECD, 2013).

Perhaps more than any other sector, tourism has the ability to influence (both positively and negatively) the resources on which it depends.

Like many other sectors, tourism faces a number of significant sustainability challenges. However, with increasing awareness of the need and value of preserving unique natural, social and cultural assets, there is an increasing motivation for the private and public sectors to invest in more sustainable tourism. Investing in sustainable tourism offers both environmental benefits and opportunities to generate significant returns, especially in the areas of energy, water, waste and biodiversity (OECD, 2013).

Tourism in the green economy refers to tourist activities that can be maintained or held indefinitely in their social, economic and cultural environment: "sustainable tourism". Sustainable tourism is not a particular form of tourism; First of all, all forms of tourism can be more sustainable (UNEP & UNTWO, 2005). A clear distinction should be made between the concept of eco-tourism and sustainable tourism: "The term ecotourism refers to the segment in the tourism sector with a focus on environmental sustainability, while sustainability principles should apply to all types of tourism activities, operations, institutions and projects, including conventional and alternative forms" (UNEP, 2011).

Sustainable tourism describes policies, practices and programs that take into account not only the expectations of tourists in relation to responsible management of natural resources (demand), but also the needs of communities that support or are affected by tourism projects and the environment (supply) (UNEP, 2011).

Therefore, sustainable tourism tends to: be more energy efficient (eg using renewable energy); consume less water; minimize waste; preserve biodiversity, cultural heritage and traditional values; support intercultural understanding and tolerance; generates local revenues and integrates local communities to improve revenue and reduce poverty. Moving towards sustainable tourism promotes significant improvements in the effect of conventional tourism, as well as growth and improvements in smaller areas focused on the natural, cultural and community resources, and as part of the industry as a whole, can in particular have positive implications for the conservation of biodiversity and poverty reduction in rural areas (UNEP, 2011).

Increasing the sustainability of tourism companies will stimulate industry growth, create better and more jobs, consolidate more investment, contribute to local development and contribute to poverty reduction, and raise awareness and support for the sustainable use of natural resources. "The Green Tourism Economy will provide significant environmental benefits, reduction of water consumption, energy use and CO2 emissions Given the large size and range of tourism, even small changes in the direction of greenery can have significant impacts. With adequate policiesand investment, the tourism sector can be at the forefront of the transformation to the green economy. The greening of the growing tourism sector would strengthen the capacity to create economic growth, employment and development throughout the world, while protecting the environment for future generations (UNWTO, 2011).

Sustainable tourism development

The massive development of tourism after the Second World War has caused a lot of negative consequences for the environment (Gašić & Ivanović, 2018). This pointed to the need to put this activity under the concept of sustainable development. In the case of tourism, as well as some other activities, it has been shown that environmental protection can not be isolated, as it forms an integral part of the development process. In that sense, tourism needs sustainable development (Gašić & Ivanović, 2018). The term "sustainable tourism" evolved from a sustainable development perspective and the need for the tourism industry to become sustainable (Jackson & Morpeth, 2000; Mair, 2015).

Tourism is not only remarkable because of the way it is accepted, it has a special position in the contribution that provides all the overall sustainable development. Firstly, this is due to the dynamics and growth

of which the subject's activity, as well as the economic effects through which affects many of the country and local destinations. Secondly, it is due to the nature of tourism, which includes a number of special connections visitors, the tourism industry, the environment and local communities. It affects three important aspects of this relationship (Stojanović, 2011; Ivanović & Madžalj, 2018):

- interaction - nature tourism as a service focused on choice experience new destinations, which means it involves a large number of mutual influence, and at the same time direknih indireknih, between visitors, local communities and their environment.
- awareness - tourism affects people's awareness of environmental issues and the differences between different nations and cultures, which is reflected in the construction of positive attitudes about sustainable development.
- dependence - tourism is based on the needs of tourists in a preserved environment, an attractive natural areas and authentic and historically important places. Therefore, it is said that the tourism industry depends on such characteristics of the tourist town.

The rapid growth of tourism during the 20th century raised the awareness of tourism workers and businessmen, as well as tourists about the need for sustainable tourism development. In fact, some important tourist resources have met the consequences of exposure to a large number of visitors who have overused the available local resources to the extent that the sites are lost or severely damaged, some of their important natural and ecological characteristics and attractions (Hirotsune, 2011).

The question arises: What is, in fact, the sustainable development of tourism? It is difficult, if not impossible, to reach agreement on the definition of sustainable tourism development. It is described as a positive approach designed to reduce tensions and conflicts that create complicated interactions between the tourism industry, visitors, the environment and communities hosted by tourists (Croin, 1990), and the more ambiguous widely quoted phrase Brundtland reports, paraphrased in defining sustainable tourism development as development that meets the needs of current tourists and tourist destinations, while at the same time protecting and increasing opportunities for the future (Ivanović & Madžgalj, 2018).

Achieving sustainable tourism is a constant process and requires continuous monitoring of the impact, the introduction of the necessary preventive and corrective measures whenever necessary (Gašić & Ivanović, 2018). Sustainable tourism must also maintain a high level of tourist satisfaction and confirm a significant experience for tourists, raise awareness of sustainability issues and support sustainable tourism practices among them (Ivanović & Madžgalj, 2018).

Stojanović (2011), in his textbook "Tourism and Sustainable Development", states the following definition of sustainable tourism, which coincide with the opinions previously cited authors (Ivanović & Madžgalj, 2018):

- Sustainable tourism is a positive approach to the development of this activity, which intends to reduce tensions and disagreements emerged in the complex interaction between the tourism industry, the visitors, the environment and local communities. This is one approach that includes a long-term concept of natural and man-made resources.
- Sustainable tourism development is such that this activity does not jeopardize the resources on which it is based, so that they remain preserved for future generations and to this generation could at the same or higher level to meet their travel needs.
- Sustainable tourism development meets the needs of present tourists and tourist regions with a corresponding increase chances for future tourists. This is such a resource that will meet the economic, social and aesthetic needs, while simultaneously supporting cultural integrity and the basic ecological processes.

According to Inskeep (1994), "the development of sustainable tourism meets the needs of current tourists and host regions, while protecting and improving opportunities for the future.It is envisaged to lead to the management of all resources in such a way that economic, social and aesthetic needs can be met while maintaining cultural integrity, essential ecological processes, biodiversity and life support systems ".

Bramvell & Lane (2000) say that "the development of sustainable tourism is a process in which the needs of tourists, tourist companies, host communities and environmental needs need to be harmonized".

Beech & Chadvick (2006) state that sustainable tourism is one that is economic, sociocultural and ecologically sustainable, and its impacts are neither permanent nor temporary.

Butler & Hinch (2007) state that sustainable tourism is one of the factors that has the potential to change tourism, but also argue that geographers, like many other researchers in tourism, were not ready to critically look at sustainable development and how it is being applied on tourism.

According to Blancas, et al. (2011), sustainable tourism is not a "specific form of tourism, but rather an approach that can be used to make all types of tourism more lifelike, socially and economically more beneficial".

By UNESCO (2010), sustainable tourism is defined as tourism that values both domestic and foreign travelers, cultural heritage and the environment.

ICOMOS (2011) believes that sustainable tourism represents a high tourist activity that can be a long-term conservation as it creates opportunities for the social, economic, natural and cultural environment of the area in which it is taking place.

UNWTO (2016) and The World Bank Group (2017) state that sustainable tourism is: "Tourism that fully takes into account current and future economic, social and environmental impacts, addressing the needs of visitors, industries, environments and households".

From the above-mentioned definitions of sustainable tourism, it may be that sustainable tourism is an industry that has a real impact on the environment and local culture and helps to create future jobs for the population. It can reduce negative social, economic and environmental impacts and make better economic benefits for local people, encourage the well-being of host communities, and develop a working situation.

As a recognition of the role of tourism in wider development, by the Globe 90 - Conference in Canada, three fundamentals for the management of tourism planning and management have been proposed (Croin, 1990):

1. Tourism must be recognized as an option for sustainable economic development and must be taken into account as well as other economic activities, when state authorities make decisions about development.

2. Tourism must have a permanent database to enable the analysis and monitoring of the tourism industry in relation to other sectors of the economy.
3. Tourism development must be carried out in a way that is compatible with the principles of sustainable development.

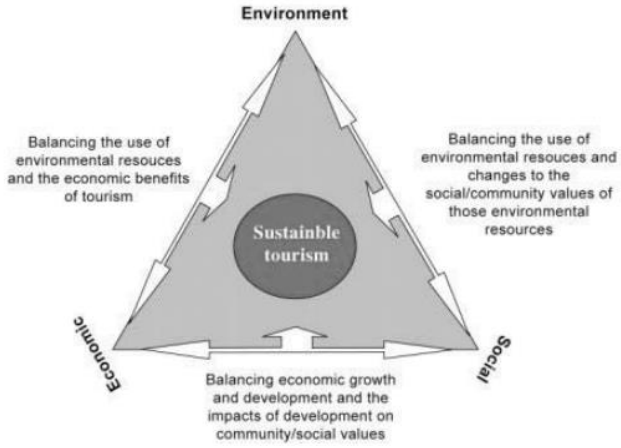
Sustainable tourism should be considered a potential route to achieve sustainable development. The three main forms of sustainability are essential for achieving sustainability through tourism (Ivanović & Madžgalj, 2018):

a) environmental sustainability,

b) social and cultural sustainability,

c) economic viability.

Figure 1: *Aspects of sustainable tourism*



Source: *Ivanovic & Madzgalj, 2018.*

Economic sustainability refers to generating prosperity at different levels of society and solving the economy of all economic activities. Of vital importance is the sustainability of enterprises and activities and their ability to maintain in the long run.

Social sustainability refers to respect for human rights and equal opportunities for all in society. It demands a fair distribution of benefits,

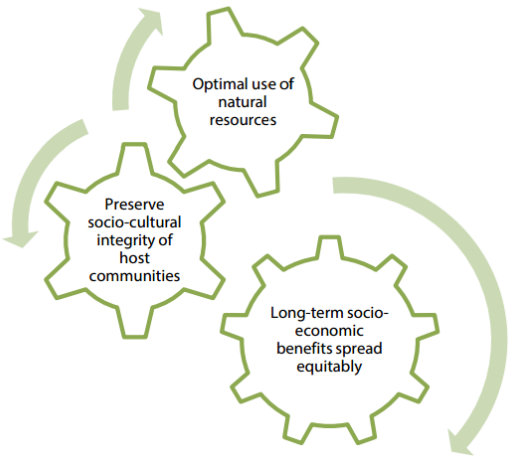
with a focus on alleviating poverty. There is a focus on local communities, maintaining and strengthening their life support systems, recognizing and respecting different cultures and avoiding any form of exploitation.

Environmental sustainability refers to the conservation and management of resources, especially those that are not renewable or useful in terms of life support. It is necessary to take action to reduce air, soil and water pollution and to conserve biodiversity and natural heritage (UNEP & UNWTO, 2005).

As the principles of sustainability relate to the ecological, economic and socio-cultural aspect of tourism development, sustainable tourism should be based on (Ivanović & Madžgalj, 2018):

- optimal utilization of environmental resources, which is a key element for the development of tourism, maintenance of basic ecological processes and assistance in the conservation of natural resources and biodiversity;
- respecting the socio-cultural authenticity of the host communities, preserving their construction and living cultural heritage and traditional values, and contributing to intercultural understanding and tolerance.

Figure 2: *Pillars of sustainable tourism*



Source: *Strategic Government Advisory, YES BANK and CII, 2017.*

Sustainable tourism is not just one type of tourism, it represents a series of sustainability principles that can be applied throughout the tourism sector, which include (UNEP & UNWTO, 2005):

- increasing the use of renewable energy sources;
- less consumption of water;
- reduction of waste;
- use bio products for the guests;
- biodiversity conservation, cultural heritage and traditional values;
- support intercultural understanding and tolerance;
- integration of local communities in order to improve living standards and reduce poverty; and
- the possibility of the company for long-term investment.

UNWTO (the United Nations agency responsible for promoting responsible, sustainable and universally accessible tourism) describes the pillars of sustainable development that are presented below. From these pillars, this document identifies 20 reasons for sustainable tourism for tourist destinations, people living there and travelers. The following reasons are just the starting point for integrating a holistic approach to sustainable tourism in development projects.

Figure 3: *Pillars of tourism for sustainable development according to the UNWTO*

Source: *According to The World Bank Group, 2017.*

Figure 4: *Reasons (20) for the development of sustainable tourism according to the UNWTO*

Source: *According to The World Bank Group, 2017*

Conclusion

Tourism launches significant investments. Adding even small percentage of investments in the green sector results in a very significant increase in investment flows. Moreover, a large number of new investment flows are directed towards developing countries, where increased investments can have a greater impact on green results. In OECD countries, investment in hotels, travel agencies and restaurants ranges from 6% of the national gross value added in Germany, and up to 32% in Portugal (OECD, 2010; UNEP, 2011).

The concept of sustainable development enables the solution of growing contradictions between the need to meet the growing needs of consumers (tourists), which leads to the rapid development of the tourism industry, and the limited number of natural, social and economic resources of the host destination in an ecological environment.

In accordance with the concept of sustainable tourism development, it is necessary not only to create conditions for the development of tourism, but also to fully take into account the consequences of this process. A complex challenge needs to be solved: reducing negative effects of

tourism and maximizing positive effects. First of all, it is necessary to take care of local people, their working conditions and environment, where it is important to take into account the social and ecological impacts of tourism development. The trinity of economic, environmental and social goals in state-run policies is the key to the success of tourism activities.

When properly planned and managed, sustainable tourism can contribute to improving living conditions, inclusion, cultural heritage and protecting natural resources and promote international understanding (The World Bank Group, 2017).

Sustainable tourism provides many opportunities for local people to improve quality of life, reduce poverty and help local economies. It defends and preserves biodiversity, preserves natural resources for future generations, preserves natural cycles in the marine coastal ecosystem and protects the environment's quality by ecosystems and reduces labor costs by taking initiatives that reduce waste, water and energy consumption. In addition, it supports the promotion of innovations and new thinking in the development of sustainable goods and services and enables the improvement of future opportunities. Moreover, it extends investment opportunities with long-term sustainability plans, and increases long-term profitability by placing plans. It keeps the destination attraction and achieves productivity and saves business activity (UNWTO, 2017; The World Bank Group, 2017).

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