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CIRCULAR ECONOMY 4.0 – AN ENTREPRENEURIAL APPROACH

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Abstract: The circular economy (CE) concept presents an accelerated roadmap toward sustainable development and is connecting academia, practitioners, policymakers and donors. Everyday business needs to be changed to enable the transition toward CE. This paper aims to examine how the entrepreneurial initiatives are creating new CE business models based on renewability, reuse, repair, longevity, upgrade and sharing. This paper gives the short presentation of CE concept with the focus on a difference from a linear economy. Based on a systematic literature review, the paper presents entrepreneurial initiatives through the practices toward CE in companies. The analysis of the most recently published articles has shown that the Industry 4.0 technologies offer a significant contribution to the CE activities and that the synergy between CE and Industry 4.0 is substantial. Companies are facing many challenges in the transition to CE and many research showed that many problems could be solved in cooperation with small businesses that have innovative CE business models. CE creates opportunities for start-up companies; therefore, the paper examines the contribution of circular start-ups to CE through innovative solutions. The main results of the paper are: a better understanding of the contribution of entrepreneurial activities to CE; in-depth understanding of the connection between different industry 4.0 technologies and CE initiatives; the list of the main problems and challenges as well as critical drivers for the success CE entrepreneurial initiatives; research agenda for future papers in the field of circular start-up and the business transition to CE. The results are relevant from macro and micro perspectives, providing insights to decision-makers in creating CE programs, as well as to support entrepreneurs.

Keywords: circular economy, entrepreneurial initiatives, startup, industry 4.0

1. INTRODUCTION

The circular economy concept has been perceived as an accelerated roadmap toward sustainable development within academia, practitioners, and policymakers. Linear economy

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means the use of raw materials and the generation of waste that is thrown away. On the other hand, CE present a model that regenerates itself, production and consumption of goods through closed loop material flows (Garcia-Muiña, González-Sánchez, Ferrari, & Settembre-Blundo, 2018; Prieto-Sandoval, Jaca, & Ormazabal, 2018).

Thinking circular is oriented on design out waste and pollution, replacement of source materials with alternative resources (more durable, bio-degradable, recycled), keeping products and materials in use and regeneration of natural systems. It presents a systematic change, not just the nature of a business but the change of the entire value chain. This paper is focused on the entrepreneurial approach in companies toward CE. Paper present CE concept, circular business models, circular start-up clasiffication and the symbioze between circular economy and industry 4.0 and a research conducted in Serba.

2. CIRCULAR ECONOMY

2.1. CIRCULAR BUSINESS MODELS AND START-UPS

Statistical data from the world's circular economy analysis in 2018 show that the world's economy is growing at a 2.5 per cent year-on-year (Reuters, 2019). In 2014, they showed that global circularity is only 9%.

In february 2019, France commits to 30% recycling of packaging platinum by 2025, while the UK encourages manufacturers to produce better quality packaging with a clear label of what can and cannot be recycled. Retail chains plan to pilot a Loop platform to deliver products in recycled packaging or packs for reuse. Leasing and joint use also emerge as forms of the circular economy. Companies such as IKEA, Renault, P&G, IKEA, H&M a few years ago started with the strategies that are based on circularity and consequently lead to revenue increases and reduced resource use.

New technologies, business and financial models are needed for longer usage or reuse of resources. Companies and entrepreneurs have become aware of the pressures associated with the of the resources consumption and are oriented to create business models based on the principles of the circular economy in order to make a profit and contribute to social well-being. Companies with innovative business models are finding new sources of competitiveness and entrepreneurs are finding their position in the market by undertaking innovative initiatives. Circular business model can be defined as “a business model in which the conceptual logic for value creation is based on utilizing the economic value retained in products after use in the production of new offerings” (Linder & Williander, 2017).

According to Lewandowski (2016) CE business models can be clasified based on next criteria: regenerate (energy recovery, circular supplies, sustainable product location etc.); share (product lease, maintaining ad repair, upgrading etc.); optimaze (assets management, waste management; produce on demand etc.); loop (recycling, resource recovering etc.); virtualize (dematerialezed services); exchange (new techologies). Basic business models based on CE are (Keplinger, 2018; Danish Ministry of environment, 2016):

- Extended product life – repair, upgrade, customization, resale
- Resource repair – resource modularity
- Circular procurement – procurement of renewable, biodegradable or recycled materials
- Product as a service – product rental or payment by use
- Exchange platform – User collaboration within product usage.

From the experience of Netherland, England and Finland we can see that the crucial role in transition toward CE have small and medium enterprises (SME) due to their flexibility, dynamism and capability provide innovative solutions very fast. Larger companies often lacking this level of agility (D'Amatao, Veijonaho, & Toppinen, 2020).

Since large companies need time to create sustainable circular business model, circular start-ups can be a provider of products and/or services for larger companies. According to D'Amatao, Veijonaho, & Toppinen (2020), large companies can create a new value chain with stakeholders. Start-ups are mainly connected with innovations and for example Netherlands has the Government plan for the CE development until 2050, with the special focus on start-ups. From their perspective start-ups are important pillar of business and could positively contribute to develop the technological innovation for the CE (Pruijssen, 2019).

Henrya, Bauwens, Hekkert & Kirchherr, (2019) analysed types of circular start-ups based on circular business models and strategies. They create the next typology of circular start-ups:

- design-based - pre-market phase through source material minimization
- waste-based - seeking additional value from waste
- platform-based - pursuing sharing/trading business models
- service-based - to increase usage efficiency
- nature-based - based on nature-based systemic solutions.

Transition to CE requires institutional support (Ranta, Aarikka-Stenroos, Ritala, & Mäkinen). According to Pruijssen (2019) the success of entrepreneurial activity is very dependent on national governmental actions, goals and tax regimes. as well as its incorporation in the education system (Kirchherr & Piscicelli, 2019). These two drivers can help in dealing with key challenges and barriers in CE implementation (Govindan & Hasanagic, 2018).

2.2. CIRCULAR ECONOMY AND INDUSTRY 4.0

Garcia-Muiña et. al (2018) confirmed that the business transformation introduced with Industry 4.0 favours competitiveness and convergence between business and technology in new production models to the same authors, Internet on thing has been seen as an asset in designing circular business model (Garcia-Muiña, González-Sánchez, Ferrari, & Settembre-Blundo, 2018).

In the last three years authors as particularity focused on opportunities that digital technologies brings to CE. Based on architecture layers technologies can be classified on digital technologies for: 1) data collection (Radio Frequency Identification (RFID) and Internet on Things (IoT), 2) data integration (Relational Database Management Systems (RDBMS) and Product Lifecycle Management (PLM) systems) and 3) data analysis (Product Lifecycle Management (PLM) systems, Artificial intelligence, Machine learning (Pagoropoulos, Pigosso, & McAloone, 2017). It is recognized that information technologies significantly contribute to circular economy, especially in regard to life cycle stages. Digital technologies can help close the material loop and further to, monitoring, control and optimize stocks (Tsenga, Tanb, Chiub, Chien, & Kuo, 2018; Lopes de Sousa Jabbour, Chiappetta Jabbour, Filho & Roubaud, 2018; Garcia-Muiña, González-Sánchez, Ferrari, & Settembre-Blundo, 2018; Nascimento et al. 2019). The authors also put a special focus on eco-design of products that enables (Mendoza, Sharmina, Gallego-Schmid, Heyes, & Azapagic, 2017; European Environmental Bureau, 2015).

3. RESEARCH DESIGN

3.1. RESEARCH QUESTIONS

Through systematic literature review (SLR) we were focused on CE and the role of how the entrepreneurial initiatives in creating new CE business models using digital technologies. Key research questions are:

- Do companies apply models or practices related to CE (renewability, reuse, repair, longevity, upgrade and sharing)?
- Do they use digital technologies in their business?
- Is the synergy between CE and Industry 4.0 recognized?
- Does CE creates new opportunities for start-ups?
- What are the key barriers as well as drivers for the success CE entrepreneurial initiatives.

3.2. RESEARCH METHOD

In order to explore defined research questions, a questionnaire has been established. Afterwards, the author conducted structured interviews with managers in different industries, after which the questions were modified in order to generate the most precise answers.

The first part of the questionnaire was composed of questions relating to demographic characteristics of a company. The second part was dedicated to the main models/practices of CE, where respondents were given the scale from 1 to 5 to assess the applicability of those elements in their companies. The third part aimed to investigate which technologies are used in business. For the purpose of this research the respondents were offered to choose more than one currently used technologies. Than they have the opportunity to evaluate the contribution of each technology on CE. Next part of the questionnaire was dedicated understanding of CE benefits as well as the main barriers in CE practice applications. Finally, the questionnaire explored the attitude of respondents in terms if start-ups can contribute to existing companies in applying CE practices or the large companies can do the transformation by itself.

4. RESULTS AND DISCUSSION

4.1. SAMPLE DESCRIPTION

The online questionnaire was distributed to managers in different industries. The preliminary analysis of the completed questionnaires, questionnaires that are incomplete were not considered in further analysis. Therefore, only 68 questionnaires have been taken into consideration. Concerning an industry, we can conclude that the majority of respondents are form IT sector (27.7%). commerce (10.5%) consulting (8.5%), agriculture (6.3%), other companies are form the field construction, food processing, pharmacy, education and training, energy, traffic etc. Only 20.8% produce only products, 47.9% are delivering services and 31.3% of companies are delivering products and services. The interesting data is that 41.7% of responded companies have product and services for the global market, 25% are exporting to the region countries and 8.3% for EU countries. 25% have products and services only for the national market.

4.2. RESEARCH RESULTS

First question was envisaged to explore if the respondents are familiar with the CE concept. One third of respondents (33.30%) are not familiar with the concept, 64,60% are familiar with the CE concept, or even are aware of this concept (Figure 1). This result implicate the necessity of CE promotion and advocacy in business world in Serbia.

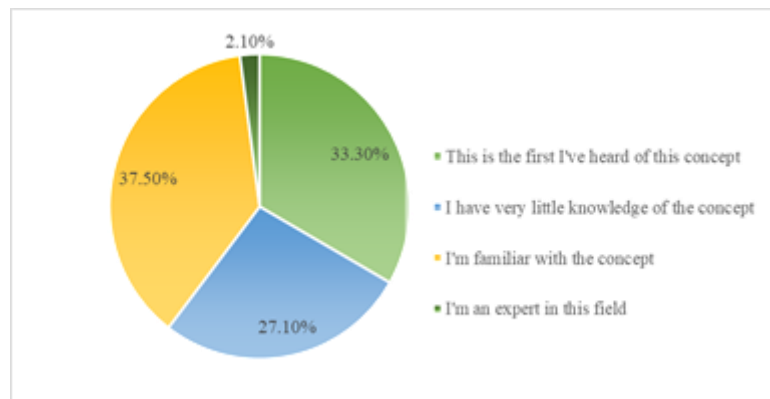


Figure 1. Awareness of CE concept

Next research question was dedicated to CE practices application (Lewandowski, 2016; Keplinger, 2018). The respondents have the option to choose one or more answer and results show that more than half (53.30%) are using Online platform for trading products (or materials); next CE practice that are common for great percentage in this research is Cooperation with other organizations from the same industry in the field of resource usage (46.70%); than we have Replacement of source materials with less intensive resources, new alternatives (more permanent, biodegradable, recycled) with 44.00%. Establish cooperation with partners in the supply chain in the field of sharing knowledge and information about processes and materials (33.30 %); Product design that enables replaceability, upgrade of new version, modularity, energy efficiency or sustainability of the product and its components (24.40%); Reduced use of resources through joint use/access/ownership with other parties (17.80%) (Figure 2).

Practice, professional bodies and academics (Mendoza, Sharmina, Gallego- Schmid, Heyes, & Azapagic, 2017; European Environmental Bureau, 2015; Reuters, 2019) that one of the most important things in implementing CE is a product design. The research results showed that this practice is lacking, compering to others CE practices. Companies need to use technologies and diversify knowledge to create innovative solutions for their business.

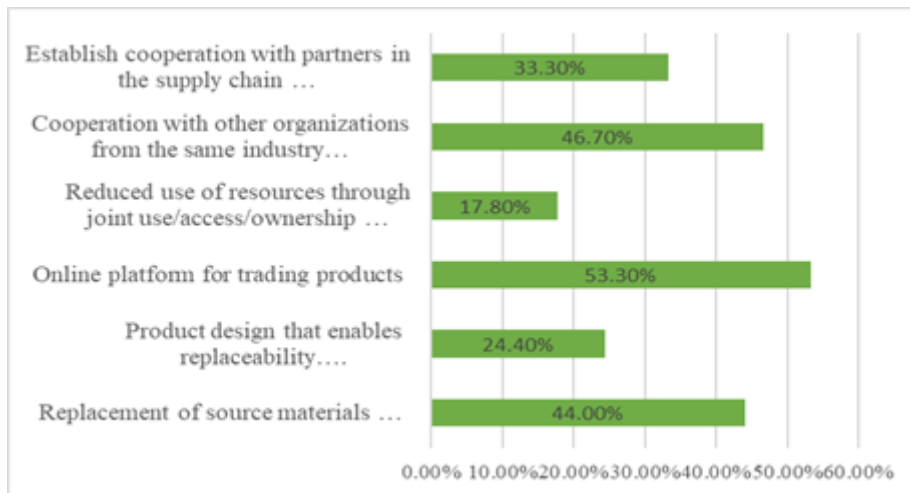


Figure 2. CE business models/practice application in companies

On the question do their business activities involve product repair, renewal, recycling and/or repurpose of products, which enable the repair and restoration of values, 75% respondents have negative response (Figure 3). 54.00% of the respondents state that they have business activities that involve a product or service where the user does not own a product, for example, a product or a service where the user does not own the product. renting, common platform, subscription, etc. (Figure 4). It is interesting to note that the positive answers are mainly from the IT industry.

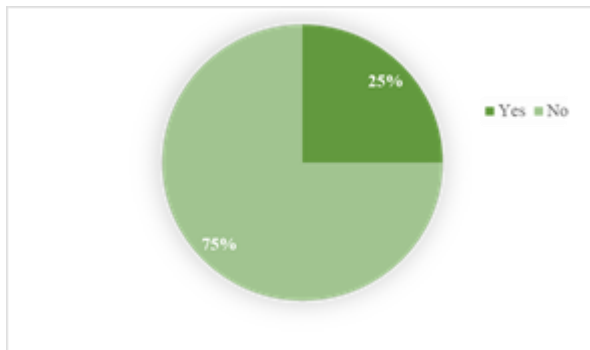


Figure 3. Product reuse, repair, renewal etc.

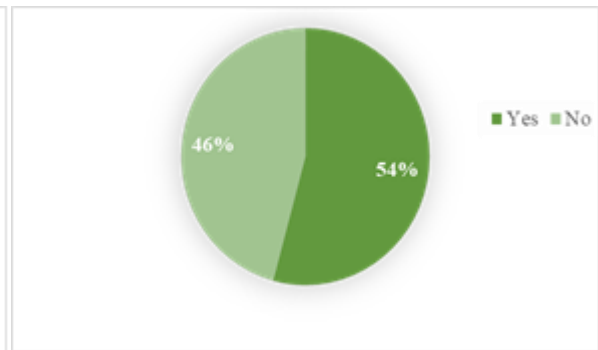


Figure 4. The user does not own the product

When it comes to the key drives of CE implementation, figure 5 shows that respondent mainly relate CE with waste management. The respondents could express their opinion on what are the key drivers for CE entrepreneurial initiatives. The results show that respondents in the most cases do not relate CE with increased profit and competitiveness, as well as the possibility of receiving grants for innovative solutions in the field of circular economy (Figure 5).

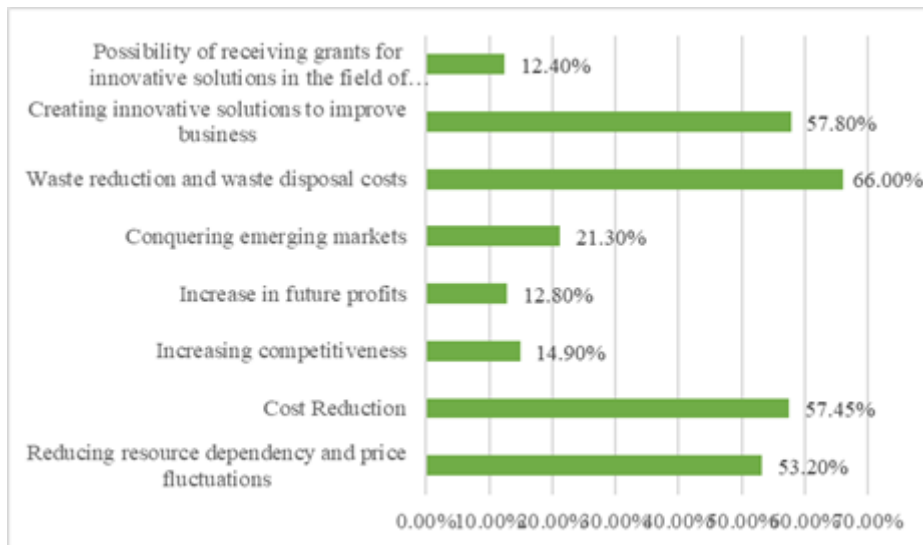


Figure 5. What are the key drivers to apply CE?

To investigate the relation between CE concept and Industry 4.0, at first it was analysed which digital technologies are in use in the companies. Respondents had the opportunity to select more than one answer. Among the most present are Big data analytics (70.70%), Relational Database Management Systems (36.60%), Machine learning (34.10%) and Product Lifecycle Management (31.70%) (Figure 6).

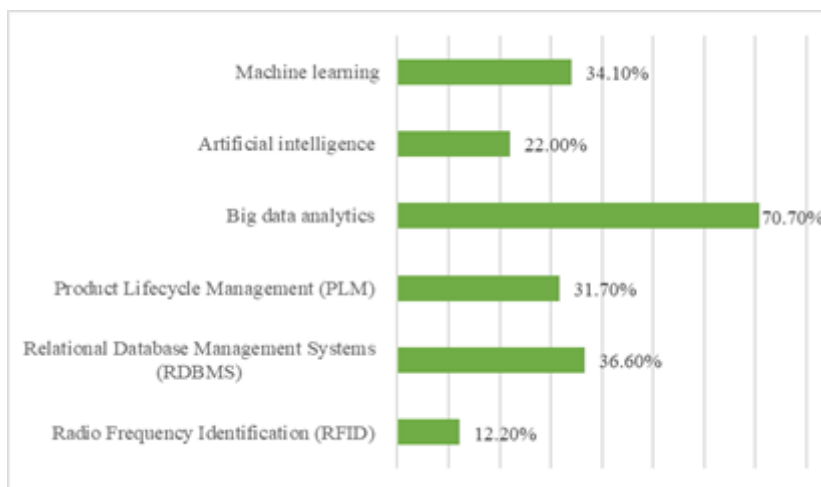


Figure 6. Digital technologies used in business

The research aimed to evaluate the extent to which digital technologies can contribute to a CE orientation. The respondents were given a scale from 1 (no impact) to 5 (contribute completely) to evaluate the contribution of each technology to CE (Figure 7). Respondent recognized Big data analytics, Artificial intelligence and Machine learning as the most important. According to results Radio Frequency Identification, Relational Database Management Systems and Product Lifecycle Management have moderate impact. Results are in line with (Lopes de Sousa Jabbour, Chiappetta Jabbour, Filho, & Roubaud, 2018; Pagoropoulos, Pigosso, & McAloone, 2017; Garcia-Muiña, González-Sánchez, Ferrari, & Settembre-Blundo, 2018) and it is confirmed that technologies have impact on CE and should

be included in creating new business solutions. Although recognized the importance of digital technologies for CE, it can be noted from the research results, that there is a space to explore and apply technologies for data collection and data integration, especially for eco-design (Mendoza, Sharmina, Gallego- Schmid, Heyes, & Azapagic, 2017).

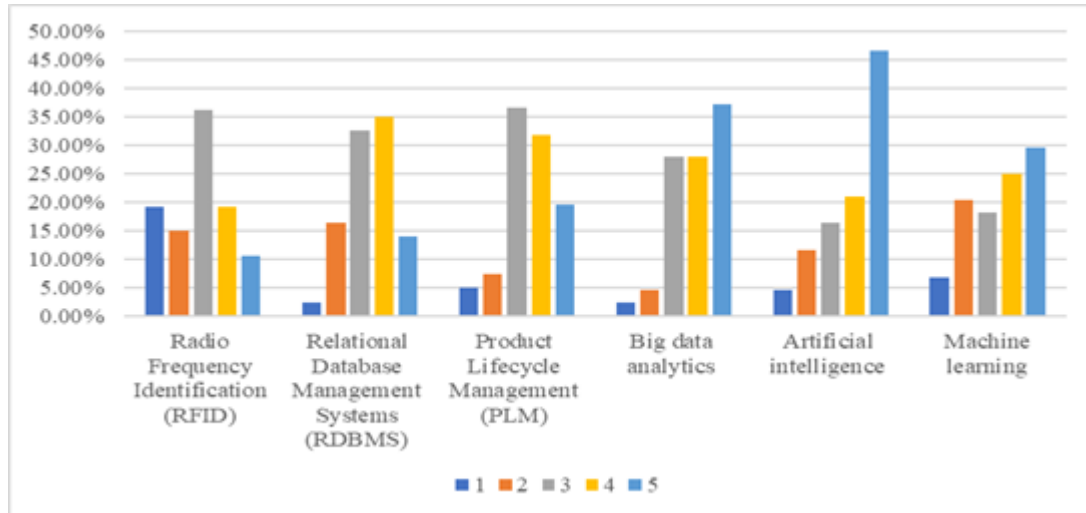


Figure 7. Digital technologies contribution to CE

As the barriers to greater orientation on the CE respondents recognized the lack of technical knowledge in the company (Figure 8).

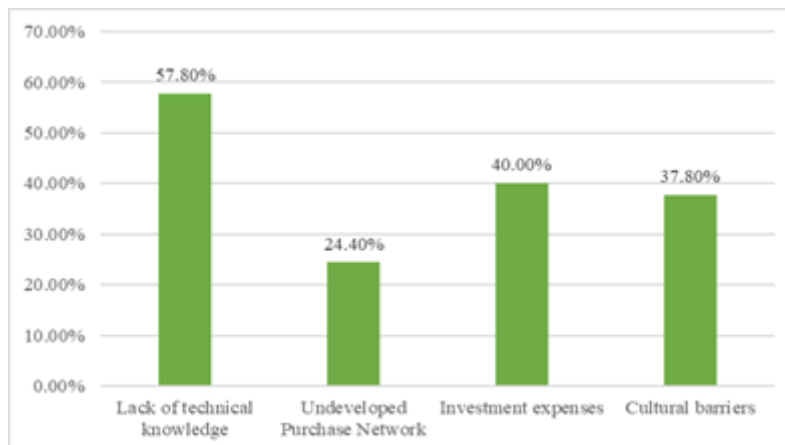


Figure 8. Barriers to CE application

Through this research it was investigated if start-ups can contribute existing companies to develop and new solution toward CE. Figure 9 shows to what extent start-ups can contribute to the development of innovative solutions in the field of CE for large companies. It is of great significance that companies see great contribution of a small business to its development and recognize the concept of open innovations. The percentage of responses for the statement that start-ups can have a small contribution or that big companies should develop their own solutions is 00.00%.

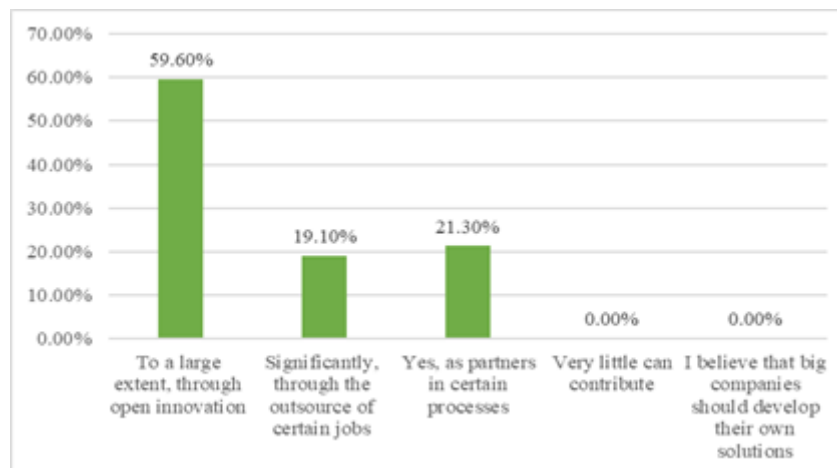


Figure 9. Can start-ups contribute existing companies in transition toward CE?

5. CONCLUSION

Based on research results it can be concluded that in Serbia companies mainly relate CE with waste management and do not relate CE with profit. It is basically related to environment protection, which is only one part of the CE. More than 30% of respondents are not familiar with the CE concept. Further, as the main barrier to transform toward CE, respondents stated technical knowledge. Upon research results and based on experience of other countries, it can be concluded that a systematic introduction of CE concept, institutional support as well as education can provide better understanding of the concept in business world and all the benefits that this concept brings. These mechanisms are important equally for small, medium and large companies. This is in line with other research studies (Kirchherr & Piscicelli, 2019; Ranta, Aarikka-Stenroos, Ritala, & Mäkinen; Pruijsen, 2019). Therefore, the findings could be interesting to governmental institutions on how to accelerate the transition toward CE. Through literature review and presented finding there is a clear conclusion that digitalization contributes greatly to CE, especially Big data analytics and Artificial intelligence. Still, there is a space for the improvement in terms of application of technologies for data collection and data integration, especially for eco-design. Further, CE requires new business models and strategies and there is a consensus that companies (especially large companies) cannot develop innovative solutions toward CE by them self and that the contribution of start-ups through open innovation in a large companies is substantial. Based on this and literature review on CE start-ups typology, it can be concluded that CE brings new opportunities for start-ups and for the existing companies.

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MULTI-CRITERIA DECISION MAKING AND VALIDATION OF THE RESULTS

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Abstract: Validation of the results of multi-criteria models represents the final phase before the implementation of the final decision. Therefore, it is necessary to examine the quality of the proposed solution and to select the dominant alternative from the considered set. In this paper, a methodology for checking the robustness of solutions of multi-criteria models is proposed, which includes four phases: 1) Comparison of results with the results of other multi-criteria models; 2) Influence of change of weight of criteria on ranking results; 3) Simulation of the dynamic environment through changing the input parameters of the initiation matrix; and 4) The impact of changes in the coefficients that are defined in the multi-criteria model based on the subjective assessments of the decision maker. The application of the proposed methodology is shown on the supplier selection problem.

Keywords: multi-criteria, sensitivity analysis, MCDM, validation

1. INTRODUCTION

Multi-criteria decision making (MCDM) methods represent powerful tools for making rational decisions while being engaged in various types of activities. Studies in MCDM problems have particularly been prevalent in recent decades with intensive developments being also observed (Kahraman et al, 2007). The reasons of such developments lie in both theoretical and practical point of views. In theoretical sense, MCDM is attractive, because it studies insufficiently structured problems, while in practical sense, MCDM represents a powerful tool for choosing adequate actions. Furthermore, the MCDM is an unavoidable tool for designing and methodological support in exploration of the diverse systems.

Methods for MCDM can be classified into five groups (Nassiri et al., 2013): 1) *Methods for determining non-inferior solutions* that determine the set of non-inferior solutions, while it is on decision maker to adopt the final solution based on his preferences. The following methods belong to this group: the weighting coefficients method, the restriction method in the criteria functions environment, as well as the Simplex method; 2) *Methods with predetermined preference* which are used to form synthesizing (resultant) criterion function. 3) *Interactive methods* in which the decision maker expresses their preferences interactively using adequate method. 4) *Stochastic methods* where the indicators of the uncertainty are included into the optimization model 5) *Methods for emphasizing subset*

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of the non-inferior solutions that narrow the subset of the non-inferior results, achieved by introducing additional elements for making decisions.

Among various MCDM methods in the literature, MCDM methods with in advance expressed preferences are most commonly used. The study scope of this paper includes methods with in advance expressed preferences, and the following part of the paper presents some of the best known: Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) (Brans, 1982), Multicriteria Optimization and Compromise Solution (VIKOR) (Opricovic & Tzeng, 2004), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Hwang & Yoon, 1981), Analytical Hierarchy Process (AHP) (Saaty, 1980), Analytic Network Process (ANP) (Saaty, 2005), Elimination Et Choice Translating Reality (ELECTRE) (Bernard, 1968), Multi-Attributive Border Approximation area Comparison (MABAC) (Pamučar & Ćirović, 2015), COmplex PROportional Assessment (COPRAS) (Zavadskas et al., 1994), COmbinative Distance-based ASsessment (CODAS) (Keshavarz Ghorabae et al., 2016), Multi-Attribute Ideal-Real Comparative Analysis (MAIRCA) (Pamucar et al., 2014, 2017), Ranking of Alternatives through Functional mapping of criterion sub-intervals into a Single Interval (RAFSI) (Zizovic et al., 2020), Measurement of Alternatives and Ranking according to COmpromise Solution (MARCOS) (Stevic et al., 2020), etc.

Since MCDM methods cannot be divided into good and bad, it is necessary to identify the method that will yield the best results for the studied problem. Most MCDM models involve determining weight coefficients of evaluation criteria in order to define priorities for each of the considered alternatives (Yusifov et al., 2019). The input parameters for MCDM models can be defined either subjectively or by measuring certain characteristics of the alternatives, or they can be calculated using a model (Wang et al., 2014). Since MCDM models are sensitive to variations in weight coefficients and stabilisation parameters, validation of the obtained data is an inevitable step in all multicriteria models. Therefore, the results validation phase is an inevitable step towards verification of the initial ranking (Djalic et al., 2020; Lukovac et al., 2019).

The results of MCDM problems can be inaccurate or subject to change in various situations, e.g. by changing the experts' viewpoints. Therefore, it is of vital importance to consider a sensitivity analysis in order to evaluate the robustness of MCDM outcomes (Saaty, 1994). There are numerous examples of sensitivity analysis in the literature related to models in the field of operational research and management, such as linear models and investment analysis (Saaty, 1980; Barron & Schmidt, 1988; Wendel, 1992; Saaty 1994; Mukhametzyanov & Pamucar, 2018). Saltelli *et al.* (2000) defined sensitivity analysis as an analysis of the effects of uncertainty in the model output, which is affected by uncertainty in its inputs. Roy (2011) indicated that imprecise approximation issues should be considered in the MCDM process in order to secure proper associated results of MCDM, since data can be variable and uncertain. For this reason, sensitivity analysis is useful for validating results. (Simanaviciene & Ustinovichius, 2012) proposed the use of sensitivity analysis for MCDM models so as to investigate the variations of the weights of the criteria so as to ensure the performance of the obtained solution. Saaty (1996) emphasized the need to perform sensitivity analysis in order to check the robustness of MCDM results and confirm their feasibility. Mukhametzyanov and Pamucar (2018) proposed statistical approach for validation of the results in MCDM problem.

Based on the presented analysis, it can be noticed that there is no single methodology for conducting the sensitivity analysis of MCDM problem results. The motivation of the author is to propose in this paper an algorithm of sensitivity analysis and validation in MCDM problems, which will help the authors to confirm the obtained results in a quality way and to

choose the dominant alternative from the considered set. Bearing in mind the recommendations in the above papers, the following steps have been highlighted (Figure 1): 1) The validation of the results through a comparison with other MCDM techniques; 2) The analysis of the effect of change in the weight coefficients on the ranking results; 3) The analysis of the ranking results in a dynamic environment; 4) The impact of changing free parameters in MCDM problem on the ranking results.

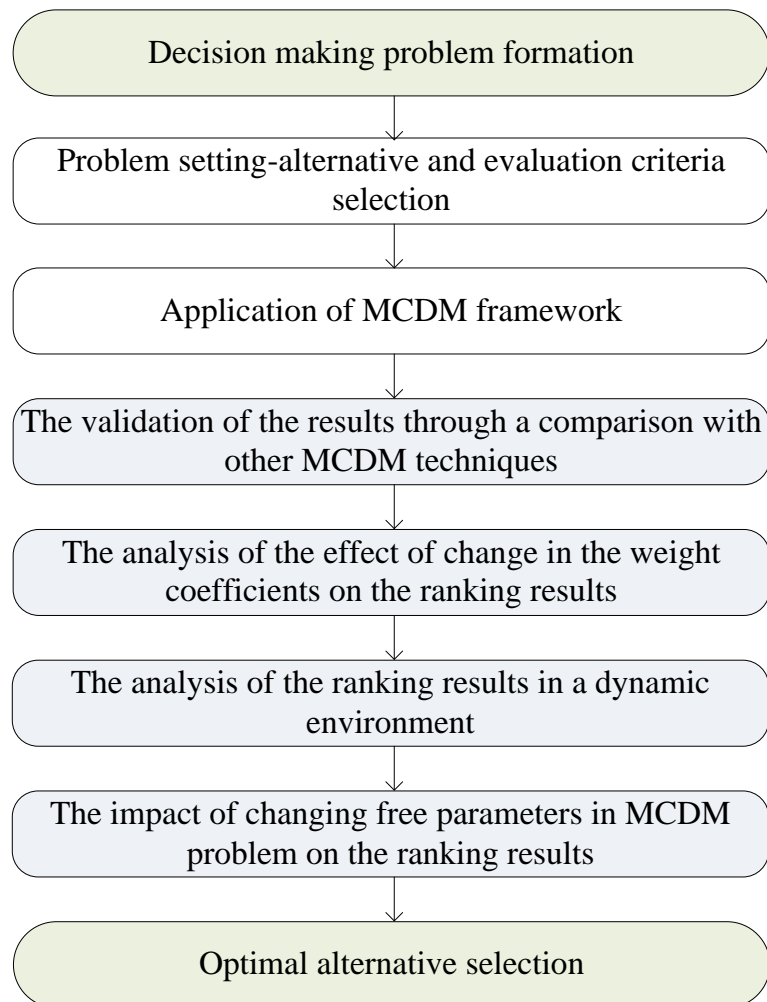


Figure 1. Proposed algorithm for sensitivity analysis in MCDM problems

2. SENSITIVITY ANALYSIS

2.1. THE VALIDATION OF THE RESULTS THROUGH A COMPARISON WITH OTHER MCDM TECHNIQUES

One of the main questions that must be answered before making the final decision is: *Did the MCDM model produce the background data?* By comparing the results of the research with the results obtained by applying other MCDM techniques, the quality of the proposed solution is checked. However, decision makers are faced with the question of which multi-criteria methodology to apply to compare results. As mentioned in the previous part of the paper, there are numerous tools in the literature for multi-criteria decision making. It is

recommended to use multi-criteria techniques that are implementing the same group of normalization techniques to compare the results.

Numerous normalization techniques are used in MCDM filed, including: Vector normalization, linear normalization (max, max-min, sum), logarithmic normalization, (Peldschus et al., 1983; Zavadskas et al., 2006 ; Zavadskas & Turskis, 2008; Eftekhary et al., 2012) etc. Different MCDM techniques apply different methods to normalize the data. For example, the TOPSIS method applies vector normalization, the VIKOR, MABAC and MAIRCA methods apply linear max-min normalization, the MARCOS method applies linear max normalization, while the AHP, ANP and COPRAS methods apply linear sum normalization. Numerous studies (Pavlicic, 1997, 2002; Mukhametzyanov & Pamucar, 2017c, 2018) have shown that the application of methods with different normalization techniques, in some situations, can lead to different solutions. The reason for possible differences in solutions using different normalization techniques lies in the fact that normalization techniques, when normalizing the same set of data, predict the data in different parts of the interval [0,1]. The following section presents an experiment that confirms this.

A set of 40 randomly generated numbers in the interval [1,9] was formed. Five normalization techniques were used to normalize the generated data set: linear sum (additive) normalization, linear max normalization, vector normalization, linear max-min normalization, and logarithmic normalization, Figure 2.

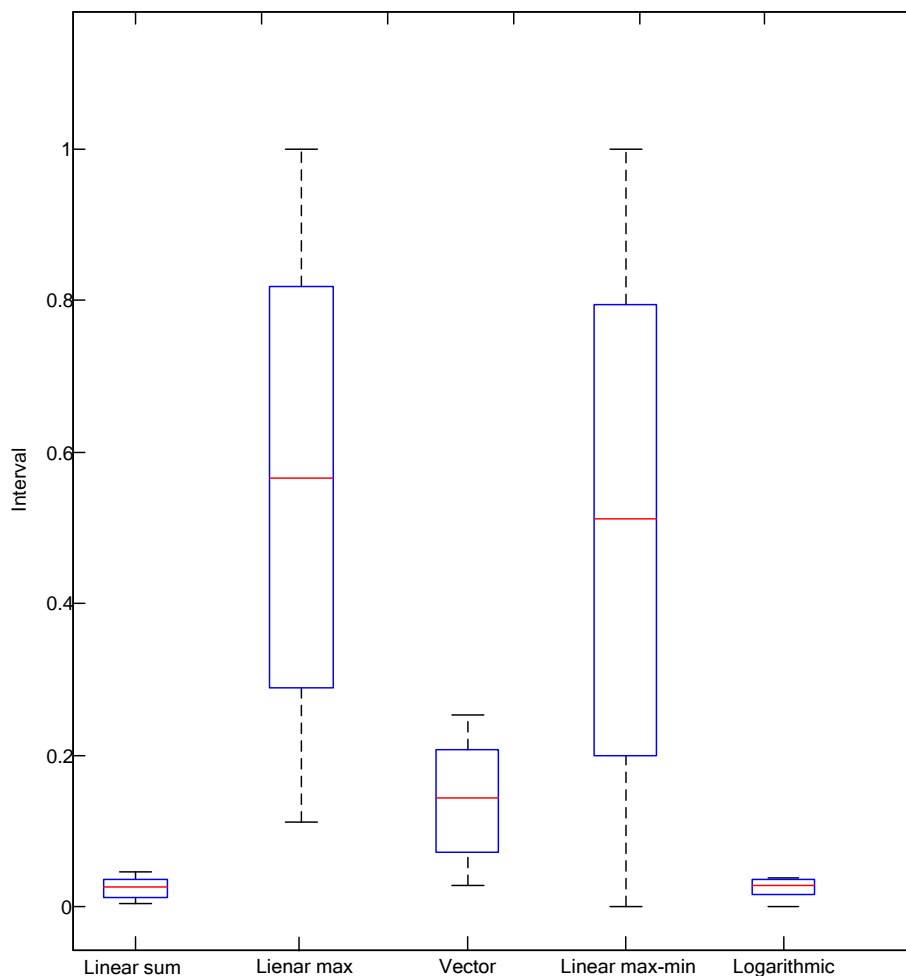


Figure 2. Normalization of a data set using different normalization techniques

Figure 2 clearly shows the differences that are obtained during the normalization of the same set of data using different normalization techniques. Only data normalized using linear max-min normalization cover the entire interval $[0,1]$, while other normalization techniques cover a larger or smaller part of the interval. These differences in normalization values in some situations can cause differences in final rankings (Pavlicic, 2020; Markovic et al., 2020). Therefore, it is recommended that when comparing the results with other MCDM techniques, choose techniques that apply the same group of normalization techniques (linear, vector, logarithmic, etc.).

2.2. THE ANALYSIS OF THE EFFECT OF CHANGE IN THE WEIGHT COEFFICIENTS ON THE RANKING RESULTS

In some situations, when applying multi-criteria models, there may be a need to change some of the criteria values used to evaluate alternatives. Multi-criteria models should respond to these requirements and produce consistent results. Therefore, simulating the change of weight coefficients of the criteria and checking their influence on the ranking results is an important step in order to validate the results. There are three commonly used approaches in the literature to generate new vectors. The first approach was proposed by Kahraman (2002) who proposed an algorithm for generating new weight vectors. The algorithm proposed by Kahraman (2002) involves the simulation of the change in the weight coefficient of the most influential criterion in the interval $[0, w_j^B]$. The second approach was proposed by Pamucar et al (2020a) which involves the creation of new weights of weights based on proportion. The third approach is to reduce the criteria weights based on the subjective assessment of the decision maker (Deveci, 2020). The third section of the paper shows the creation of new vectors of weight coefficients using the algorithm proposed by Pamucar et al (2020b).

2.3. THE ANALYSIS OF THE RANKING RESULTS IN A DYNAMIC ENVIRONMENT

One of the most important problems that occur in MCDM methods with predetermined preferences is the lack of resistance of MCDM methods to rank reversal problems. If MCDM methods show logical contradictions, expressed as unwanted changes in ranking of the alternatives when non-optimal alternatives are added or deleted from the existing set of alternatives, these indicate issues with the mathematical treatments of the applied MCDM method. This problem can be illustrated with the following example in which three candidates are examined (candidate A, B and C) who applied for the same work position (Zizovic et al., 2020). We also assume that for the ranking of the candidates one of the MCDM methods is used and that method suggested the following ranking of the candidates: $A > B > C$. Moreover, we shall assume that the candidate B, who obtained second rank, is replaced with a worse candidate D. At the same time, the candidates A and C remained in the set of examined candidates with the completely same characteristics as before. It is essential that the new set of the alternatives (A, D and C) is ranked, under the assumption that the criteria have completely the same weights as before. It would be logical that the MCDM method suggests candidate A as the best solution under the new conditions. However, in actual practice, it happens that the problem of unwanted changes in the ranks of the alternatives occurs in most of the MCDM methods (Belton & Gear, 1983).

The rank reversal problem was noticed and presented for the first time by Belton and Gear (1983), who analyzed the use of AHP for ranking alternatives. In their research, Belton and Gear (1983) conducted a simple experiment in which three alternatives and two criteria were analyzed. After the initial ranking of the alternatives, they formed a new set of alternatives by introducing a copy of the non-optimal alternative. After evaluating the new set of alternatives while keeping the same criteria weights, inconsistencies were observed as the ranking order of the best alternative was changed. Thus, it was confirmed that rank reversal happens in AHP. A few years later, Triantaphyllou and Mann (1989) noticed the same thing again in AHP when the non-optimal alternative was replaced by the worst alternative, and not only with the copy of the alternative, as shown by Belton and Gear (1983). Triantaphyllou and Mann (1989) conducted the same experiment on two other methods, namely Weighted Sum Model (WSM) and Weighted Product Model (WPM). The mentioned authors concluded that none of these methods are efficient in solving rank reversal problem. Later, Triantaphyllou and Lin (1996) tested five MCO methods including WSM, WPM, AHP, revised AHP and TOPSIS in terms of the same two evaluative criteria in fuzzy environment and came to same conclusions. Later on, many authors pointed out the rank reversal problem in many MCO methods (Triantaphyllou, 2000; Saaty, 2005; Kujawski, 2005; Leskinen & Kangas, 2005; Pamucar et al., 2017; Vesković et al., 2020).

Although there is a large number of MCO methods already developed in the past few years that give successful results for solving real world problems (Badi et al., 2019). However, most of these methods are not able to successfully eliminate rank reversal problems. Among such methods that were developed in the last ten years, it has been observed that only lattice MCDM method successfully eliminates rank reversal problems (Zizovic et al., 2011, 2020). However, this method has a complex mathematical algorithm, requiring profound knowledge in net theory (Zizovic & Damljanovic, 2012). The complexity of lattice algorithm significantly limits its broader use (Damljanovic et al., 2012). Moreover, in literature, several studies have shown that the rank reversal problem can be solved when traditional methods are modified substantially, although these modifications acquire understanding of the original mathematical apparatus of the traditional models (Pamucar et al., 2017b). Since it is evident that internal changes in the decision matrix, such as the introduction or removal of a new alternative, may lead to a change in the final preferences, a very important step in the sensitivity analysis of each MCDM model should be to check the robustness of the solution in case of a change in the number of non-optimal alternatives in the considered problem.

2.4. THE IMPACT OF CHANGING FREE PARAMETERS IN MCDM PROBLEM ON THE RANKING RESULTS

In many MCDM techniques, there are parameters that are defined based on the subjective preferences of the decision maker. Thus, for example, in WASPAS and CoCoSo methods, the parameter λ ($\lambda \in [0,1]$) is used to calculate compromise strategies in the criterion function and is determined on the basis of the decision maker's preference. For the value of the parameter λ , the authors usually take the values $\lambda = 0.5$ (Ecer & Pamucar, 2020). However, the question arises as to how the change of the parameter λ in the interval $[0,1]$ affects the change of the final rank of alternatives. Therefore, the simulation of the change of free parameters in MCDM models should be an indispensable step in order to verify the obtained solution.

In addition to the application of traditional MCDM decision-making techniques, various operators are increasingly used in the field of MCDM to aggregate group decisions such as: Bonferroni mean operator (Bonferroni, 1950), Hamy mean operator (Hara et al., 1998), Maclaurin mean operator (Maclaurin, 1729), Muirhead mean operator (Muirhead, 1902) etc. In addition to the application of classical operators in the field of MCDM, there are numerous examples in the literature of expanding operators using uncertainty theories (Yazdani et al., 2020), as well as the application of hybrid operators in decision support systems (Pamucar et al., 2020d). Among the advantages of using operators in decision support systems are: 1) Taking into account attribute relationships and 2) Eliminates the impact of extreme/inconsistent data. Since most operators use parameters that affect the transformation of the mathematical formulation of the operator, it is necessary to analyze the impact of these parameters on the choice of dominant alternatives in the decision support system.

3. CASE STUDY: SENSITIVITY ANALYSIS AND VALIDATION OF MCDM MODEL RESULTS

Sensitivity analysis and validation of results is presented in a multi-criteria problem that considers evaluation of supplier selection using the WASPAS method (Pamucar et al., 2019). In the example, an evaluation of four alternatives was performed, which were evaluated in relation to seven criteria. The weighting coefficients of the criteria were defined using the Level Based Weight Assessment (LBWA) model (Zizovic & Pamucar, 2019), as follows $w_j = (0.162, 0.162, 0.270, 0.235, 0.202, 0.115, 0.124)^T$. After the application of the WASPAS model, the initial ranking of alternatives was obtained according to the following $A1 > A3 > A2 > A4$, Table 1. The criteria values in the decision matrix and step by step calculations by applying the WASPAS method are

Tabela 1. Relative significance of the alternatives and their final ranking

Alternative	K_i	Rank
A1	0.752	1
A2	0.610	3
A3	0.629	2
A4	0.518	4

After obtaining the initial rank of alternatives, it is necessary to check the robustness of the obtained solution. Using the previously described methodology, in the following section, sensitivity analysis and validation of LBWA-WASPAS model solutions are presented.

3.1. A COMPARISON WITH OTHER MCDM TECHNIQUES

Since the WASPAS method uses linear sum normalization to transform the criterion values into the interval [0,1], methods that apply linear normalization were chosen to compare the results. In following part, the results of the LBWA-WASPAS model are compared MABAC (Pamucar & Cirovic, 2015), CODAS (Keshavarz Ghorabae et al., 2016) and VIKOR (Opricovic & Tzeng, 2004) models. The comparative overview of ranks by various MCDM techniques are presented as given in Figure 3.

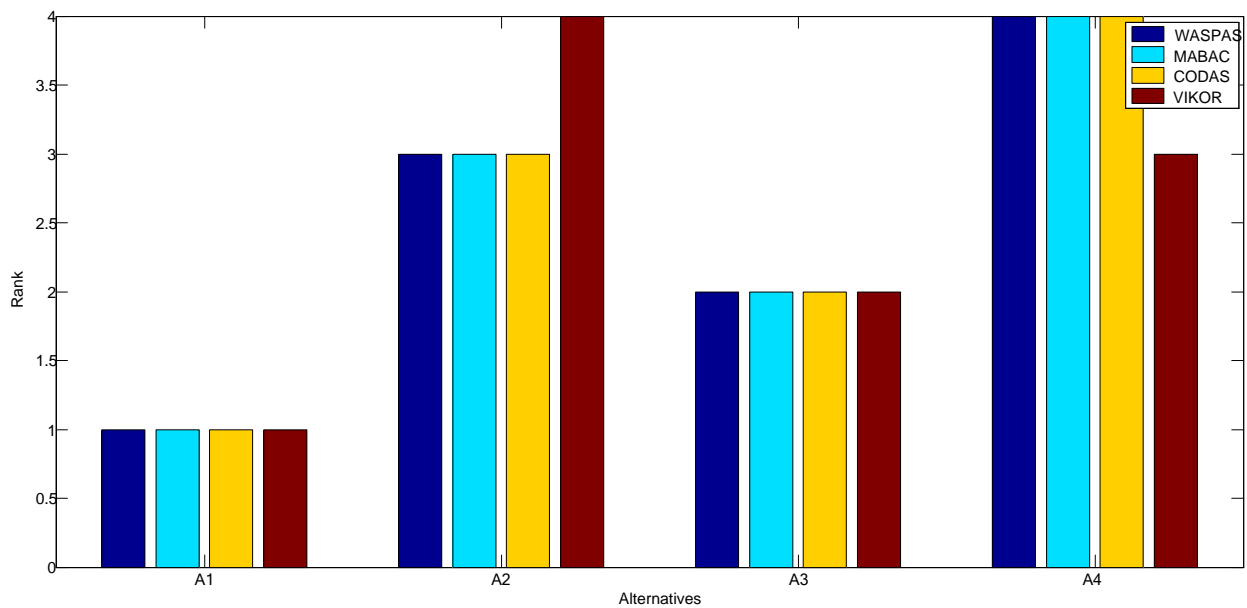


Figure 3. The ranking of alternatives in terms of various MCDM techniques

The rank of alternatives according to the presented methods shows that the alternatives A_1 and A_3 are the best-ranked alternatives through all models. MABAC and CODAS have fully confirmed the ranking of the WASPAS model. In the VIKOR model, only the last ranked alternatives (A_4 and A_2) changed, while the remaining alternatives kept their ranks. We can conclude that A_1 and A_3 are the best alternatives by all models, while the A_4 alternative in four models (WASPAS, MABAC, CODAS and VIKOR) is the worst one. We can conclude that there is high correlation between the proposed approach and other tested MCDM models. The analysis presented here showed that WASPAS provided stable solutions that were confirmed by the results of other MCDM techniques.

3.2. EFFECT OF CHANGE IN THE WEIGHT COEFFICIENTS ON THE RANKING RESULTS

In the following part, the change in the value of the weight coefficients of the criteria is simulated and their influence on the change of the utility functions values is analyzed. The approach proposed by Pamučar et al (2020a) was used to create new vectors of weight coefficients, which implies the creation of new vectors of weight coefficients based on proportion.

A total of 50 new vectors of weight coefficients were created, through which the change of the value of the most influential criterion (w_b) was simulated. The values of the weighting coefficients of the remaining criteria were corrected by applying the proportion $w_n : (1 - w_b) = w_n^* : (1 - w_b^*)$, where w_b^* represents the corrected value of the weight coefficient of the most influential criterion, w_n^* represents the reduced value of the considered criterion, w_n represents the original value of the considered criterion and w_b represents the original value of the most influential criterion.

The criterion that has the highest value of the weighting coefficient, i.e, in this case criterion C3, was chosen as the most influential criterion. In the first scenario, the weight of

the most influential criterion is reduced by 1%, while the weights of other criteria are proportionally corrected by applying the above shown proportion. Weight vectors formed through such 50 scenarios are shown in Figure 4

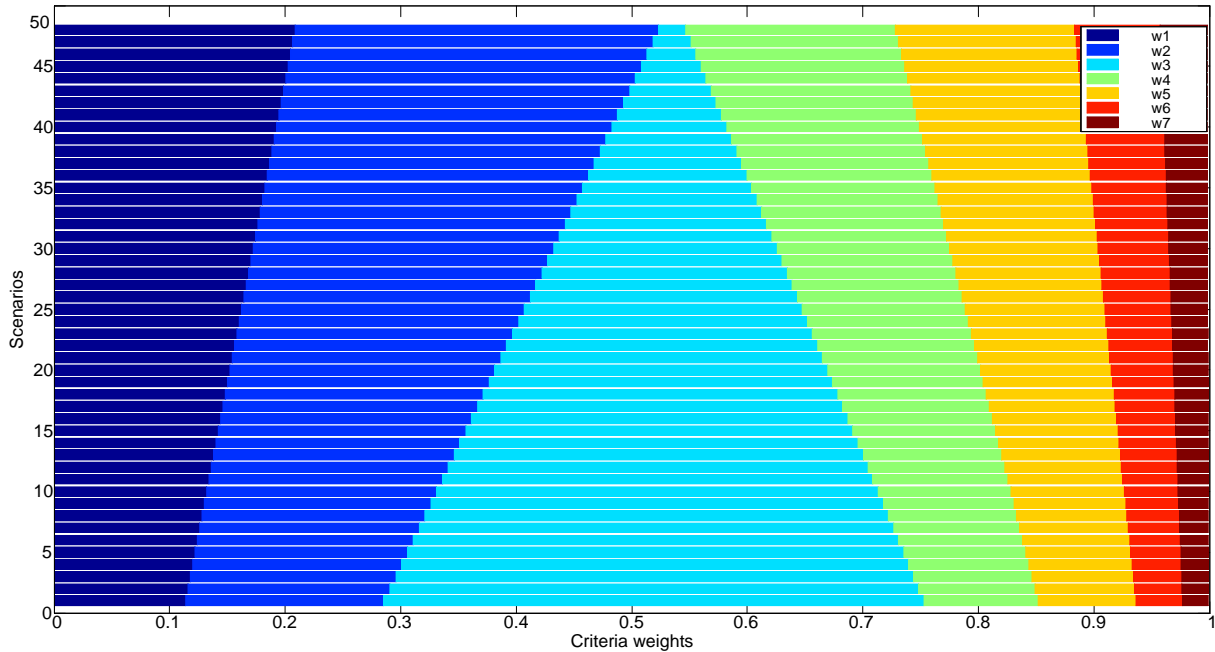


Figure 4. New criteria weights obtained through 50 scenarios

After the formation of new vectors of weight coefficients, it is necessary to perform an analysis of their impact on the change of utility functions of the alternatives, i.e. to perform an analysis of the change in the rank of alternatives. The influence of the change of weight coefficients on the utility functions of the alternative is shown in Figure 5.

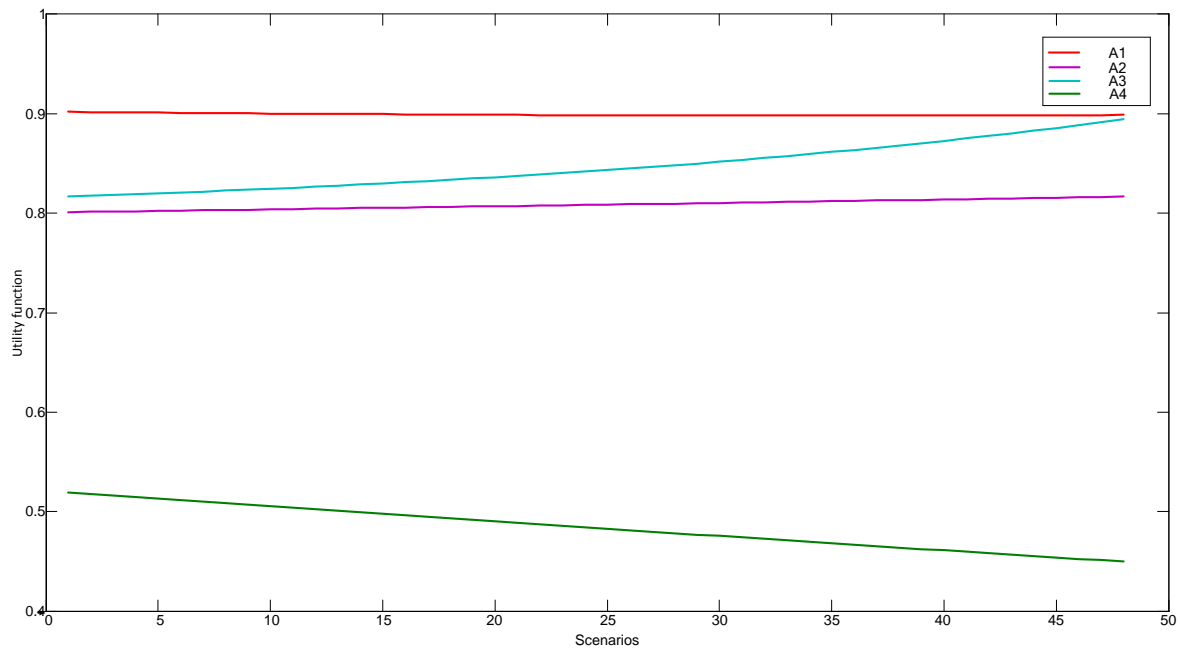


Figure 5. Influence of new sets of criteria weights on changing of utility functions

From Figure 5 we notice that there is a significant impact of changing the most influential criterion on the change in the value of utility functions of the alternatives. However, despite the evident changes in the values of utility functions, there are no changes in the ranks of alternatives. Through all 50 scenarios, the initial rank was confirmed, so we can conclude that alternatives A1 and A3 stand out as the dominant solutions. With this conclusion, it should be emphasized that alternative A1 has an advantage over A3.

3.3. THE INFLUENCE OF DYNAMIC MATRICES ON RANK REVERSALS

Changing certain parameters of decision-making matrix, such as introducing a new or eliminating the existing alternative, can lead to changes in preferences. In the following part, therefore, several scenarios are formed in which the change of the elements of decision-making matrix is simulated. In the dynamic decision matrix for every scenario, a change in the number of alternatives is recommended and the recalculated ranks are analyzed. Scenarios are formed for situations where one inferior alternative is removed from the subsequent consideration, while the remaining dominant alternatives are ranked based on the new decision matrix.

When the considered supplier selection problem is solved using the proposed LBWA-WASPAS model, the ranking of the suppliers is generated as $A1 > A3 > A2 > A4$. It indicates that alternative A4 is the worst option. In the first scenario, alternative A4 is eliminated from the list of alternatives and a new decision matrix is obtained with four alternatives (A1, A2 and A3). The new decision matrix is again solved with a new ranking order of the alternatives as $A1 > A3 > A2$, which shows that A1 still remains the best alternative and A2 is the worst alternative. In the next scenario, A2 (the worst alternative) is eliminated and the remaining alternatives are ranked as follows $A1 > A3$.

It becomes clear from presented results that when the worst alternative is eliminated, there is no change in the position of the best ranked alternative. Thus, this model does not cause any rank reversal among the alternatives. Alternative A1 remains as the best ranked in all the scenarios, which substantiates the robustness of the decision making model in a dynamic environment.

3.4. THE IMPACT OF CHANGING OF PARAMETERS IN MCDM PROBLEM ON THE RANKING RESULTS

Since the WASPAS method was used in this example, which uses the parameter λ to calculate score functions, which is defined arbitrarily in the interval $[0,1]$, it is necessary to examine the influence of changing the parameter λ on the ranking results. In the next part, ten scenarios were formed in which different values of the parameter λ were considered. In the first scenario, the value of $\lambda = 0.0$ was defined, while in each subsequent scenario, the value of λ was increased by 0.1. The influence of the change in the value of the parameter λ on the ranking results is shown in Figure 6.

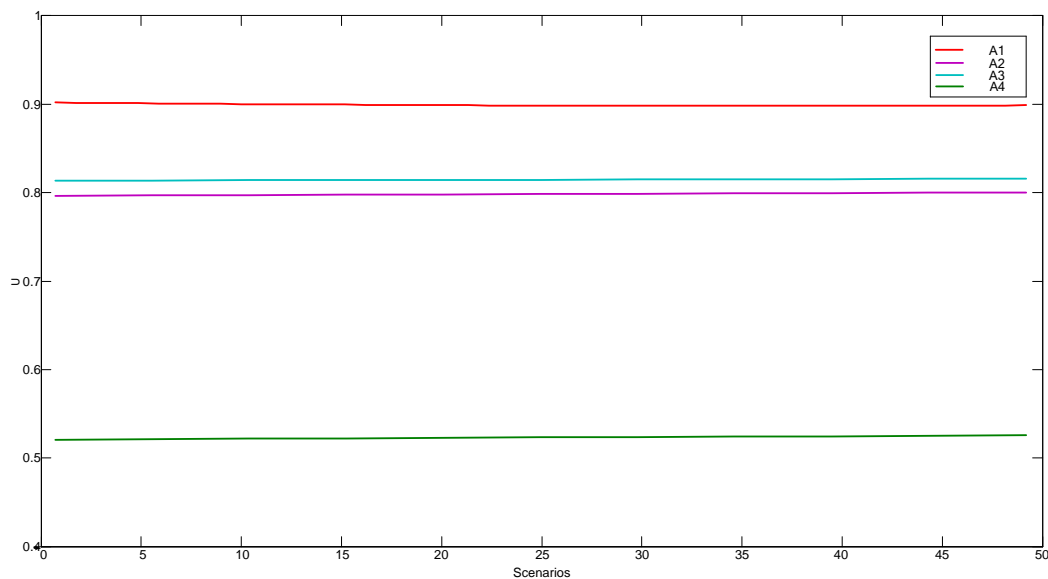


Figure 6. The analysis of the influence of the parameter λ

Based on the results shown in Figure 6, we can observe that changes in the parameter λ in the interval $[0,1]$ minimally affect a change in the value of the criterion functions. These changes are not enough to cause changes in the ranking. This minimal influence of the parameter λ on changing the values of the criterion functions shows that there is a clearly defined mutual advantage of the alternatives and that the rank is validated and credible. Also, the fact that the influence of the parameter λ on the ranking results is directly dependent on the value of the initial decision matrix must be emphasized. Thus, for the other values of alternatives/criteria in the initial decision matrix, the parameter λ may have an effect on the rank change.

Since the Bonferroni aggregator was used to aggregate the values in the initial matrix, it is necessary to examine the influence of the change of the parameters p and q on the ranking results. Earlier studies (Pamucar et al., 2020a; 2020b) have shown that changes in p and q parameters lead to mathematical transformation of the Bonferroni functions, which further influences changes in the values of the functions themselves. As the influence of the p and q parameters on the results of the functions can be significant, it is necessary to review their influence on the results of the evaluation. The analysis of the change in the value of the parameter p and q is performed through a total of 300 scenarios. In the first 100 scenarios the change in the parameter p in the interval $p \in [1, 100]$ is analyzed, while the value of the parameter q through all 100 scenarios is $q = 1$ (Figure 7a). In the next 100 scenarios, the change in the parameter q in the interval $q \in [1, 100]$ is analyzed, while the value of the parameter p through all 100 scenarios equals 1 ($p = 1$), Figure 7b. In the third phase, through the last 100 scenarios, the impact of changing both parameters simultaneously is analyzed, which implied a change in p and q in the interval $p \in [1, 100]$ and $q \in [1, 100]$, Figure 7c. The limit for variation of the values of the parameters p and q is limited to the value of $p = 100$ and $q = 100$. Based on a large number of simulations of the values of the parameters p and q , it is observed that there is no significant change in the ranks of alternatives for parameter values over 100. The results of the influence of the p and q parameters on the ranking results are shown in Figure 7.

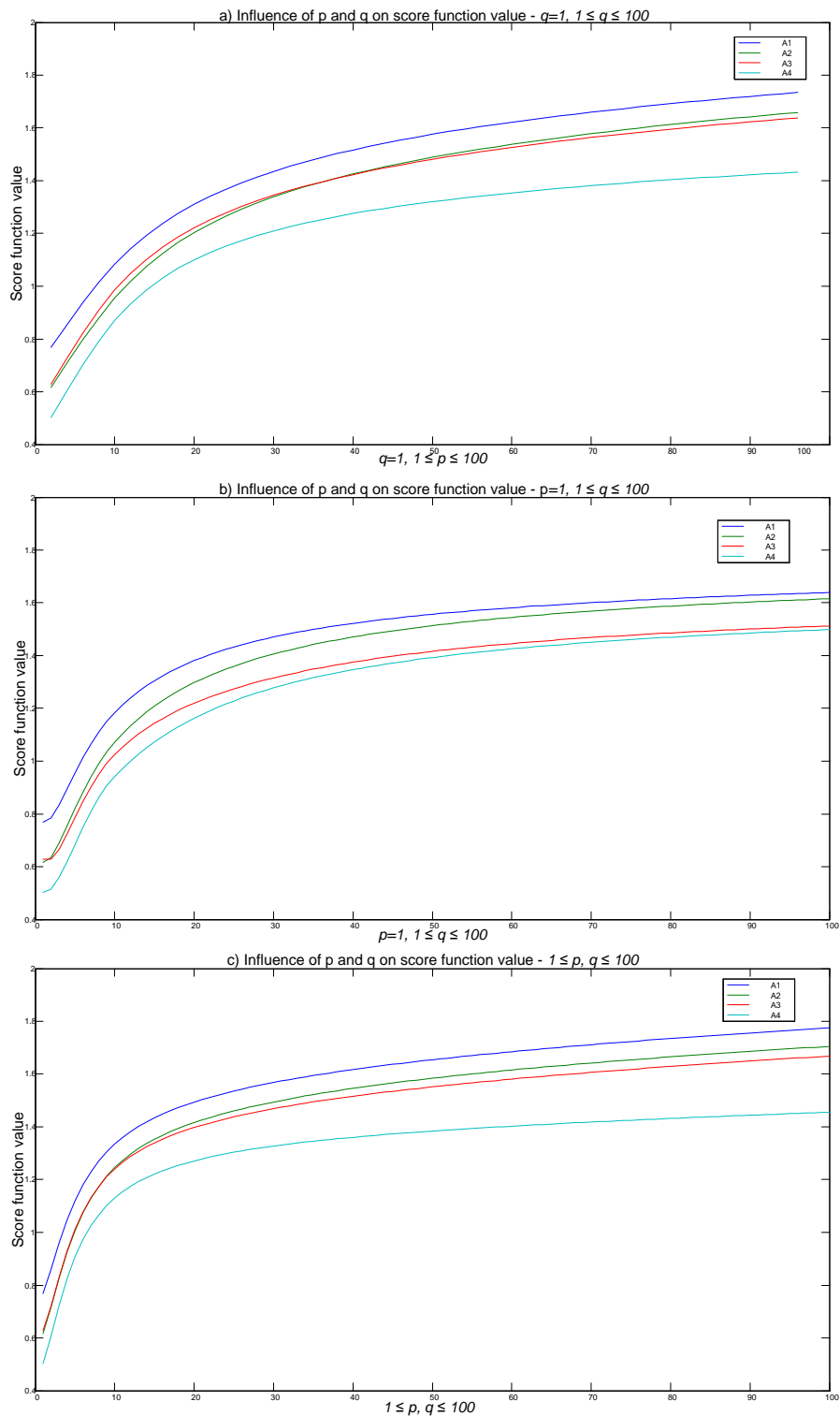


Figure 7. Influence of p and q parameters on ranking results.

Decision makers select the values of the parameters p and q to their preferences. When making decision in real conditions and real time, it is recommended that $p=q=1$ be the value for both parameters. This simplifies the decision-making process, at the same time allowing internal links between attributes to be considered. From Figure 7, it is shown that when the parameters p and q have different values, there are minor changes in the ranks of the

considered alternatives. Correspondingly, from Figure 7, it can be clearly understood that there are no significant changes in the ranking of the top-ranked alternatives (A1 and A3). This means that there is a satisfactory advantage between the considered alternatives and that the alternatives A1 and A3 stand out as dominant from the considered set. From this example we can deduce that changes in the parameters p and q influence on changing the values of the criterion functions, but that the first-ranked alternatives have a sufficient advantage over the others. This example shows that changes in the values of the p and q parameters can influence changes in the initial ranks, so analyzing the influence of the values of the p and q parameters on the final rank is a requisite step in the direction of validation of the initial rank.

4. CONCLUSION

This paper presents a proposed methodology for sensitivity analysis and validation of results obtained using the MCDM model. The proposed methodology involves conducting sensitivity analysis and validation of results through three phases. The first phase involves comparing the obtained results with the results of other multi-criteria tools. In the second phase, the sensitivity analysis through the variation of the values of the weight coefficients of the criteria is proposed. In the third phase, a methodology for simulating a dynamic environment in an initial decision making matrix is proposed. In the fourth phase, a methodology for analyzing the impact of changing coefficients whose values are arbitrarily defined in MCDM models is proposed.

The proposed methodology for sensitivity analysis and validation of MCDM model results is presented on a realistic example of supplier selection. All four phases of the proposed methodology were implemented on the considered example and based on the presented analysis, the dominant alternative from the considered set was chosen. The presented methodology aims to improve the methodology for validation of MCDM model results. Therefore, the directions of future research should be directed towards the improvement of the proposed methodology through the addition of new activities that will help in making a quality and reliable decision.

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COMPARATIVE ANALYSIS OF EFFICIENCY OF VARIOUS SUPERVISED MACHINE-LEARNING ALGORITHMS IN WATER QUALITY INDEX PREDICTION

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Abstract: The creation of adequate monitoring process and prediction of surface water quality are issues that were intensively studied and improved during the last two decades. The authors of contemporary studies give their efforts to reveal techniques and develop hybrid models that contribute to the realization of efficient and effective water quality management. Some of the methods that have been increasingly used in water quality real-time prediction are based on supervised machine learning algorithms.

The aim of this study was to determine which supervised machine learning technique is the most reliable in predicting the water quality index (WQI) and water quality class (WQC). The study was conducted on the water quality dataset of Danube River on its course in Serbia. Representative supervised machine learning algorithms (General Linear Model, Deep learning, Random forest, Gradient Boosted Trees and Support Vector Machine) were employed on the data set and the results indicated that the Deep Learning performed the best.

Keywords: water quality index, supervised machine learning algorithms, Danube river, Deep Learning, Support Vector Machine, Random forest

1. INTRODUCTION

Water is vital for the survival of the living world on Earth. Surface water bodies are the main source of water which is of great importance in human daily life. Although water is considered a non-renewable resource, its' quality is degraded and compromised that lead to a rapid reduction of freshwater quantity. It is encouraging the fact that the vulnerability of this resource has been recognized, and there are more and more studies and initiatives aimed to develop water quality management based on precisely and timely monitoring and predicting trends of surface water quality. The real-time prediction of parameters has been recognized as an indispensable step in the process of contemporary river basin management.

In the last few years, there have been more and more environmental studies aimed at defining the most reliable forecasting model. Among them, models created by supervised machine learning algorithms are recognized as a powerful tool for the prediction of environmental changes. (Gislason et al., 2006; Muttill & Chau, 2007; Dunbabin & Marques, 2012; Singh et al., 2013). Supervised learning is based on training a data sample from data source with correct classification already assigned (Sathya & Abraham, 2013). When it comes

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to the estimating and predicting water quality using machine learning there are numerous studies dealing with this issue (Di et al., 2019; Zhu et al., Chen et al., 2020). Modeling experiments are designed to test the prediction and classification accuracy of the model based on various scenarios composed of different water quality parameters. The main contribution of the learning models is reflected in possibility to provide accurate early warning with minimal possible parameters and maximum prediction precision (Chen et al. 2020). Supervised learning is a machine learning algorithm which receives feature vector and target pattern as an input to build a model (Gakii & Jepkoech, 2019). In a supervised learning model, the algorithm learns on a labeled dataset, providing an answer key that the algorithm can use to evaluate its accuracy on training data.

According to the literature, some of the most representative machine learning algorithms are General Linear Model (GLM), Deep Learning (DL), Random Forest (RF) and Support Vector Machine (SVM). GLM is used to model the linear relationship between a dependent variable and one or more independent variables. The model expresses the value of a predicted variable as a linear function of one or more predictor variables and it is applicable in water quality management. DL allows computational model, which consist of multiple processing layers to learn representations of data with multiple levels of abstraction. DL was implemented and its' utility was confirmed in many hydrogeology studies (Solanki et al., 2015). RF is an ensemble learning model based on the decision tree as basic models. In the RF, each tree uses a sample obtained by bootstrap (Gisaslon et al., 2006). As one of the most famous machine learning method RF has been proposed and applied in various areas (Yu et al, 2017; Leros & Villarica, 2019). SVM determines the support vectors of a hyperplane which separates the observations of two classes with maximum margin. In many studies, support vector machine algorithm has been prevailed in terms of classification, accuracy and precision evaluation measurement (Modaresi & Araghinejad, 2014; Aburub et al., 2016; Vijayakumar & Mahesh, 2019).

The Water Quality Index represents a numerical expression that is used in the flowing water quality assessment. Based on some very important parameters, water quality index can provide a simple indicator of overall water quality. Water quality index incorporate measurements of numerous water quality parameters into a mathematical equation that rates the health of particular water body. Serbian Environmental Protection Agency has developed index for water quality determination – Serbian Water Quality Index (SWQI). In the case of SWQI, ten physico-chemical and microbiological water quality parameters (biochemical oxygen demand, dissolved oxygen, electro-conductivity, orthophosphates, suspended solids, temperature, total nitrates, pH, ammonium ion, coliforms) compose indicator of surface water quality.

The aim of this study was to determine which supervised machine learning technique is the most reliable and achieve the best performances in water quality prediction.

2. EXPERIMENTAL

2.1. DATA SET

Data set used in this study is consisted of one year (January 2018 – December 2018) measurements of ten water quality parameters (Table 1). These data are part of the data fund of the Serbian Environment Protection Agency (SEPA).

Table 1. Analyzed parameters and abbreviations

Parameter	Abbreviation
Temperature	T
pH value	pH
Suspended solids	SS
Dissolved oxygen	DO
Electrical conductivity	EC
Total nitrogen	TN
Ammonium ion	NH ₄
Orthophosphates	PO ₄
Biochemical oxygen demand	BOD ₅
E.coli	E.coli
Serbian water quality index	SWQI

The monitoring area was the Danube river on its' course through Serbia. The locations of ten analyzed monitoring stations are presented in Figure 1.



Figure 1. Sampling stations on the Danube river in Serbia

The numeric value of the water quality index was calculated by using the “Calculate your SWQI” software package of the Serbian Environmental Protection Agency (www.sepa.gov.rs).

The first step after the data collection and calculation of SWQI was application of normalization technique to the obtained data set. After the data were cleaned, they were normalized using q-value normalization to convert them to the range of 0-100 to calculate the SWQI using ten available parameters. Once the SWQI was calculated, all original values were normalized using z-score.

3. RESULTS AND DISCUSSION

The descriptive analysis was applied in order to determine overall water quality of the Danube River on its course through Serbia, during the year of 2018 (Table 2).

Table 2. Descriptive statistics

Parameter	Min.	Max.	Mean	Std. deviation
T	1.7	24.5	12.9	6.888
pH	7.8	8.4	8.1	0.170
EC	138	828	443	165.370
DO	55	125	91	10.607
BOD	2	5.9	3.3	0.975
SS	3	488	40	58.426
TN	1.01	7.10	2.81	1.40
PO₄	0.027	0.159	0.095	0.031
NH₄	0.07	0.20	0.12	0.031
E.coli	2600	240000	89510	86601.647
SWQI	59	91	76	7.421

According to the descriptive indicator, the mean value of SWQI which amounts 76 assigns the water quality of the Danube River to the third category, or water of good quality.

In the data processing it was used software packages Rapid Miner Studio which enables the realization of defined study aims. The model created for the purpose of this study is presented in Figure 2.

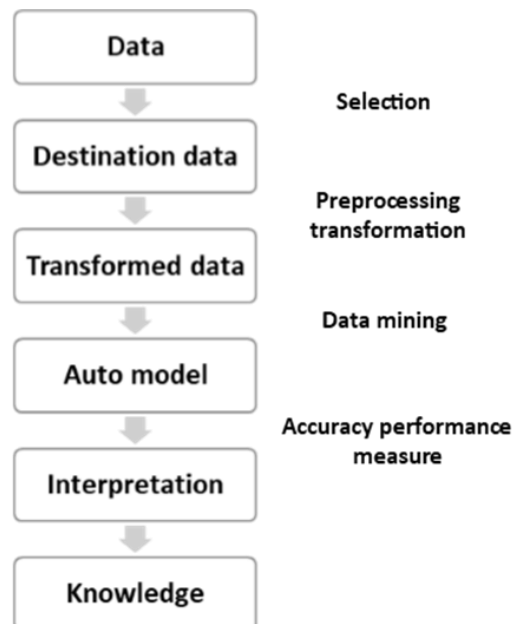


Figure 2. Model prediction framework

A software platform Rapid Miner Studio was used for comparison of the precision and accuracy of the proposed algorithms. Input variables were water quality parameters that are

used for calculation of SWQI and SWQI was selected as a predictive variable. After the preprocessing, parameters BOD, PO₄, NH₄ and E. coli. were excluded from further analysis because the reliability tests (Correlation, ID ness, Stability, Missing and Text ness) marked them as insufficiently adequate for the SWQI prediction.

Reduced data set was further modeled using five different machine learning techniques: Deep Learning, Support Vector Machine, Gradient Boosted tree, Random Forest and General Linear Model. Model performance was evaluated using three indices: the coefficient of determination (R²), the root mean square error (RMSE), and the mean absolute error (MAE):

$$R^2 = \left(1 - \frac{\sum_{i=1}^m (I_{pi} - I_{mi})^2}{\sum_{i=1}^m (I_a - I_{mi})^2}\right) \quad (1)$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^m (I_{pi} - I_{mi})^2}{m}} \quad (2)$$

$$MAE = \frac{1}{N} \sum_{i=1}^N |M_i - O_i| \quad (3)$$

After the auto modeling, model performance indices were obtained (Table 3). Comparison of the values of the coefficients R², RMSE and MAE indicate that the Deep Learning model was characterized by the best accuracy and it is recognized as the machine learning algorithm with the best performances in the process of SWQI prediction.

Table 3. Comparison of analyzed algorithms by means of R2, RMSE and MAE

Machine Learning Algorithm	R²	RMSE	MAE
Random Forest	23.027	4.665	3.959
Gradient Boosted Tree	23.499	4.69	4.029
Support Vector Machine	24.31	4.666	3.995
General Linear Model	19.896	4.388	3.683
Deep Learning	19.599	4.252	3.58

4. CONCLUSIONS

Machine learning based models are being used increasingly for the prediction and forecasting of a number of water resources variables, including rainfall, flow, water level and various water quality parameters. In most of them, those are recognized as a valuable alternative for forecasting situations.

In this study five machine learning models (Deep Learning, Support Vector Machine, Gradient Boosted tree, Random Forest, General Linear Model) were utilized in prediction of the water quality level of the Danube river on its course through Serbia. The results show that Deep Learning obtained the highest accuracy and precision. Deep Learning uses a multiple hidden layer structure to increase the classification and fitting capability to big data and multi-feature data. Compared with traditional neural networks, it shows strong computing power. This indicates the highest level of confidence in terms of the model prediction.

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Conference papers:



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BRAKE FORCE TESTING IN ERGONOMICALLY ADJUSTED CRANE CABINS

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Abstract: Crane operators' job is extremely demanding. They work long hours in constrained workspaces in awkward posture. Their neck extension, trunk flexion and repetitive arm movement are associated with an increased risk of developing neck and shoulder pain that leads to reduced working capacity, quality and safety. The comfortable operator posture could not be achieved without considering the anthropometric criteria to analyze aspects of seat comfort, visual displays locations, pedal controls, reaches etc. When proposing novel, anthropometrically assessed and adjusted seat solutions, it is important to analyze pedal brake force exerted. In this paper 68 crane operators participated in survey, with task to test novel seat solution and corresponding exerted pedal brake force. Mark 10 EK3 200 ergonomic test kit was used to measure pedal brake force. Examined variables included: height and weight (body mass index), pedal brake force average value, deviation of each three measurements from average value and absolute measurement error. After descriptive statistics, Spearman's correlations are calculated. Besides proving novel solution, there also has been found statistically significant correlation between body mass index and mean value of force, as well as between BMI and absolute measurement error. It is recommended, in future research to enlarge sample and repeat statistical testing.

Keywords: Pedal brake force, BMI, crane operator, descriptive statistics, absolute measurement error

1. INTRODUCTION

The comfortable operator posture could not be achieved without considering the anthropometric criteria to analyze aspects of seat comfort, visual displays locations, pedal controls, reaches etc. Previous studies show that there is a need to optimize the interior space and to enhance the safety and comfort of multi-users.

Crane operators job is very demanding since remain in cabins during almost the whole shift (Fung, et al., 2016; and Bongers, et al., 1988). Kushwaha & Kane (2016) and Kuijt-Evers (2003)

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based on data collected through questionnaire conclude that more than half operators rated crane cabin comfort as “average/poor” with special attention on seat design.

The aim of this paper is to test brake force which participants are able to exert when using anthropometrically adapted crane cabin with novel seat. After introduction, literature review is done, then follow methodology description and results of statistical examinations, and finally conclusions are given.

2. LITERATURE REVIEW

A possible explanation for the improper crane cabin adequacy for the operator may be found in the fact that today’s available standards and manufacturers rely on the anthropometric data of the general instead of crane operators` population (Zunjic et al., 2015).

Contemporary anthropometric characteristics (including variation in anthropometric measurements, gender, and operator fitness) and the orientation and layout of the cabin should be considered as contributing factors in designing a crane cabin of high quality in order to ensure the safety and comfort of the operator and his environment (Spasojević, Brkic, et al., 2014). Brkić, VK Spasojević et al. (2015) also point out to operators’ biomechanical and visual problems and propose novel cabin design based drawing-board mannequins and kinematic modeling. Essdai et al. (2016) use multivariate anthropometric models, spanning 95% of the population on the basis of a set of 8 anthropometric dimensions to obtain dimensions of the interior space, necessary for the accommodation of the crane operator.

Wang et al. (2000) use sample of French crane cabin operators and computerized human model MAN3D in the ergonomic evaluation of a container crane workplace (Figure 1). Large number of authors emphasize seat and foot problems of operators (Wang et al., 2000; Spasojevic Brkic et al.,2015; Zunjic et al., 2015). Despite today's` the risk awareness, incidents in crane’s operations have not substantially decreased. Proposed design enables the operator’s fatigue and stress reductions due to ergonomic adjustments, together with increasing the productivity of the crane and safety and security while decreasing production and insurance costs.



Figure 1. Crane operator workstation (adapted from Wang et al. 2000)

On other side, Vogt et al. (2005) define a concept for an interior layout process in terms of the ergonomic posture of the human body and comfort angles for the human skeleton (Figure 2).

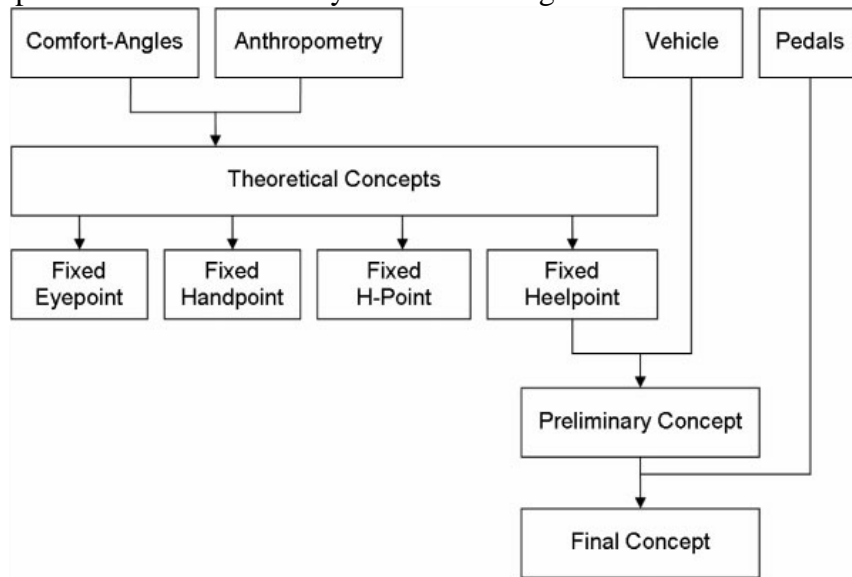


Figure 2. Interior vehicle layout concept (Vogt et al., 2005)

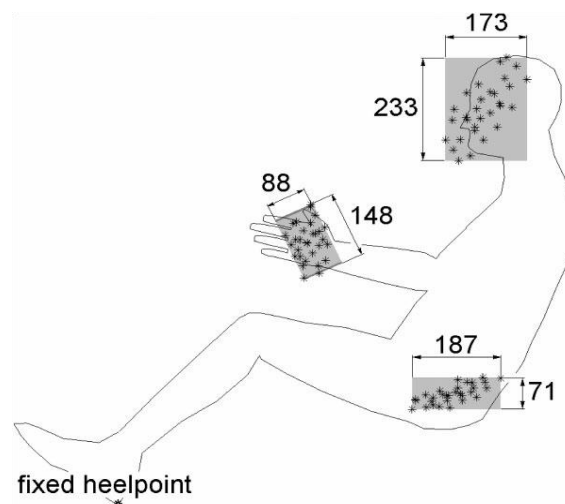


Figure 3. Fixed heel point (Vogt et al., 2005)

Pedals are very important in ergonomic design (as in Figure 1), especially because design the most often starts from fixed heelpoint, as in Figure 3. But, studies of the comfort of pedal operation have very rarely been reported in existing literature (Pannetier & Wang, 2014). Despite today's the risk awareness, incidents in crane's operations have not substantially decreased. Novel seat design and its adjustment to pedals which enables the operator's fatigue and stress reductions, and leads to increasing the productivity of the crane and safety and security while decreasing production and insurance costs, is needed. Till now, there are only few patents focused on problems of crane cabin brake - Actuator mechanism for crane turntable brake and Dual piston swing brake system for cranes (Jackson & Jackson, 2000; Pottorff, 1974).

3. METHODOLOGY AND RESULTS

Solution needed for ergonomic adjustment of operator seat offers our patent WO 2020/149757 A1 (Spasojevic Brkic et al., 2020).

For measurement of pedal brake force Mark 10 EK3 200 ergonomic test kit was used. Experimental tests to measure operators` force exertion on brake pedals in working position have an aim to prove that proposed positions are comfortable were conducted.

Results which test our novel solution are as follows.

There were 68 crane operators in the sample. Their task was to use brake pedal with maximal possible force. Three measurements were taken, as in Table 1.

Table 1. Descriptive statistics

Measurement	N	Me	Med	Min	Max	R	SD	cv(%)	VT
Height (mm)	68	1815.882	1810.000	1570.000	2010.000	440.000	87.660	4.83	par.
Weight (kg)	68	79.382	80.000	50.000	125.000	75.000	13.760	17.33	par.
BMI	68	24.006	23.862	17.500	34.626	17.126	3.398	14.16	par.
1st measurement (N)	68	241.125	215.750	45.000	553.500	508.500	114.720	47.58	npar.
2nd measurement (N)	68	242.993	220.500	79.000	556.000	477.000	115.888	47.69	npar.
3rd measurement (N)	68	239.853	225.000	65.500	709.000	643.500	133.302	55.58	npar.
Average value of force (N)	68	241.324	225.750	74.000	579.000	505.000	109.886	45.53	npar.
Deviation from aver.value 1	68	0.199	-3.417	-237.667	151.000	388.667	54.402	27402.71	npar.
Deviation from aver.value 2	68	-1.669	2.083	-164.667	96.667	261.333	42.622	-2553.56	npar.
Deviation from aver.value 3	68	1.471	-2.750	-161.000	165.833	326.833	57.958	3941.11	npar.
Absolute measurement error	68	55.775	44.417	4.333	237.667	233.333	42.650	76.47	npar.

Note: N- number of subjects, Me - mean, Med - Median, R -rank, SD - standard deviation, cv-coefficient of variation, VT - variable type, par. - parameter, npar. non-parameter.

Spearman's correlations of the considered variables are shown in Table 2. It is evident that there is a statistically significant correlation between BMI-index of body mass and mean value of force, as well as between BMI and absolute measurement error.

Table 2. Spearman's correlations of the considered variables

			p - value	significance
height	v.s.	mean value of force	0.00356	n.s.
height	v.s.	Absolute measurement error	-0.0527	n.s.
weight	v.s.	mean value of force	0.02508	n.s.
weight	v.s.	Absolute measurement error	-0.00358	n.s.
BMI	v.s.	mean value of force	0.32728	<0.01
BMI	v.s.	Absolute measurement error	0.13180	n.s.
mean value of force	v.s.	Absolute measurement error	0.40487	<0.001

Note: p- value - p level of test, significance - level of significance, n.s. not significant

The graphs below show the ratios of mean force to height, mean force to weight, mean force to BMI, absolute errors to height, weight, and BMI (Figures 4-9):

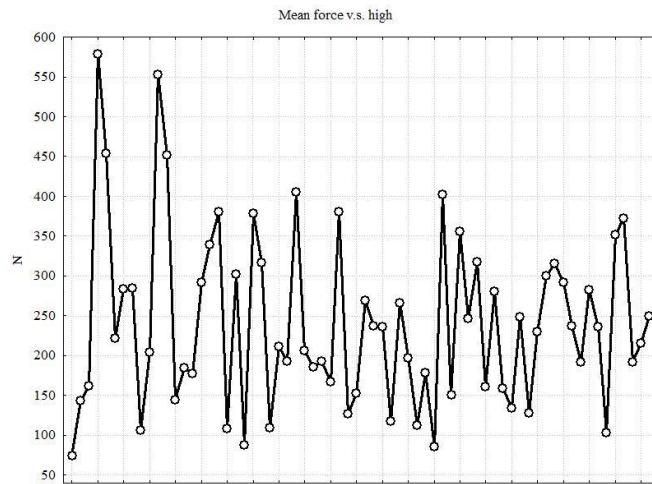


Figure 4. Interrelations between mean force and high

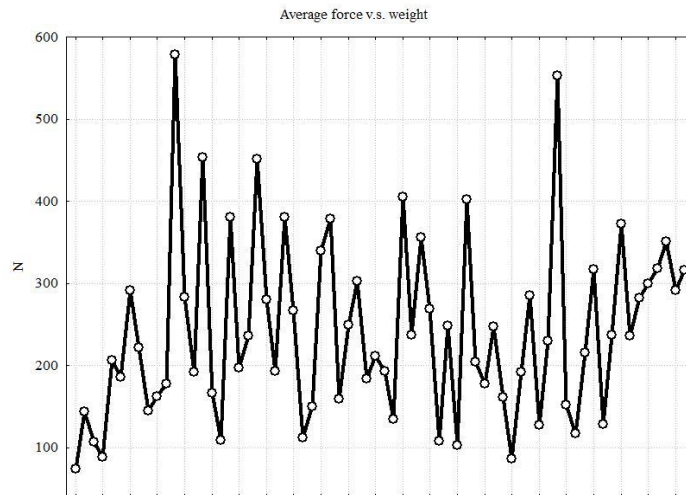


Figure 5. Interrelations between average force and weight

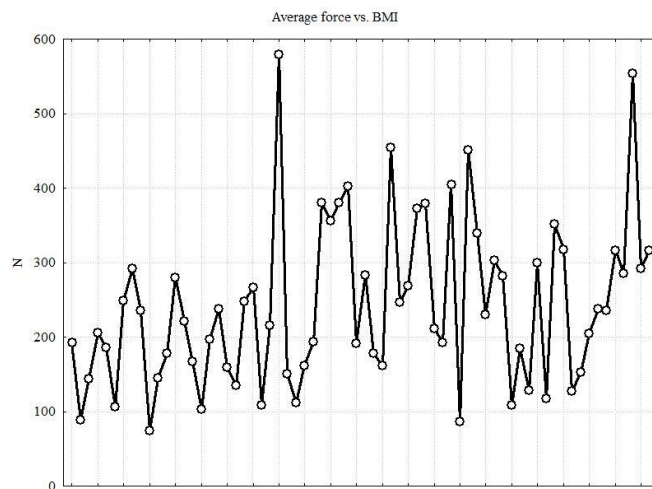


Figure 6. Relationship between average force and BMI

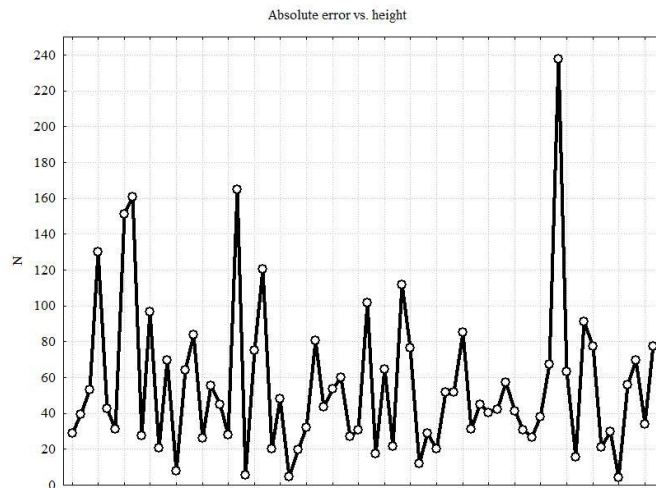


Figure 7. Relationship between absolute error and height

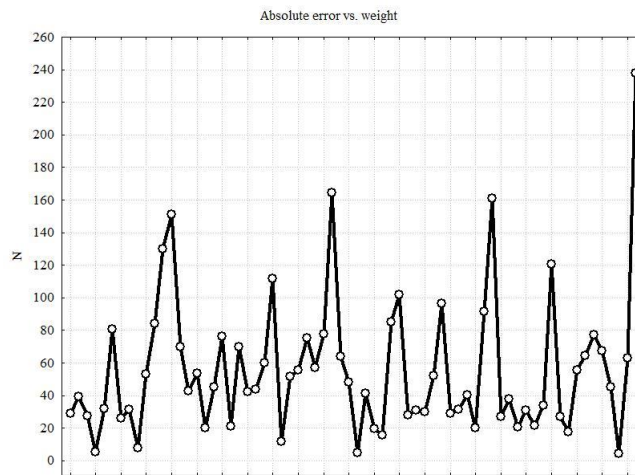


Figure 8. Relationships between absolute error and weight

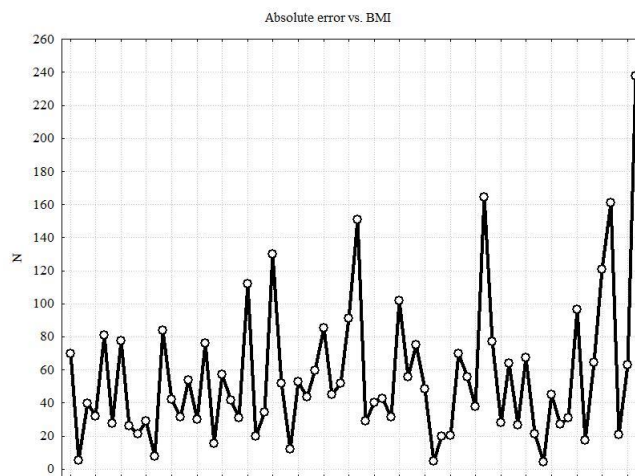


Figure 9. Interrelationships between absolute error and BMI

4. CONCLUSION

Crane operators execute very demanding, hard job, most frequently in not comfort position. Survey aimed to enable crane operators greater comfort appear more frequently in the last few years. Anyhow, solutions which lead to greater operator comfort are still rare.

This paper aimed to test relation between ergonomically adapted seat and brake pedal usage.

Results show that the measured forces that the crane operator achieves on the brake pedal in the working position have the expected values, which means that proposed seat solution is adequate. Survey has also proved a statistically significant correlation between BMI-index of body mass and mean value of force, as well as between BMI and absolute measurement error.

It is recommended, in future research to enlarge sample and repeat statistical testing.

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RESEARCH ON ACCIDENT SITUATIONS OF CRANE TRANSPORT SYSTEMS

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Abstract: Although in recent years more and more attention is paid to risk-based maintenance techniques and technical diagnostic methods are being implemented on an ever-increasing scale, cranes still participate with as much as one third in all deaths in certain types of industry. In line with that, the subject of this research is the verification of an instrument for the investigation of accident situations of the crane transport system. After conducting a factor analysis and reliability analysis, it was confirmed that the instrument with 8 dimensions of different weight factors can be used as valid and reliable. Data were collected in 51 domestic companies, where crane transport systems are used. The mean value of collected data shows that the examination of accident situations of the installed crane transport system is at a very low level in the domestic industry - 18.95 out of 75 points. The proposal of further research is to link the obtained data with other variables that affect the operation of the crane transport system, such as the commitment of management to risk management, training of maintainers and operators, prescribed work procedures, process safety information, change management, occupational safety and machine inspection procedures.

Keywords: crane transport system, risk, accident, factor and reliability analysis

1. INTRODUCTION

Cranes are extremely widespread group of machines, fundamental for transport processes in the construction, process, production and many other types of industry. (King, 2012). They are very massive, load can be dropped or mishandled and as such can pose a danger to human life and cause significant material damage. (King, 2012; Milazzo et al., 2016; Spasojevic Brkic et al., 2015; Brkic et al., 2015). Accordingly, previous research estimates the cranes cause a third of fatal accidents out of the total number of accidents occurring in the construction industry (Brkic et al., 2020). The consequences of accidents caused by the operation of cranes, in addition to material damage, sick leave and reduced employee motivation, often include injuries at work and/or deaths of employees in the immediate vicinity of the production plant or construction site (Zrnić et al. 2011; Pratt et al., 1997; Brkic et al., 2015). For this reason, it is necessary to study in more detail the causes of accidents on construction sites so that they can be successfully predicted and prevented. In order to do that, it is necessary, first of all, to collect data, but not only on data on previous accidents, but also to make a detailed analysis of work procedures and accident research.

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After that, it is necessary to adequately process the data in order to draw valid and reliable conclusions. In this paper, factor analysis of data collected by survey companies in the Republic of Serbia that use crane transport is presented, as the very first step towards reducing the number of accidents on sites where cranes operate and a very important factor that will determine the further course of research.

The paper after introduction in the second section provides an overview of previous research related to the number of fatal accidents in the world. The third section gives a detailed description of survey which was performed, followed by an exploratory factor analysis in order to reduce the dimensionality of the space, with the application of “varimax” rotation when it is necessary. At last, in the fourth part conclusions and future research avenues are given.

2. PREVIOUS RESEARCH

In the available literature, researches dealing with factor analysis of data obtained by surveying companies that use crane transport are rare. The research conducted so far relates primarily to the number and causes of accidents that have occurred on construction sites around the world.

According to that, there is research that based on data from the U.S. Bureau of Statistic for 2006, 72 deaths of workers were registered during accidents sampled by crane operation. Between 1997 and 2006, there were 818 deaths in the crane accidents in the United States of America (Arnold & Itkin, 2019), while between 2002 and 2006 in U.S.A. Texas leads with 27, then California with 25 and Louisiana with 17 fatal accidents (Arnold & Itkin, 2019).

Non-compliance with crane manufacturer’s regulations regarding loads and other restrictions is generally considered to be the main cause of accidents (Arnold & Itkin, 2019). The main causes of crane related accidents are (Arnold & Itkin, 2019):

- use of the crane for needs that are outside the production specifications and inadequate choice of crane,
- extreme weather conditions,
- improper crane set up,
- falling debris and other dangerous conditions around the crane,
- contact with transmission lines.

Wiethorn (2014) conducted a study of crane accidents in 49 U.S.A. states, South Africa, Brazil, Canada, the Bahamas, Puerto Rico, and the Virgin Islands and created a large database. The database records 716 accidents in the period from 1983 to 2013 years. By further analysis of the data collected in the database, Wiethorn (2014) observed the structure of primarily and secondarily responsible persons responsible for the accidents. Primarily responsible persons are defined as persons who, if they did not violate their responsibilities (did not perform their responsibility properly), the accident would not have occurred, while secondarily responsible persons are considered persons who have violated their responsibilities, the accident would have worsened, but its occurrence regardless of other factors. In the 94% U 94% of crane accidents, the human factor had an impact.

Shin (2015) also considered accident causes for construction tower cranes. The research was conducted in Korea, and included 38 construction tower cranes, in the period from 2001 to 2011 years, in which fatal accidents occurred. In the observed accidents, 53 people were died, while 15 were injured, which is a total of 68 victims. According to the

phases of work, it was determined that 36.8% of deaths occurred during installation (climbing), and 18.4% during the dismantling phase. The highest percentage of accidents, 68.4% occurred during installation/dismantling, while 18.4% occurred during normal operation.

Tomakov et. al. (2018) conducted research on the causes and consequences of crane accidents in Russia. According to their data, in 2016, 76,832 companies and organizations were monitored, and 725,000 different types of lifting equipment were recorded. Of this number, there were 200,113 lifts on 24,086 cranes and construction tower cranes.

During 2016 (on all lifting equipment covered by the research), 62 accidents were recorded in which 38 people died in 2015 there were 59 accidents and 58 people died. For the same accidents, 16 were injured in 2016 and 21 injured in 2015 (Tomakov et. al., 2018).

During 2016 in Russia, there were 42 accidents that occurred only during the operation of cranes, while 1 accident occurred during lifting (construction tower crane), 2 during the installation of cranes, and one when working with a cable car (Tomakov et. al., 2018).

Raviv et al. (2017a) analyse 51 accidents and 161 near misses and report on qualitative and quantitative analysis methods for a structured investigation of tower-crane-related incident stories (near misses and accidents) and come to conclusion that technical failures are the most hazardous risk factors within the tower crane domain, while failures related to the human factor were found to be only second to those related to technical factors. The same authors in (2017b) implement the analytic hierarchy process (AHP) to evaluate the quantitative outcome severity level values on data collected from near-miss reports and find a direct relationships between technical factors and the magnitude of their risk potentials, and inverse relationships between human factors and their risk potentials.

The survey Brkic et al. (2020) analyses accidents caused by crane operation from 1985 to 2018 year in 71 countries, with the aim of determining the frequency of injuries at work and deaths in each country individually and isolating those with the highest number of accidents, which results in one of the two outcomes, using Pareto analysis. Pareto analysis shows that 80% of fatal accidents occur in the following countries: Romania, China, Turkey, Bulgaria, Poland, Israel, Croatia and Spain. The main causes of accidents involving cranes using Pareto analysis identified machinery (including construction), inadequate use, assembly/disassembly and transport of the crane because 80% of accidents are due to their causes. Proposed further research, according to Brkic et al. (2020) is a detailed analysis of the role of the human factor in the dominant causes of accidents.

Previous research definitely points to the necessary analysis of the human factor, so this paper covers the effect of the human factor in the accident investigation process.

3. SURVEY DESCRIPTION

The survey instrument - questionnaire was sent by e-mail to 60 companies in Republic of Serbia, which use the crane transport system. Although official data is not available, the population of companies with a crane transport system, according to the authors of the survey and five surveyed experts, is not significantly larger. After three sending of the survey (initial sending and two reminders – requests to conduct the survey), during three months, 51 companies responded (with an average of 122 employees). Unexpectedly high response to the survey was noticed, 85%, which shows a very high degree of interest of the respondents in solving problems in the crane transport system.

The average number of employees in the surveyed companies is 159.85 with a standard deviation of 247.12. The survey was completed by experienced employees, with an average of 18.25 years of work experience. The surveyed companies have ISO 90000 certification in 73%, ISO 14000 in 47% and ISO 18000 in 51% of cases, while 42% of companies points out that they have an integrated management system for all three standards.

Table 1. Questionnaire layout

10	Question	Possible result	Real result
10.1	Is there a procedure for investigation the cause of incidents/accidents?	10	
	Does the procedure require the application of research findings of prevent new similar incidents?	5	
10.2	Does the procedure require the examination team to include:		
	a. A member trained in incident investigation techniques?	3	
10.3	b. A member acquainted in detail with the process of operation of the crane transport system?	3	
	Is there an accident/incident record that includes the following information?		
	a. Date of incident	1	
	b. Incident investigation start date	1	
	c. Incident description	5	
	d. Identified causes of the incident	5	
10.4	e. Evaluation of potential hazards and probabilities frequency of occurrence	5	
	f. Recommendations needed to prevent the incident	5	
10.4	Based on the history of failures, does it can be seen that the envisaged procedures for investigation the incidents of the crane transport system are being applied?	5	
10.5	Is adequate staff (engineers, crane operators...) involved in the analysis of incidents/accidents that occurred due to failure of equipment components of the crane transport system, in order to discover the cause of failure?	10	
10.6	Are all incident/accident investigation reports submitted to the suppliers of the crane transport system and is there a written procedure by which the suppliers undertake to prove that the incident did not occur through their fault?	7	
10.7	Have all incident reports of one crane transport system in the last year been forwarded to all other organizational units using the same or a similar crane transport system?	4	
10.8	Does the incident investigation procedure require that its findings be included in future risk analyses?	6	
	TOTAL POINTS	75	

4. FACTOR AND RELIABILITY ANALYSIS

Table 2 shows the calculated mean values and standard deviations for each question from survey.

Table 2. Mean value and standard deviation

Question	Mean Value	Standard Deviation
10.1	1.053	3.223
10.2	0.368	1.116
10.3	7.632	4.536
10.4	1.421	5.113
10.5	4.947	2.147
10.6	2.895	1.100
10.7	0.158	0.688
10.8	0.474	1.429

The primary goal of factor analysis is to compress the information contained in the original variables into a smaller set of new composite dimensions with minimal loss of information, respectively retaining a sufficient amount of information. Consequently, one of the main reasons for applying factor analysis is the law of “savings“ or parsimony, which allows a larger number of variables to be explained using as few sets of variables as possible, without significant loss of information (Hair et al., 1998). The aim of factor analysis is also the selection of factors describing the construct, which should be based on previous research, if any, and it is desirable to confirm the proposed factors by several experts (Cattell, 2012; Kline, 2014). The main goal of factor analysis has two lower level goals:

- a) reducing the dimensionality of the original space by factorization procedures and
- b) determining the connection between the constructs and the factors that describe it.

The sample size required for factor analysis is at least 50, and preferably 100 or more observation units (Cattell, 2012; Kline, 2014; Hair et al., 1998; Joseph et al., 2010). In the interpretation of factor analysis, it is very important to consider the total variance of variables explained with retained components, while the communality of an individual variable speaks about how much variance of a certain variable is explained with retained components (Cattell, 2012; Kline, 2014). Also, if groups of factors are not clearly recognized by the principal components method, it is necessary to transform them i.e. rotate factors to achieve factor independence. There are different ways of rotation, and the basic division is into orthogonal (“quartimax, varimax, equimax”) and oblique, depending on whether the factors are uncorrelated (orthogonal) or correlated (oblique) (Cattell, 2012; Kline, 2014).

The factor loading represents the correlation of the factor describing it, so that a higher factor load means that the factor better describes the construct. For the sample size in this study (51), a factor level of 0.70 is considered significant for test strength 0.80 and a significance level of 0.05 assuming that the errors assume twice the value of the conventional correlation coefficient (Hair et al., 1998; Joseph et al., 2010).

Table 3. Factor loadings

Factor loading (Varimax raw) Method: Principal components (Significant loads >.7)		
	Factor - 1	Factor - 2
10.1	0.908204	0.374172
10.2	0.964765	0.171371
10.3	0.859704	0.289482
10.4	0.636330	0.727179
10.5	0.872064	0.130890
10.6	0.111489	0.840722
10.7	0.305721	0.886343
10.8	0.861332	0.421805
Explained variance	4.507897	2.469431
Share in total variance	0.563487	0.308679

The Cronbach α coefficient describes the degree of consistency between multiple measurements of a variable by a coefficient and is calculated according to the formula (Hair et al, 1998):

$$\alpha = \left(\frac{k}{k-1} \right) \cdot \left[1 - \sum \frac{s_i^2}{s_{sum}^2} \right], \quad (1)$$

where is:

s_i^2 - variance for k individual measurements,

s_{sum}^2 - variance for the sum of all measurements.

The lower limit of acceptability for the Cronbach α coefficient is 0.70 as suggested by Nunnally, although many authors use less than 0.60, and the standardized α coefficient represents reliability when the values for all dimensions are standardized (z transformed), and calculated according to the formula (Hair et al., 1998):

$$\alpha_{st} = \frac{k \cdot \bar{r}}{1 + (k - 1) \cdot \bar{r}} \quad (2)$$

where is:

k – number of dimensions in the scale,

\bar{r} - mean correlation between dimensions.

The results of the reliability analysis are shown in Table 4.

Table 4. Reability of the scale - Cronbach α

Mean value=19.7059 Std.Dv.=15.7560 N:51 Cronbach α : .889347 Standardized α : .940875 Average correlation: .726901					
	Mean value – after rejection	Variance – after rejection	Standard Deviation– after rejection	Correlation	α - after rejection
10.1	18.23529	154.3368	12.42324	0.958385	0.840187
10.2	19.19608	212.4321	14.57505	0.903735	0.877141
10.3	11.80392	142.4713	11.93614	0.832600	0.868521
10.4	18.31373	144.2153	12.00897	0.842688	0.864456
10.5	14.54902	192.6005	13.87806	0.752565	0.868946
10.6	17.00000	226.5098	15.05024	0.469243	0.894917
10.7	19.58824	230.9481	15.19698	0.683474	0.895653
10.8	19.25490	210.7782	14.51820	0.943090	0.875073

Analysis in Table 4 shows that there is an adequate reliability of the scale, greater than 0.70.

5. CONCLUSIONS AND FUTURE AVENUES FOR RESEARCH

In this paper, statistical analysis of data obtained by surveying 51 companies in the Republic of Serbia that use certain type of crane transport system is done. The response to the conducted survey of 85% is a clean indicator of awareness of the problem of accidents that occur when using the crane transport systems.

The factor with the highest mean value, and even the best practice in Republic of Serbia, is the record of accidents/incidents in which the following data are: date of the incident, date of the beginning of incident investigation, description of the incident, identified causes of the incident, evaluation of potential hazards and probabilities, frequency of occurrence and recommendations needed to prevent the incident. The lowest value factor is related to the forwarding of incident reports of a certain crane transport system to other organizational units that use the same or a similar crane transport system. Reliability analysis also showed that there is adequate reliability of scale of all factors, while factor analysis showed a division into two groups of factors. The first group of factors consists of variables related to accident investigation procedures and records and the involvement of adequate staff in those jobs, and the second variables on failure history and incident/accident investigation reports. In this way, the redundancy of the data obtained by surveying the company was reduced, so that the conclusions can be reliable and valid.

The recommendation to companies in which crane transport systems operate is to:

- use the proposed measuring instrument to assess and monitor the situation, as valid and reliable,
- pay special attention to forwarding reports on incidents of the crane transport system to other organizational units in the company that use the same or a similar crane transport system,
- follow the procedures for investigating the causes of incidents/accidents, that the testing team includes a member trained in incident investigation techniques and a member thoroughly acquainted with the process of operation of the crane

transport system, that the record contains all necessary data, that based on failure history procedures for testing incidents of crane transport system, that adequate staff (engineers, crane operators...) are involved in the analysis of incidents/accidents, that all reports on incidents/accidents are submitted to suppliers of crane transport systems and weather there is a written procedure the suppliers undertake to prove that the incident did not occur through their fault, that all reports on incidents of one crane transport system in the last year have been forwarded to all other organizational units using the same or similar crane transport system and that the incident investigation procedure necessarily requires that its findings be included in future risk analyses,

- when they exist, the shortcomings of their work should be balanced between two groups of factors – those related to accident investigation procedures and records and the involvement of adequate staff in these tasks, on the one hand and those related to failure history variables and incident/accident investigation reports on the other hand.

The proposal of further research is to link the obtained data with other variables that affect the operation of the crane transport system, such as the commitment of management to risk management, training of maintainers and operators, prescribed work procedures, process safety information, change management, occupational safety and machine inspection procedures.

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LEADER VS. EMPLOYEES: INVESTIGATION OF DIFFERENCE IN PERCEPTION OF ORGANIZATIONAL CULTURE IN SMALL AND MEDIUM-SIZED ENTERPRISES

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Abstract: The purpose of this study is to investigate the differences in the perception of organizational culture between leaders and employees in small and medium sized enterprises in R.N. Macedonia. In order to gain a deeper understanding, the research will analyze the role of gender, age and tenure in shaping the potential differences between these two groups of employees. Data is collected using the VOX Organizations- a model proposed by Bojadzjev et. al. (2011) for measuring organizational alignment of organizational culture values of leaders and employees. A total of 8 companies with 93 employees participated in the research. The findings indicate that all companies fall into the category Democratic Entrepreneurship. Both genders have very similar perceptions regarding the two core dimensions of the organizational culture, with slightly more females perceiving the organizational culture as more democratic compared to males. With slight variations between companies and industries, both leaders and employees perceive the organizational culture as democratic and entrepreneurial oriented. This study will contribute to a greater understanding in the difference in the perception of organizational culture between leaders and employees in SMEs. The incorporation of the findings may contribute to developing more successful alignment strategies for SMEs making an integrative organizational environment for all levels and thus creating a competitive advantage. Furthermore, these findings help in creating a better understanding of the role of gender, age and tenure and delineating its relationship with organizational culture in SMEs.

Keywords: Organizational culture, SME, gender, age, tenure, employee, leader

1. INTRODUCTION

Although most of the future managers might have a feeling that the concept of organizational culture has been present in science for a long time, Hofstede et al. (1990) states that this term was only recently used in a scientific literature in the US (Pettigrew, 1979). The concept of organizational culture is developed from the fields of anthropology and sociology and became a key topic of organizational research in the 1980s (Ouchi & Wilkins, 1985). However, it has gain the attention and increased its influence in the business world in the last four decades. It is believed, that the concept of organizational culture was developed in order

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to emphasize the importance of the working atmosphere in the organizations over its functioning and success.

The modern managers are becoming more aware that the technology, product development, hierarchical maintains and power are not the only issues for organizations, but the attention has to be focused on the people working within, because they are the key factor for achieving better performance. In this direction, their job is to build solid and strong cultural values that will create a working environment for bringing people together and aligning their attitudes and behavior within the business process. As a result, the scholars began to explore the concept of organizational culture in order to help leaders and managers better make sense of organizational characteristics, thus improve organizational effectiveness and performance through managing both orderliness and chaos. (Trice & Beyer, 1993).

2. THE CONCEPT OF ORGANIZATIONAL CULTURE

The organizational culture is one of the most complex concepts among the organizational theories. The complexity is due to the different approaches that the authors use while explaining its nature. The study conducted in 1998, shows that within the academic literature there are 54 different between 1960 and 1993 (Tharp,2009). According to Kroeber and Kluckhohn (1985), there are more than 160 relevant definitions, based on variety of: geographical locations where they are made, religious beliefs, traditions and/or social backgrounds. This proves the belief that there are differences in ways the organizational culture is defined. What is common in all studies is that organizational culture is difficult to be measured, systematized and defined under the same umbrella In order to understand organizational culture; one must begin by primarily understanding the concept of culture. Culture has been defined as a historically transmitted pattern of meanings embodied in symbols. (Geertz, 1973) which is elusive, intangible, implicit, taken for granted and part of every organization” (Deal & Kennedy. 1982). This “use of symbols in the meaning of culture” is supported by many other authors (Deal & Kennedy, 1982; Trice & Beyer, 1993).

The following table provides an overview of the definitions found in the relevant academic literature.

Definition of organizational culture	Source
organizational culture can be understood as “distinctive constellation of beliefs, values, work styles and relationships that distinguish one organization from another”	(Harrison, 1993 cited in Maleka et al., 2015).
a system of shared meaning held by members, distinguishing the organization from other organization	Martins and Martins (2009, p.380).
perception of an individual of what his/her coworkers know, believe and mean	Keesing as cited by Jeger (1986).

as persistent patterns of norms, values, practices, beliefs and assumptions that shape the behavior of individuals and groups in a college or university and provide a frame of reference within which to interpret the meaning of events and actions on and off campus”	Kuh and Whitt (1988), (p. 6).
shared perceptions of organizational work practices within organizational units that may differ from other organizational units	Van den Berg & Wilderom’s (2004, p.571).
collective values, beliefs and assumptions being shared among members, existing at multiple levels and influencing the attitudes and behaviors of the employees	(Schein, 1990, Cameron & Quinn, 2011, Hartnell, Ou, & Kinicki, 2011).
Through organizational culture members can learn about the history of the organization thus they will know what their expected behavior is. Organizational culture can inspire its members to devote to the organizational values as well as to believe in the work they do. Organizational culture controls the organization through certain models of behavior. Organizational culture is an important factor for greater productivity and profitability.	Martin and Siehl (1983).

3. ORGANIZATIONAL CULTURE IN MACEDONIAN SMEs

Although the organizational culture is more spread in business practice and it is one of the main focus in management field, still there is a lack of research conducted in Republic of North Macedonia. One of the first studies dedicated on organizational culture that is conducted in the country is dealing with the question whether the organizational culture exists in Macedonian companies (Bojadjev and Krliu, 2007). This research does not only show that there is an existence of organizational culture within the Macedonian organizations, but also that the values of the founder are the key source of the culture.

The companies in the Republic of North Macedonia are considered to be socially and environmentally conscious. In the selection process, the companies are looking for right people that are corresponding with the organizational culture, although the introduction of the newcomers to organizational culture is not considered to be significant. According to the research, the employees do not consider the organization being responsible for employee’s career advancement and that there is a connection between organizational culture and leadership style.

Dominant culture in Macedonian enterprises is Mercenary culture which is characterized with low score on sociability and high score on solidarity. Moreover, they are focused on innovation, prefer to be team-oriented and they put an attention to details. Organizational cultures in small and medium enterprises do not have strong impact as national culture has over the employee’s behavior (Magdinceva-Sopova, 2012).

Another research shows that managers in the county do not possess skills which will result in detailed understanding of the whole business and they are focused on building competitive advantage through authorizing employees in the decision making process. Still, the companies use the outmoded way of “doing things” which is not practiced anymore by other companies in today’s business world (Macedonia 2025, 2014). The bottom-up flow of information practice is considered to have positive impact over efficiency and effectiveness of the Macedonian SMEs as well as that matching right people with right position is a practice for differentiating one organization to other (Abduli, 2013).

4. VOX ORGANIZATIONIS

VOX Ogranizations- “the voice of organizations” is a model proposed by Bojadziev et. al. (2011) for measuring the organizational alignment building on the theories of both, Semler (1997) and Tosti (1994) cited in Kolvitz (2016). Through this instrument, the organizational alignment was presented through two aspects; organizational culture and leadership present the non-formal part, and organizational structure, policies and strategy present the formal side of the organizational functioning.

Fundamental postulates of this instrument are designed in the way that the dimensions are developed to reflect the broader cultural environments and the specifics of the organizations in Macedonia and probably the region of the neighbouring countries.

Based on two core dimensions, Democratic vs Autocratic and Entrepreneurial orientation, the instrument proposes a typology of a “4 Culture Types” and those are: Entrepreneurial Autocracy; Entrepreneurial Democracy; Conservative or Managerial Autocracy and Conservative or Managerial Democracy as well as “4 Leadership Types” that correspond on the proposed culutre types: “Steve Jobs like”, “Jack Welch like”, “Army officer like” and “Banker like”.

To provide a full understanding for organizational alignment, VOX Organizationis take into consideration the formal part of the organization which is any formal document that might influence the behavior.

5. METHODOLOGY

The research was conducted in the first half of 2020 in small and medium sized companies in North Macedonia. The sample consisted of 93 employees and leaders from 8 companies that are considered to be SMEs. Most of the respondents were females (38,7%) and the rest were males. When it comes to age distribution, the majority of the respondents were between 35 and 40 years (43% or 40), followed by those aged between 45-55 years (23% or 22), then those aged 25-35 years (22% or 21) and 10 people aged +55 years or 10%.

The instrument used has been developed to measure the dimensions of the Vox Organizationis. The instrument has 21 items and uses a 5 point Likert-type scale to measure 2 dimensions or 4 sub-dimensions. The first core dimension is related to the decision-making and behaviour policies of the company and studies whether the organization is democratic or autocratic. This dimension actually has question three sub-dimensions: Decision Making and Behavior, People versus task orientation and Open versus Closed system. The second core dimension is Entrepreneurial Orientation and measures the tendency toward risk taking by the company and its employees. The VOX dimensions give an approximation of the culture type of the organization based on the two core dimensions and therefore provide an understanding

in regards to the organizational culture position in one of the four culture types proposed by VOX Organizationis.

6. RESULTS

To get an initial idea of the perceptions of the employees about the two dimensions, a mean and standard deviation for each dimension and sub-dimension was calculated which are given in Table 1 where the scores for the core dimensions are given in bold. This result was based on the answers of all respondents together. According to the data provided, it can be seen that the respondents have a tendency to perceive the organizational culture of the companies as democratic (M=3.64) Therefore, the companies stimulate openness in decision making process, flow of information as well as appropriate behavior awareness. The organizational cultures in the companies studied, according to employees opinions are people oriented which provides understanding that the companies respect their employees and take care of their work-life balance as well as giving timely feedback and adequate physical workplace conditions.

Organizational cultures are described as being open. This means that companies foster collaboration not only between the employees and sectors but also with the external environment.

If taken into consideration only the two core dimensions, the participants deem the overall culture of the company to be Democratic and entrepreneurial oriented. This means that the organizational cultures are democratically oriented and they stimulate experimentation, development of new product and ideas or is more oriented towards stability.

Table 1. Mean and Standard Deviation for the dimensions of VOX Organizationis

Organizational Culture perceived by the Employees

	Mean		SD	
	D1: Democratic vs. Autocratic Organization	D2: Entrepreneurial Orientation	D1: Democratic vs. Autocratic Organization	D2: Entrepreneurial Orientation
Company A	4,11	3,13	0.09	0.31
Company B	2,70	2,83	0.08	0.38
Company C	4,28	3,39	0.11	0.52
Company D	3,59	3,21	0.18	0.31
Company E	4,41	4,5	0.25	0.32
Company F	4,02	3,54	0.14	0.1
Company G	4,04	3,03	0.06	0.24

Leader's Values

	Mean		SD	
	D1: Democratic vs. Autocratic Organization	D2: Entrepreneurial Orientation	D1: Democratic vs. Autocratic Organization	D2: Entrepreneurial Orientation
Company A	4,12	3,83	1.48	1.6
Company B	3,39	3,17	1.55	1.33
Company C	4,74	3,83	0.71	1.83
Company D	4,02	3,83	1.28	1.33
Company E	4	4	1.09	0.8
Company F	4,17	3,83	0.96	1.17
Company G	4,13	3	1.24	0.9

In order to have a deeper understanding of the perceptions of the organizational culture various comparisons have been made for different demographic groups. Table 2 presents the results of the t-test for perception of organizational culture for gender for the two core dimensions. As it can be seen both genders have very similar perceptions regarding the two core dimensions of the organizational culture. The females perceive the organizational culture as more democratic than males, although both genders perceive the culture as being more democratic than autocratic. From Table 2, one can see that there is no statistically significant difference between males and females on a level $p < 0.05$, with exception of the democratic perspective of females and males in Company C and Company D.

Table 2. T-test results for Gender

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company A	D1: Democratic vs. Autocratic Organization	Female	4.15	0.36	0.82	0.12
		Male	3.33	0.48		
	D2: Entrepreneurial Orientation	Female	3.76	0.26	0.85	0.08
		Male	2.91	1.11		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company B	D1: Democratic vs. Autocratic Organization	Female	2.93	0.96	0.21	0.45
		Male	3.14	0.27		
	D2: Entrepreneurial Orientation	Female	3.16	1.47	2.89	0.65
		Male	0.27	0.37		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company C	D1: Democratic vs. Autocratic Organization	Female	4.4	0.38	0.36	0.004
		Male	4.04	1.04		
	D2: Entrepreneurial Orientation	Female	3.41	1.13	0.02	0.92
		Male	3.39	1.36		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company D	D1: Democratic vs. Autocratic Organization	Female	3.29	0.31	0.69	0.018
		Male	3.98	0.49		
	D2: Entrepreneurial Orientation	Female	2.94	0.40	0.47	0.23
		Male	3.41	0.40		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company E	D1: Democratic vs. Autocratic Organization	Female	4	0	0	0.28
		Male	4	0		
	D2: Entrepreneurial Orientation	Female	4	1	0	0.94
		Male	4	0		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company F	D1: Democratic vs. Autocratic Organization	Female	3.97	0.37	0.03	0.88
		Male	4	0.20		
	D2: Entrepreneurial Orientation	Female	3.38	0.30	0.21	0.59
		Male	3.59	0.09		

In company G, no male employees are working. Therefore, no t-test results for gender is provided.

Another t-test was done in order to study the difference in the perceptions between leaders and employees. The Table 3 presents results that show that there are no statistically significant differences in the opinions about the organizational culture between the two groups. This means that both the leaders and the employees think that the organizational culture of the companies is democratic and entrepreneurial oriented.

Table 3. T-test results for Leaders versus Employees

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company A	D1: Democratic vs. Autocratic Organization	Employee	4.11	0.09	0.01	0.94
		Leader	4.12	1.48		
	D2: Entrepreneurial Orientation	Employee	3.13	0.08	0.7	0.28
		Leader	3.83	1.6		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company B	D1: Democratic vs. Autocratic Organization	Employee	2.70	0.08	0.69	0.34
		Leader	3.39	1.55		
	D2: Entrepreneurial Orientation	Employee	2.83	0.38	0.34	0.50
		Leader	3.17	1.33		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company C	D1: Democratic vs. Autocratic Organization	Employee	4.28	0.11	0.46	0.15
		Leader	4.74	0.71		
	D2: Entrepreneurial Orientation	Employee	3.39	0.52	0.44	0.57
		Leader	3.83	1.83		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company D	D1: Democratic vs. Autocratic Organization	Employee	3.59	0.18	0.43	0.52
		Leader	4.02	1.28		
	D2: Entrepreneurial Orientation	Employee	3.21	0.31	0.62	0.34
		Leader	3.83	1.33		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company E	D1: Democratic vs. Autocratic Organization	Employee	4.41	0.25	0.41	0.69
		Leader	4	1.09		
	D2: Entrepreneurial Orientation	Employee	4.5	0.32	0.5	0.47
		Leader	4	0.8		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company F	D1: Democratic vs. Autocratic Organization	Employee	4.02	0.14	0.15	0.81
		Leader	4.17	0.96		
	D2: Entrepreneurial Orientation	Employee	3.54	0.1	0.29	0.58
		Leader	3.83	1.17		

	Dimension	Gender	Mean	SD	Mean Difference	Sig (2-tailed)
Company G	D1: Democratic vs. Autocratic Organization	Employee	4.04	0.06	0.09	0.06
		Leader	4.13	1.24		
	D2: Entrepreneurial Orientation	Employee	3.03	0.24	0.03	1.06
		Leader	3	0.9		

The differences in perceptions of organizational culture between different age groups were studied based on ANOVA test results, shown on Table 4 (Appendix). All age groups consider the culture as Entrepreneurial Democracy. The shows that there are no statistically significant differences between different age groups, except in the Companies D, where $p=0.05$.

7. DISCUSSION AND CONCLUSION

The main aim of the research was to explore the organizational culture in SMEs in the Republic of North Macedonia. For this purpose, the component of Vox Organizationis for investigating organizational culture was implemented in 7 companies in different sectors. The following segment of the discussion will focus on the organizational culture within different industries in the Republic of North Macedonia. As it was presented in the results section, the findings from the research suggested that the employees from companies in different industries such as construction industry, construction materials industry, food industry, wine industry and IT industry perceive that their companies are more democratic than autocratic.

More specifically, the results indicated that the employees in all explored industries feel that the companies encourage openness in decision making, consultations with employees in regards to work-life balance opportunities, timely feedback and care for the work place conditions.

In regards to entrepreneurial orientation, the organizational members consider that overall, the organizational culture of the studied companies should be considered as entrepreneurial oriented. The results of the research indicate that both genders have very similar perceptions regarding the two core dimensions of the organizational culture. There is no statistically significant difference between males and females in the perception of organizational culture with females perceiving the organizational culture as more democratic than males, although both genders show tendency to perceive the culture as more democratic. According to the academic literature, there are gender differences in perceiving culture. In other words, different approaches may be employed by male and other by females while leading and organizing the business transactions with the company (Tipu, 2018). However, in this study the similarity of gender and organizational culture can be understood based on the difference in industry studied for this research, because different industry impose different gender. Considering all the above, we may consider that gender differences may contribute to our further understanding of different cultural orientations in SMEs in the country. The results from this research show that there is no statistically difference in the perceptions between employees and leaders. This provides an understanding that both groups think that the organizational culture of the companies are democratic and entrepreneurial oriented. Therefore it can be concluded that both the leaders and the employees place the organizational culture on the border of Entrepreneurial Democracy. In comparison with the academic literature, there is a lack of information regarding the positional perception of organizational culture.

8. LIMITATIONS OF THE STUDY

There are limitation of this study are not excluded. One can consider that the risk of social desirability bias is one of the main limitations for this study. Even though, the respondents are anonymous, still the level of honesty provided in direction of organizational perception and feeling should not be taken for granted. Another risk is self-selection bias, meaning that there is a lack of information whether the respondents are representative of the total population in a specific industry. The last limitation is the demographic location of the respondents. This research was investigated only in the Republic of North Macedonia, and therefore the additional studies should provide more comprehensible analysis of such variables.

9. CONCLUSION

The academic literature contains an extensive discussion on the topic of organizational culture. However, there is a gap when it comes to understanding of organizational culture in SMEs in Republic of North Macedonia. At the same time, this study provides an overview and understanding of the organizational culture availability in the academic literature. Furthermore, there is a recommendation for selected organizational culture instrument in context of the SMEs. Besides the identified organizational culture type in SME, there are different options on which culture can influence the SMEs. The discussion provided also

reveals the benefits that SMEs may have when they identify and understand their culture, leadership and alignment, as well as their influence on performance of the business.

APPENDIX

Table 4. ANOVA Results for Age

Company A

Anova:
Single
Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
25-35	2	7,388889	3,694444	0,347222
35-45	2	7,133333	3,566667	0,642222
45-55	2	6,766667	3,383333	0,093889
55	2	6,866667	3,433333	0,375556

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0,117593	3	0,039198	0,107472	0,951349	6,591382
Within Groups	1,458889	4	0,364722			
Total	1,576481	7				

Company B

Anova:
Single
Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
25-35	2	6,1	3,05	0,027222
35-45	2	5,988889	2,994444	0,051914
45-55	2	6,133333	3,066667	0,008889
+55	2	5,466667	2,733333	0,32

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0,144074	3	0,048025	0,470802	0,718913	6,591382
Within Groups	0,408025	4	0,102006			
Total	0,552099	7				

Company C

Anova:
Single
Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
25-35	2	6,733333	3,366667	0,002222
35-45	2	8,05	4,025	0,740139

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0,433403	1	0,433403	1,167633	0,392864	18,51282
Within Groups	0,742361	2	0,371181			
Total	1,175764	3				

Company D

Anova:
Single
Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
25-35	2	9,233333	4,616667	0,027222
35-45	2	7,477778	3,738889	0,010432
45-55	2	9,50932	4,75466	0,002956

ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	1,214218	2	0,607109	44,84905	0,005822	9,552094
Within Groups	0,04061	3	0,013537			
Total	1,254828	5				

Company E

All employees are aged in category 25-35. Therefore no ANOVA is provided.

Company F

Anova:
Single
Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
215-35	2	7,516667	3,758333	0,106312
35-45	2	7,583333	3,791667	0,098765
45-55	2	7,15	3,575	0,21125

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0,054444	2	0,027222	0,19616	0,831643	9,552094
Within Groups	0,416327	3	0,138776			
Total	0,470772	5				

Company G

Anova:
Single
Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
35-45	2	7,2	3,6	0,375556
45-55	2	7,013333	3,506667	0,3872
55+	2	6,933333	3,466667	0,667654

ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0,018726	2	0,009363	0,019637	0,98068	9,552094
Within Groups	1,43041	3	0,476803			
Total	1,449136	5				

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NEW CHALLENGES TO THE MANAGEMENT DECISION - MAKING PROCESS IN DIGITAL BUSINESS ENVIRONMENT

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Abstract: Modern trends in the processes of economic enterprises activity transformation launch new challenges to the procedure for developing and making management decisions. Business infrastructure is rapidly changing, standard methods are losing their relevance in the context of using IT and Big Data technologies. The speed of data collection allows not only to reduce the time for solving current issues but also to increase the level of decision's adaptability. The most urgent issue is the possibility of transforming the decision-making process to the digital business environment. On the one hand, the introduction of digital technologies makes it possible to build an algorithm for making decisions without the participation of the human factor, and on the other hand, there is a question about the possibility of managing business processes in the organization based on decisions, which made by artificial intelligence. The article presents a new approach to the role of the decision-making subject in the process algorithm, as well as new competencies required by managers in the modern business environment. In addition, based on the analysis of specific features of the management decision-making process, made a conclusion about the conditions and the possibility of adapting the process in the digital space.

Keywords: digital transformation, business-processes, decision making, digital management, digital competences

1. INTRODUCTION

Decision making is a routine function of any individual in everyday life. Management-related decision-making is the function of the head of business entities regardless of the size, organizational form and scope of the enterprise. It is not difficult to make a decision, it is difficult to make the right decision. The events of the past few years show that the traditional process of developing and making management decisions is being transformed following changes in economic realities, thereby posing a challenge to the competencies of management in general and the ability of individual leaders to perform management tasks, in particular.

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2. DECISION - MAKING PROCESS TRANSFORMATION

Consider a decision-making process as an algorithm for a step-by-step activity performance in the context of the influence of external and internal factors and their change in the context of digital transformation of the world and national economy as a whole. The main stages of decision-making are considered to be: the process of aggregating relevant information to identify the main factors influencing the goals of the organization, studying the array of data using general and special analysis methods, developing and analyzing possible implementation alternatives, choosing the optimal alternative using quantitative and heuristic approaches, and ensuring implementation of the decision. Global changes of external factors affecting the management function and entailing new requirements to ensure the process of effective organization management lead to the need to develop and implement digital management competencies. By digital management competencies, the authors of the publication understand competencies that determine the ability to make decisions in the context of business transformation taking into account changes in factors influencing the efficiency of the system.

One of the main factors influencing the decision-making process in modern conditions is time and speed of implementation of changes. Technological processes, business processes of the organization's operational activities, preferences and needs of people are accelerating and constantly changing. The catalyst for the acceleration of the pace of an individual's everyday life and the avalanche-like increase in the achievements of scientific and technological progress is the computerization and informatization of society, speed, accessibility, the ability to aggregate, process and exchange significant amounts of information. At the same time, information is received in real time, which should ensure timely decision-making. An estimated 4.1 billion people were using the Internet in 2019, up 5.3 percent from 2018, with 1 million more Internet users every day (Figure 1).

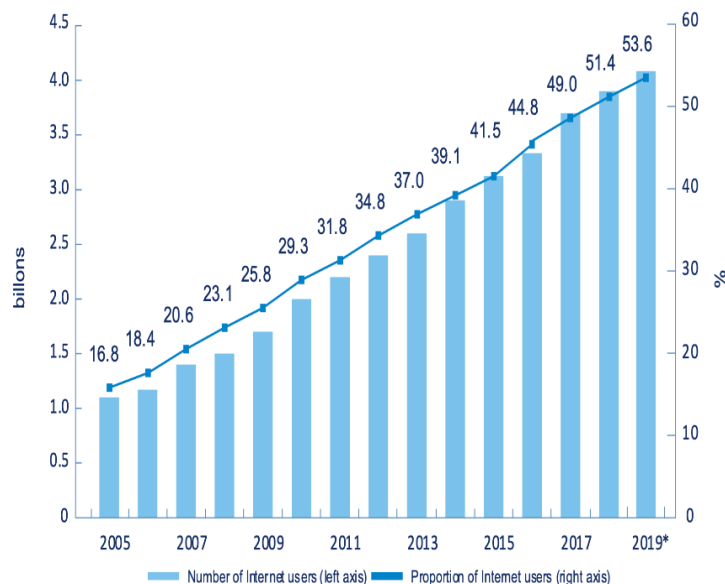


Figure 1. Number of Internet users (<https://itu.foleon.com/itu/measuring-digital-development/internet-use/>)

Between 2005 and 2019, the number of Internet users grew by an average of 10 percent per year (Figure 2).

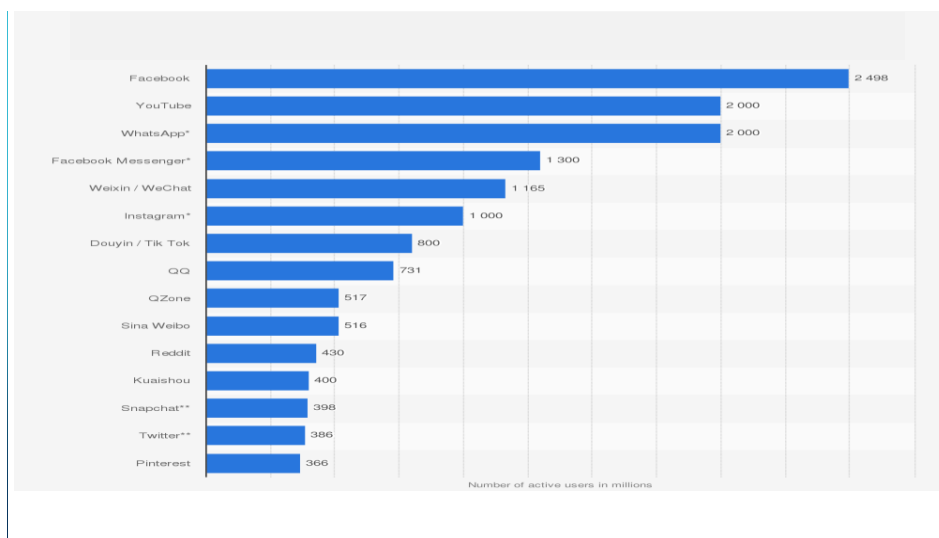


Figure 2. Number of Internet users of popular social networks
(<https://itu.foleon.com/itu/measuring-digital-development/internet-use/>)

The acceleration of the process is also associated with the elimination of the boundaries of the distribution of information which leads to the possibility of obtaining information in a relatively short time. Communication and exchange of information, the ability to make decisions online is also due to the active use of social networks, cross-border distribution of information between countries and continents. Currently, the most popular social networks have billions of users (<https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/>). Under these conditions, the development and decision-making process undergoes fundamental changes: firstly, the time frame for the development and adaptation of solutions is narrowing, and secondly, the amount of information and the required speed determines the possibility of using artificial intelligence, the technological capabilities of which will exceed the physical abilities of a person. At this stage of collecting information, the question arises about a person's limited capabilities, about his/her ability to perceive the current volume of information per unit of time, to realize and assess the degree of its reliability, and also to determine its relevance and degree of influence on the management object.

Today, in the context of the development of information technologies, the key driver of the development of economy in general and the organization in particular is Big Data technologies. It should also be noted that at the stage of collecting relevant information, the decision-making process undergoes dramatic changes. Previously, the main task of this stage was to collect enough information to analyze the current situation, to aggregate and sort it. For this purpose, accounting indicators and management accounting data of the sphere of interests of the organization were used. At the same time, access to external sources of information about the activities of potential counter parties was practically inaccessible. The development of information technologies and the capabilities of data collection technologies of Big Data determine new data sources, ensure their statistical processing and accessibility to users, and also allow collecting an almost unlimited amount of information about the behavioral, social, and professional characteristics of the subject. Currently, the following are considered sources of data collection for making management decisions at all levels (level of economic entities of

the national economy, state and international organizations): administrative data (from government sources, insurance funds, medical institutions, statistical information, etc.), operational data about transactions between business entities (online payments, transactions of bank accounts, transactions using mobile devices, data on purchases, deliveries, refusals), data of neural networks (satellites, road and meteorological sensors, etc.), behavioral data of users from Internet sources, including not only information about the nature and frequency of requests, but also allowing to track the characteristics of the user by his comments, statements and other activities (source of individual opinions) (<http://unstats.un.org/unsd/statcom/doc14/2014-11-BigData-E.pdf>). The amount of information generated by users is growing in ever-increasing proportions. According to the forecasts, by the end of 2020, the volume of stored information on a global scale will reach about 40-44 zettabytes (1 ZB ~ 1 billion GB), by 2025 up to 400 zettabytes.) (<https://habr.com/ru/company/moex/blog/256747>) A distinctive feature of information storage is the lack of its structuredness, which imposes new requirements on the user.

The collection of information with the use of Big data technologies makes it almost impossible to process it solely using the physical abilities of the individual, as well as traditional computer data processing programs. Large databases are of the following characteristics - the volume of information, its diversity, high speed of collection and distribution which entails the need for software technologies to collect and process information, build a database architecture, storage and security of storage and access to the systems. Demand is driving the growth of the global big data software market, which was estimated of \$ 168.8 billion in 2018 and is projected to grow to \$ 274.3 billion by 2022, it will amount to 13.2 percent with a five-year compound annual growth rate (<https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/>).

Currently, technologies have been developed and continue to develop to collect, aggregate, manage and analyze a large amount of information. Analysis methods include a group of data mining methods, data fusion and integration, statistical and cluster analysis, a set of natural language processing (NLP) methods, modeling, crowdsourcing, genetic algorithms, visualization, etc. Hadoop, HBase, SQL analysis methods are becoming popular ((p.29-33), <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/big-data-the-next-frontier-for-innovation>). These methods have the competence in their application and interpretation of the results obtained. So, the process of making management decisions requires collection and process of an array of data and information. In modern conditions, this process is fully automated and has fundamental differences from previously used technologies for collecting financial and management information. The main differences between business processes are presented in Table 1. These differences, in the opinion of the authors, will determine the digital competencies of a modern leader.

Table 1. The main differences between business processes (Made up by the authors)

Big data analysis	Traditional data analysis
Data is coming in real time	Data is coming discrete as it is collected
Data is updated in real time	Data is updated discrete as it is collected
Data can be increased horizontally and vertically	Possibility of data increase is limited
Possibility to search necessary data using IT technologies	The necessary information is collected at the user's request
IT technologies provide data analysis at the user's request	Working with data requires preliminary analysis
Data analysis competencies are required	Specific programs and methods of data analysis are required

Big data analysis tools and technologies, such as predictive analytics and data mining will be more and more in demand by organizations and government agencies, as they will allow them to make decisions and generate new ideas for business. In addition, the use of artificial intelligence will provide necessary speed and accuracy of analytics, which will allow improve operational and strategic business processes in real time. The business intelligence and analytics software market is projected to reach \$ 14.5 billion by 2022.

Another factor that determines the external infrastructure of the management decision-making process is the level of risk and uncertainty of the external and internal environment. The volatility of the business environment determines an increase in the likelihood of realizing risks, the sources of which are not always obvious, and the consequences are not predictable. In all areas of life, the level of risk is growing and in the near future, according to experts, this indicator will only increase (see Figure 3).

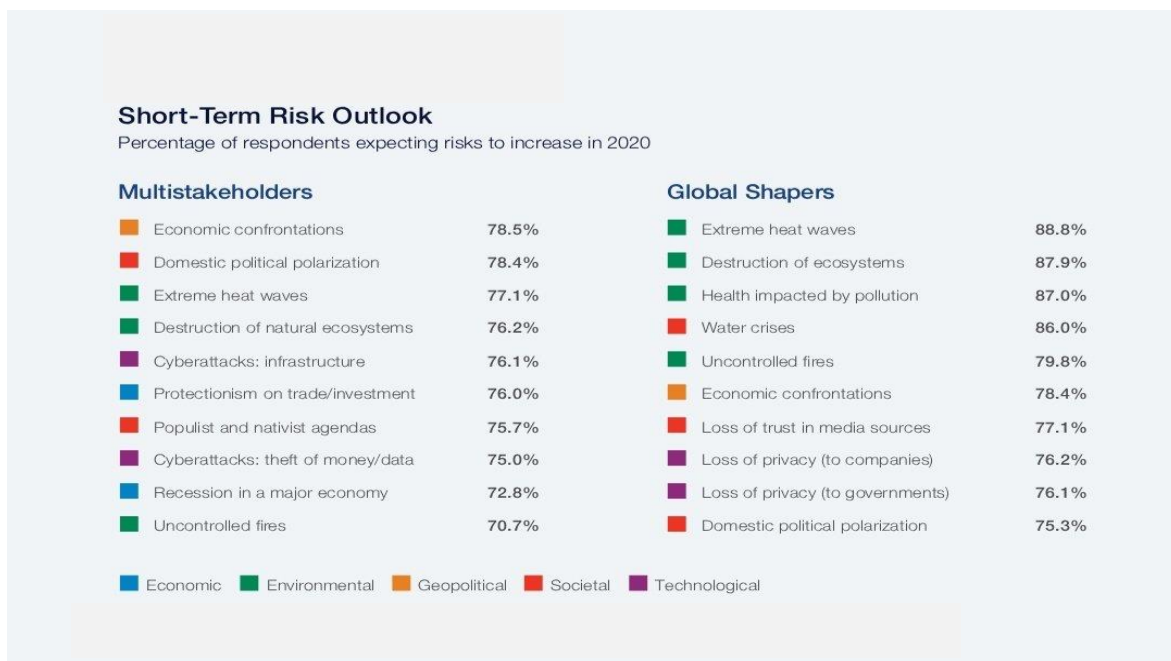


Figure 3. Short-Term risk outlook (p.29-33), (<https://www.weforum.org>)

In these conditions, decision making becomes not just a choice of an alternative course of action, but also a matter of taking risk. The updated international standard on risk management offers an integration model linking the decision-making process and accounting for the impact of risk factors. When making decisions, one should take into account not only the potential impact of risk on the control object, but also the complexity of the risk, the speed of its manifestation, and the possibility of adapting the system. And if earlier the goal of risk management was to minimize the likelihood of implementation and the scale of the impact, today a new direction of work is also emerging - namely, "risk addition", which represents the possibility of increasing it under certain conditions and the need to accept these conditions in full when performing operational functions and strategic management while ensuring the stability of the system (https://www2.deloitte.com/content/dam/Deloitte/ru/Documents/risk/russian/rules-of_game-changing.pdf). In this context, it should be noted that in the context of opportunities for the growth of digitalization of the economy, the use of virtual and augmented reality tools, the use of technologies for collecting and processing a huge amount of data, one of the main risks is the risk of cyber attacks and fraud, as well as the risk of using artificial intelligence. The experts of the world economic forum included these risks in the list of top 10 risks in the long term period (for the next 10 years) (<https://www.weforum.org>). All this entails the need to form new competencies in the subject of management, which will combine not only managerial knowledge, but also the skills of risk assessment and decision-making in conditions of increasing uncertainty, taking into account risk appetites and the level of tolerance to the effects of negative factors.

3. MANAGEMENT COMPETENCIES

It is becoming obvious that the speed of change, the continuity of obtaining information, the increasing level of risk and uncertainty of the external environment, the rapid development of technology require a modern leader to have professional knowledge and skills in the field of management and organization of work. Change is happening so quickly and the reason is so unclear that it is almost impossible to be ready in advance. One more factor of the infrastructure for making management decisions should be noted, namely the uncertainty of development, the possible existence of several alternatives in the long term and even in the short term perspective. These conditions require, on the one hand, the ability to find new solutions and implement them in a relatively short time, and on the other, the ability to implement solutions in stages, generate new ideas, make adjustments and revise solutions in real time.

The authors of the publication systematized the main methodological principles of their classification having analyzed the required competencies of specialists in business processes transforming in the context of digital transformations, in order to set tasks for analysis. This publication will consider the main types of competencies of decision-makers for hard competencies, the so-called "Hard Skills" and soft (flexible) competencies, known as "Soft Skills".

Traditionally, rigid competencies in management include a certain set of fundamental, technical skills of a person that allows him/her to make decisions using formalized, standard decision-making technologies, for example, using mathematical, statistical methods or using programming methods for the purpose of mathematical modeling and forecasting business processes, descriptive data analysis, planning business tasks, etc.

Some time ago, in the absence of the prevalence of flexible competencies, due to their irrelevance to existing business processes, rigid skills were the only important ones and served as the basis for setting a task in business processes. At the same time, the main advantage of the person most fully fluent in hard skills was the ability to act according to instructions, according to a template, that is, to make a decision according to a certain scheme, bringing the entire sequence of actions to automatism; flexible, creative skills became useless.

Moving on to the characteristics of flexible competencies, one should consider the fact that in this case decision-making is based on the ability to think not in a standard way, using a template, but showing flexibility to the conditions of a changing business environment creatively. In this case, a person is able to adapt to some of the features of the business process, making a decision in one case or another, using the so-called agile technique. At the same time, the aspect of multivariate choice is used when making a decision.

Today, flexible skills and an agile management approach are relevant to the requirements of modern companies operating in a digital business environment and allow them to be adaptable when making a certain type of business decision, adjusting the process in one direction or another.

When making a comparative analysis of hard and soft competencies when making a decision, one should systematize the main parameters inherent in both skill groups. The systematization data is presented in Table 2.

Table 2. Comparative analysis of hard and soft competencies (Made up by the authors)

Hard Skills issues	Soft Skills issues
Consistency in decision making	Adaptability in decision making
Clear decision-making algorithm	Team skills
Simple problem statement	Management flexibility
Limited options for the decision	Adaptation to the business-process
Possibilities for predicting a solution	Non-standard decision made
Possibilities of template duplication of a solution given similar input parameters	Multivariate of tasks

Thus, analyzing the data in the table, it should be noted that each of the described types of competencies contains a certain set of parameters that can be used when making a decision within a certain business process. In the modern "digital" world, it is impossible to make a decision, focusing only on rigid competencies, since the parameters of the decision-making entry into decision-making have changed significantly, as was mentioned by the authors earlier. In this case, more flexible, non-standard, in some cases, generated by a team of participants, creative solutions are required that meets the requirements of Soft Skills more.

On the other hand, in today's digital economy, it is impossible and impractical to make business decisions only focusing on agile management, originality and creativity. We are talking about the fact that huge arrays of Big Data that are generated every minute on the international and Russian markets in various areas of economic activity, as well as in companies carrying out commercial activities in the framework of small, medium, large-scale business and on business platforms of the type marketplaces and ecosystems, require modern managers to have an aggregate set of skills and competencies from the Hard and Soft groups, allowing them to adopt an adequate, based on understanding of machine data generation algorithms that can "work" with these algorithms, customize them in business processes, ultimately adapting a decision made to a specific business task of a company or market.

4. COMPETENCIES MODEL

Completing the substantiation of the principles of decision-making in the short or long term perspectives, one should additionally think of the fact that digital technologies (large amounts of data, the capabilities of modern software products, artificial intelligence, neural networks and machine learning), it was described in detail in the previous section of the publication, require rethinking the principles of using the hard and soft competence approach when making a business decision.

In an era of active use of information technologies by companies, decision makers should focus on combining these types of skills, forming a so-called integrated competency model of skills among the company's specialists, including basic hard skills in such important areas as mathematics, statistics, computer science, programming, later people will refer to the skills of expressed in adaptability, creativity, the ability to work in a team, following their role, stress resistance, and so on acquired by a human being . In our view, it is such a competency model that is the basis for the effective work of company personnel in the near future, since it allows to achieve a synergistic effect when using both hard and soft skills, that is, knowing how to correctly set a business problem using hard skills, and how to solve it, using the elements of agile competencies in the best possible way. Figure 4 shows the competence model of transformation of the main parameters of business processes and management competencies.

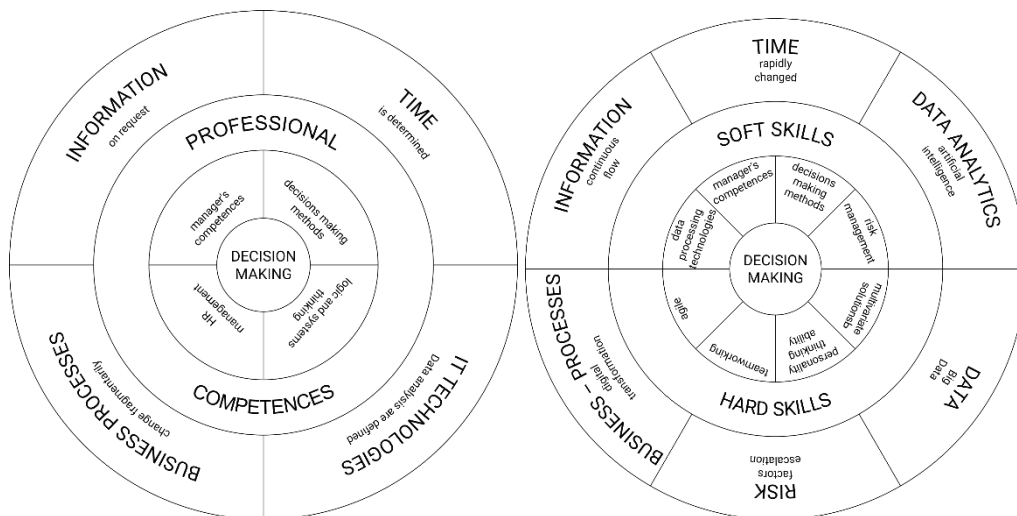


Figure 4. The competence model of transformation of the main parameters of business processes and management competencies [Made up by authors]

Having conducted a comparative analysis of open source data of the modern educational environment of higher education on the example of leading Russian universities, the authors of the publication did not come across a single educational program of higher education (bachelor's and master's degrees) that would enable applicants to get an education at the junction of hard and soft competencies by studying basic courses related to mathematics, statistics, computer science, information technology, on the one hand, and data management, teams, business processes, on the other hand. Perhaps the appearance in Russian universities of such an integrated educational program could provide an opportunity for the preparation of

modern, highly qualified specialists for work in companies in the business environment of the future.

5. CONCLUSIONS

Thus, based on the analysis of environmental factors that determine the activities of the organization today, as well as taking into account the requirements for the management process and the competencies of the decision maker, the authors made the following conclusions:

1. The competencies of a manager are now becoming broader than professional management skills and also require the development of personal characteristics that contribute to an increase in the efficiency of the managerial decision-making process (a combination of hard and soft skills).

2. Professional management competencies (hard skills) provided by the traditional management training need significant multiple examination and improvement in terms of supplementing with technical skills in the field of software, the ability to analyze information, formulate and solve programming problems with the risk and uncertainty in the external environment.

3. Personal qualities of a leader (soft skills) should be developed in the field of leadership at all stages of development and decision-making, using agile technologies, and the ability to carry out activities under conditions of an ever-increasing pace of change.

4. All this allows us to conclude that the educational programs of higher education of management training should be developed at the junction of humanitarian and technical (technological) disciplines, providing training to leaders of a new format, capable of setting and solving problems in the context of digitalization and opportunities of artificial intelligence on an ever-increasing scale.

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GRAPH DATABASE MODELING OF A 360-DEGREE E-CUSTOMER VIEW IN B2C E-COMMERCE

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Abstract: For every B2C e-Commerce company, one of the major hurdles is the challenge of tracking the digital footprints of each e-Customer's activities during their online shopping sessions. As online competition becomes fiercer over time, online retailers face increasingly more sophisticated e-Customers. Knowing their buying habits and online shopping behaviors, which is a basic premise for building any strategies vis-à-vis retaining current and attracting new e-Customers, creates great opportunities for those who are capable of following and capturing relevant data about their e-Customers' digital trails. Usually part of contemporary CRM systems, the digital profile of an e-Customer, also known as 'a 360-degree e-Customer view', represents a collection of all e-Customers' data in one place. In this paper, a graph database modeling framework for constructing a 360-degree e-Customer view is proposed, with a single aim of exploring the possibilities of using NoSQL graph databases in storing highly relational data reflecting the complex interactions between e-Customers and a particular B2C e-Commerce website during online shopping sessions. The modeling framework is based on the utilization of a Customer Behavior Model Graph (CBMG) and is being implemented in Neo4j. The resulting graph database model represents a solid basis for answering a plethora of CRM-related questions.

Keywords: 360-degree view, e-Customers, graph databases, B2C e-Commerce, Customer Behavior Model Graph (CBMG), Neo4j

1. INTRODUCTION

The rapid growth and use of ICTs, particularly the broad proliferation of the Web 2.0 paradigm in the last two decades, have dramatically changed conventional ways of doing business throughout the world. The e-Commerce model has become a deciding factor both for the survival and prosperity of businesses in the contemporary global surrounding. Going online has provided businesses with plenty of new possibilities, but several possible obstacles to new market approaches have also been revealed. At the same time, the way how people shop has witnessed a seismic shift, too. The advent of the B2C e-Commerce paradigm has fundamentally changed the shopping behavior of millions of people worldwide since the modern ICTs have transformed every aspect of the sales process, including sourcing, browsing, searching, recommending, choosing, comparing, checking, ordering, receiving...

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This has contributed to a great deal of continual transformation of e-Customers, who became highly sophisticated. Though e-Commerce has provided more opportunities than ever before, it provides a very individual form of shopping for e-Customers. Each online shopper is different, displaying his/her patterns of behavior. Having minded this notion, it is of the utmost importance for online retailers to meet various e-Customers' expectations, and to induce positive online shopping experience and satisfaction. For online businesses, the best business strategy of all is, without question, the production of content e-Customers who might eventually produce even more e-Customers. Satisfied e-Customers are the only prerequisite to attract and then retain new e-Customers in the long run.

According to Roy H. Williams, a famous American businessman, "the first step in exceeding customer's expectations, is to know those expectations." In the current, so-called 'digital economy', making organizations more customer-centric becomes a crucial task, because the more they know about their customers, the less they need to worry about losing them. The more they know about their customers, the more they can provide to them the information that is increasingly useful, relevant, and persuasive. The so-called 'age of the customer', representing a transition in power from institutions and organizations towards customers, has changed and continues to change, the rules of business (Forrester.com, 2011). The first step in managing the value, experience, and expectations of customers successfully is to know who the customers are. Therefore, the design and construction of a 360-degree view of customers and their behavior must be prioritized, since "companies that make extensive use of customer analytics are more likely to have a considerable impact on corporate performance, outperforming its competitors" (Fiedler et al., 2016). In that context, a relevant, personalized, and ubiquitous customer service can be achieved solely by undertaking actions such as identification, knowing, evaluating, developing, customizing, retaining, and anticipating (Casariego Sarasquete, 2017, pp. 57–58).

The part '360-degree' denotes 'complete' or 'all-around', whilst the part 'view' refers to the ability to see something from a particular place or angle. Therefore, the term '360-degree view of a customer' suggests the ability to use the best available and most relevant information about each customer to enhance sales, marketing, and servicing decisions.

Recognizing the need for gathering all the e-Customers' interactions with a particular virtual store during their online shopping sessions, as well as the necessity to understand and learn from their online behavior, thus being able to anticipate their next moves, needs or expectations, the paper focuses on developing a framework for building a 360-degree view of e-Customers, based on the utilization of Customer Behavior Model Graphs (CBMGs) and NoSQL graph databases.

The rest of the paper is organized as follows. Section 2 provides an overview of some of the most prominent research, including white papers, made on the concept of a '360-degree view of customers' during recent years. The corresponding graph database model, based on the Customer Behavior Model Graph (CBMG) and the graph database model of an arbitrary e-Commerce website, is being proposed in Section 3, whilst Section 4 provides illustrative examples of how the graph database, implemented in Neo4j, can be effectively used for answering several CRM-related questions using Cypher Querying Language (CQL). The last section concludes.

2. RELATED RESEARCH

Due to the increasing significance, the research on the 360-degree view of customers is becoming a focusing point of a growing number of studies worldwide. What follows is just a glimpse of some of the most prominent research made lately on this hot topic.

Barker (2011) points out that the need to collect and manage data in a bid to recognize consumers at any touchpoint is greater than ever. By comparing internal and external customer data integration management, the article looks at the cutting-edge techniques for gathering and maintaining data both on- and off-line, while taking into account single customer databases and 360-degree views of customers. The author concludes that better data quality management can maximize value from customers' database records, and clearer and more accurate decisions can be made, which can ultimately improve profitability and revenues.

Recognizing the fact that there is a significant gap regarding the usage of Customer Knowledge Management (CKM) in practice, Vasireddy (2016) attempts to address the complex research problem of how to manage customer knowledge to achieve a 360-degree view of customers in organizations, by proposing a comprehensive CKM practice framework, based on the findings from the conducted empirical studies as well as from knowledge gained from the existent CKM literature overview.

Shahina et al. (2016) focus on the implementation of a customer-centric approach vis-à-vis e-Commerce-based friends' recommendation systems using the Neo4j graph database, thus enhancing their performances in terms of time and complexity.

Satish & Yusof (2017, p. 278) refer to the 360-degree view of customers from the perspective of Big Data analytics for enhanced customer experiences with crowdsourcing, as a means for showcase customer's interaction history with the corresponding outcomes. This can help to know the level of customer satisfaction and dissatisfaction with various products. From the crowdsourcing perspective, it should point out both positive and negative outcomes of product promotions, customer loyalty, and retention. The visualizations of the 360-degree view of customers should be able to give recommendations on how to promote products and new customer acquisitions to enhance customer support and co-learning of different aspects, as well as to troubleshoot errors and do anomaly detections, to conduct omnichannel pricing and promotions, and payment flow analysis.

According to Casariego Sarasquete (2017), "Being able to anticipate your customer's behavior is the holy grail for every business leader." The observed customer's behavior is made up of repetitive transactions and recurring purchases, as well as navigation and interactions through digital properties, channels, devices, applications, and social networks that can now be tracked and stored. The research establishes the foundation for a common data representation model of tracked customer behavior in a form of a 360-degree holistic view of the customer and its behavior that can be used effectively by organizations to represent any given customer-centric business model, thus allowing the analysis of the most popular marketing problems like segmentation, cross-selling, retention, etc.

Finsterwalder (2018) investigates the 360-degree view of actor engagement in service co-creation, pointing out the need for interpreting it as an encompassing concept with 'receptive' (i.e. psychological) as well as 'transmissive' (i.e. behavioral) properties.

3. BUILDING A MODEL OF A 360-DEGREE VIEW OF AN E-CUSTOMER

The majority of e-Customers that visit a particular e-Commerce website can be classified into two, three, or more classes according to their similar behavior patterns they exhibit during online shopping sessions. To describe the online shopping behavior of specific classes of e-Customers, special types of graphs, known as Customer Behavior Model Graphs (CBMGs) have been introduced (Menascé & Almeida, 2000; Menascé & Almeida, 2000). CBMGs are graph-based models that characterize web shopping sessions of e-Customers belonging to a specific class, while they are visiting a particular virtual store. Put differently, they capture the navigational patterns of e-Customers through a particular e-Commerce website, as viewed from the web server perspective (Figure 1).

Each particular e-Customer exhibits various behaviors during various online shopping sessions, i.e. no two online shopping sessions, even of the same e-Customer, are identical. The specific online shopping behavior of an e-Customer determines both the dynamics (i.e. the frequency and the randomness) and the structure (i.e. the order) of the invoked e-Commerce functions, such as LOGIN, REGISTER, LOGOUT, SEARCH, BROWSE, BUY_NOW, etc. It should be notified that, due to simplicity reasons, the simplified CBMG shown in Figure 1 does not depict many well-known e-Commerce functions that can be found with contemporary online stores, such as SAVE_FOR_LATER, MAKE_OFFER, ADD_TO_WATCHLIST, etc.

For instance, having minded a CBMG of a hypothetical generic e-Commerce website (Figure 1), a specific e-Customer who knows what to buy and is highly determined to make an online purchase, may well invoke a specific set of e-Commerce functions in the following order:

ENTER_PAGE → LOGIN → SEARCH → VIEW_ITEM → BUY_NOW → LOGOUT → EXIT_PAGE

On the other hand, previously, the same e-Customer, without knowing what to buy, and, therefore, without being determined to make an online purchase, could invoke e-Commerce functions in the following sequence:

ENTER_PAGE → BROWSE → VIEW_ITEM → ... → BROWSE → VIEW_ITEM → SEARCH → VIEW_ITEM → BROWSE → VIEW_ITEM → ... → BROWSE → VIEW_ITEM → EXIT_PAGE

Finally, the same e-Customer, who knows what to buy, but is rather reluctant, because he/she is not determined to make an online purchase, could invoke a specific set of e-Commerce functions in the following order:

ENTER_PAGE → SEARCH → VIEW_ITEM → LOGIN → ADD_TO_CART → VIEW_CART → REMOVE_FROM_CART → EXIT_PAGE

Each particular CBMG, specific to an e-Commerce website, is comprised of N states, where state #1 is always the ENTRY state (designated by letter 'E' in Figure 1), and state #N is always the EXIT / LOGOUT state (designated by letter 'X' in Figure 1), whilst the states 2, 3, ..., N-1 correspond to the states HOME (1), BROWSE (2), ..., REMOVE_FROM_CART (11), respectively. Besides the characteristic set of states, a CBMG is being also described by a set of possible transitions between two particular states i and j, designated by directed arcs from state i to state j. The set of states and the set of possible transitions refer to the static aspect of a CBMG since they reflect the structure of the e-Commerce website and does not depend on the way e-Customers access and use it. All e-Customers of a particular e-Commerce website share the same static aspect of the CBMG.

The $N \times N$ transitional probability matrix $P = p[i, j] = p_{i,j}$, whose elements are the probabilities of transiting from state i to state j in one step, represents the dynamic aspect of a CBMG. In Figure 1, such probabilities, which denote, in fact, relative frequencies of invoking specific e-Commerce functions, are being designated in a form of labels $p_{i,j}$, assigned to each directed arc between certain pairs of states in the CBMG.

The proposed graph database model for gaining a 360-degree e-Customer view of a particular online retailer website is based solely on the static aspect of its specific CBMG. The e-Customer-centric graph database model, resembling the interaction between a particular e-Customer and a hypothetical generic B2C e-Commerce website, is depicted in Figure 2. All N states of a CBMG shown in Figure 1 are being transformed into relationships in the graph database model, starting from a single central node, labeled as INTERNET_USER (Figure 2), and ending into several other nodes' types, representing corresponding entities with specific attributes, which are constitutive parts of the generic e-Commerce relational data model proposed by Williams (2009). This way, the invocations of various e-Commerce functions, which reflect the interaction between a specific e-Customer and the online retail store during online shopping sessions, are naturally represented as relationships in the graph database model. The semantic power and the semantic context of the proposed graph database model rely entirely on the relationships' names, directions, and attributes since graph databases are purpose-built to store and navigate relationships. Relationships are 'first-class citizens' in graph databases, and most of the value of graph databases is derived from these relationships. In this particular case, the relationships connecting pairs of nodes are more valuable than the data itself because they represent the invocations of e-Commerce functions, i.e. they reflect the e-Customer's interaction with the e-Commerce website.

The resulting graph database could address "one of the great macroscopic business trends of today: leveraging complex and dynamic relationships in highly connected data to generate insight and competitive advantage", because "the ability to understand and analyze vast graphs of highly connected data will be key in determining which companies outperform their competitors over the coming decade" (Robinson et al., 2015).

All the relationships represented in Figure 2, besides their specific attributes, include a set of three custom attributes: `date_time` (a timestamp), `session_GUID` (a globally unique identifier of each particular online shopping session), and `IP_address` (the IP address of the Internet user/e-Customer interacting with the e-Commerce website). These attributes are the key ones in the process of traversing the graph during the execution of various queries that contribute to the completion of 360-degree views of e-Customers. The `date_time` attribute stores the date and time information in a format 'yyyy-mm-dd hh:mm:ss.sss' according to the ISO 8601 international standard. The `session_GUID` attribute stores a 128-bit integer number, which is both big and distinctive enough to identify each online session uniquely. Each online shopping session starts at the moment when the Internet user accesses the e-Commerce webpage for the first time and lasts till the moment when he/she exits it or closes the window rendering the HTML code of the e-Commerce webpage. The `IP_address` attribute stores the IPv4 address of the Internet user who accesses and interacts with a particular e-Commerce store in dotted decimal notation.

As an example, Figure 3 displays an excerpt from the test graph database, implemented in Neo4j, a highly scalable and schema-free (NoSQL) graph database management system, offering ACID-compliant transactions and native graph storage and processing. The test graph database itself is built entirely using the graph database model presented in Figure 2 as a blueprint. It shows only the interactions of a particular e-Customer with a specific e-Commerce website during accomplishing three of his/her online shopping

sessions, each comprised of a set of e-Commerce functions invoked in a specific order, being mentioned previously in this Section. For demonstration purposes, the e-Customer accesses the e-Commerce webpage from two distinct IP addresses, whilst all the values of nodes' and relationships' attributes have been chosen arbitrarily.

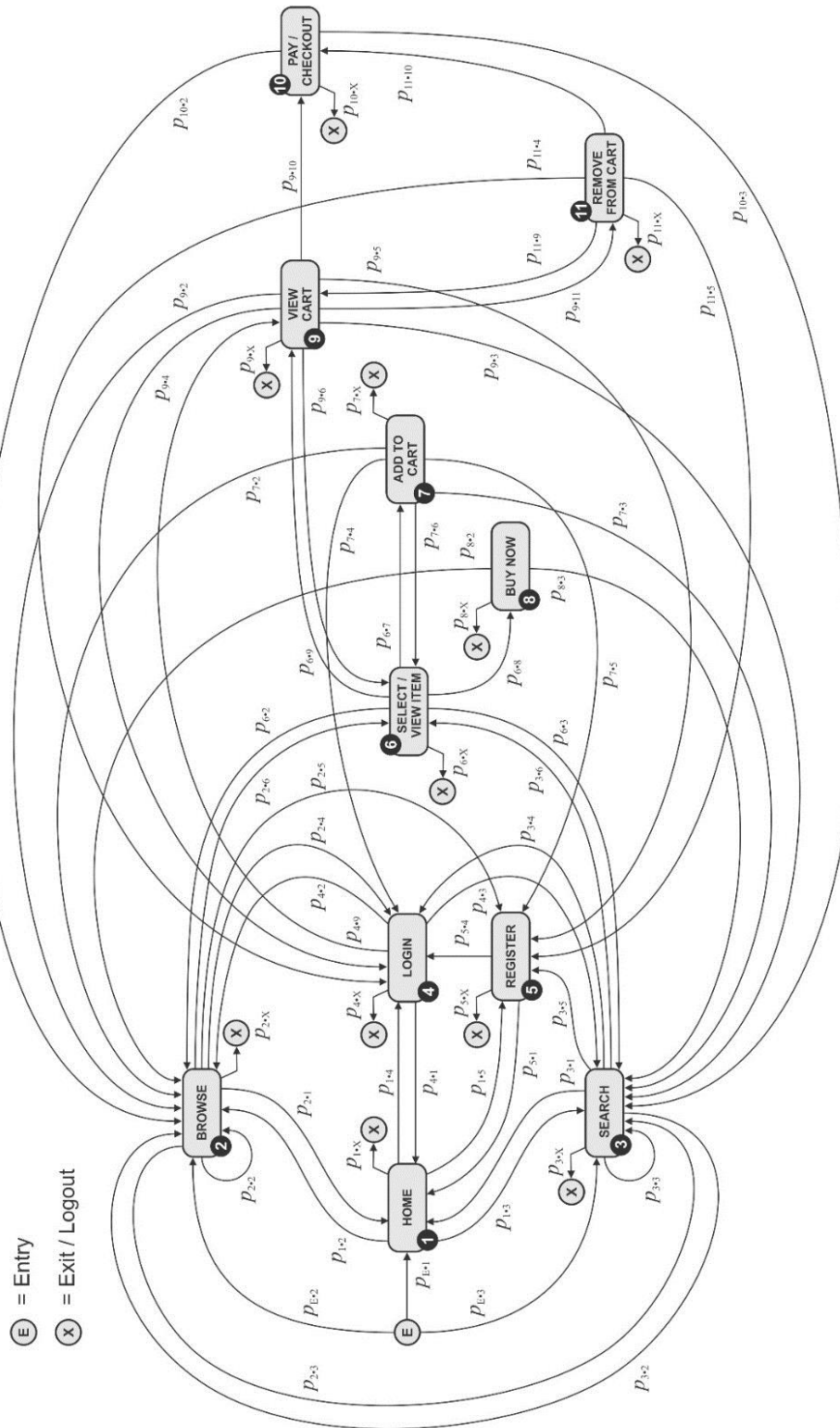


Figure 1. CBMG of a hypothetical generic B2C e-Commerce website (rotated)

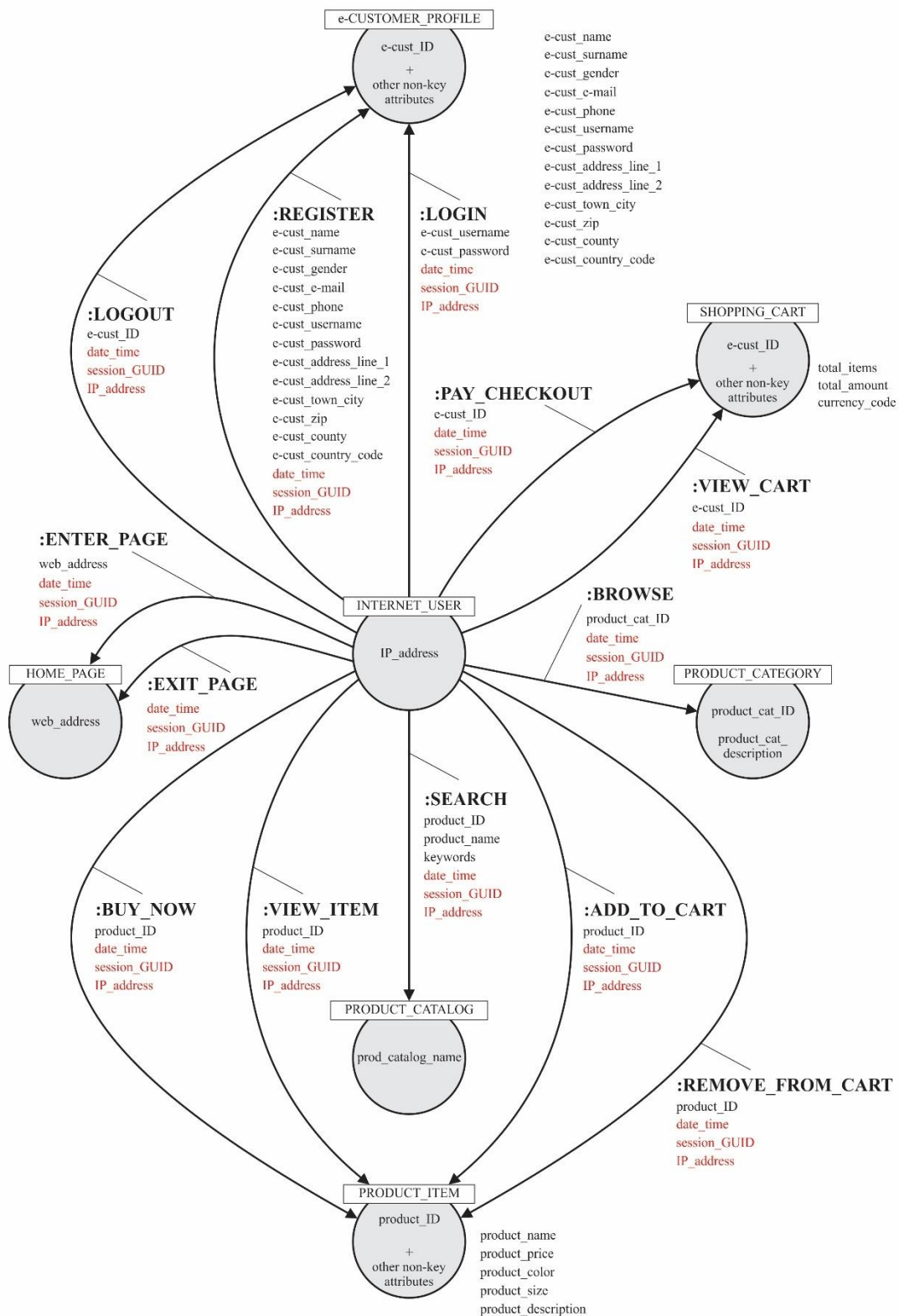


Figure 2. E-Customer-centric graph database model, resembling the interaction between e-Customers and a hypothetical generic B2C e-Commerce website

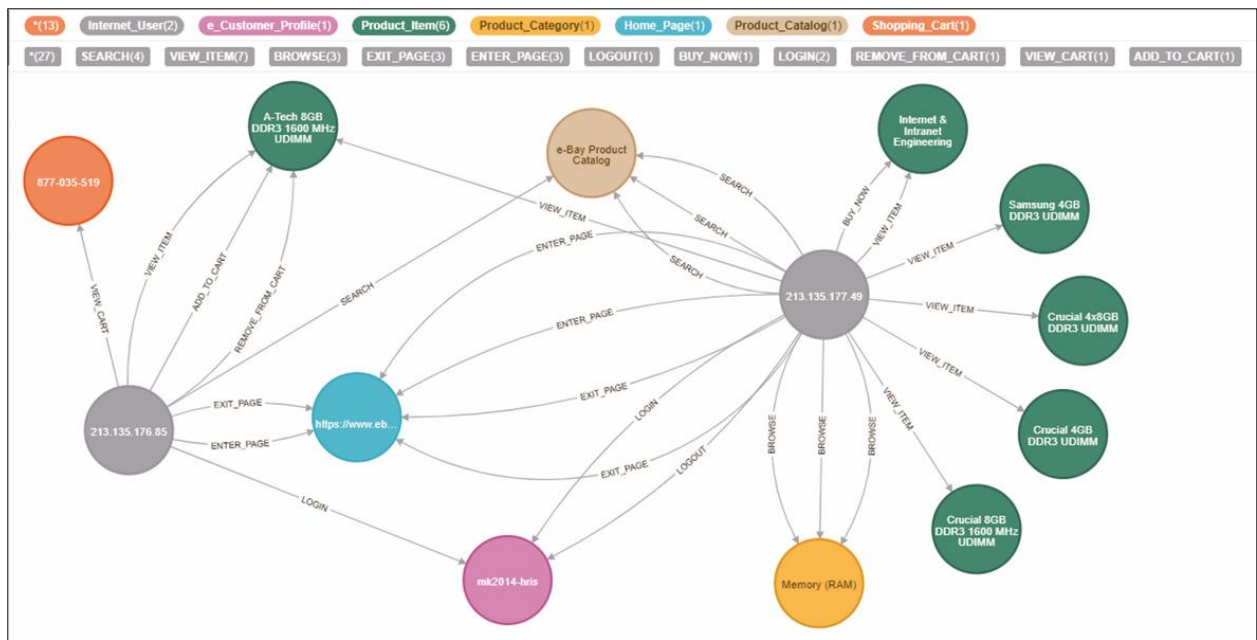


Figure 3. Excerpt from the Neo4j-based graph database, depicting the interactions between a specific e-Customer and a hypothetical B2C e-Commerce website during three online shopping sessions from two distinctive IP addresses

4. ANSWERING CRM-RELATED QUESTIONS USING A GRAPH DATABASE

Table 1 contains some of the most important CRM-related questions (first column), as well as the Cypher Query Language (CQL) programming code, for defining corresponding queries (second column) to address the posed questions vis-à-vis the implementation of the previously proposed graph database model in Neo4j.

Table 1. Examples of CRM-related questions and the CQL code needed for their addressing

CRM-related question	Cypher Query Language (CQL) code
How many times has e-Customer 'MK2014-hris' logged in to the e-Commerce webpage during August 2020?	<pre>match (a:Internet_User)-[r:LOGIN]->(b:e_Customer_Profile) where r.e_cust_username="mk2014-hris" and left(r.date_time, 4)="2020" and substring(r.date_time, 5, 2)="08" return count(*) as number_of_logins</pre>
What distinct IP addresses have e-Customer 'MK2014-hris' used to log in to the e-Commerce webpage so far?	<pre>match (a)-[r:LOGIN]->(b) where b.e_cust_username="mk2014-hris" return distinct a.IP_address</pre>
Knowing that e-Customer 'MK2014-hris' has logged in to the e-Commerce website from two IP addresses, 213.135.176.85 and 213.135.177.49, what unique product categories has he/she browsed so far?	<pre>match (a)-[:BROWSE]->(b) where a.IP_address="213.135.176.85" or a.IP_address="213.135.177.49" return distinct b.product_cat_description</pre>
Knowing that e-Customer 'MK2014-hris' has accessed the e-Commerce website from the IP addresses 213.135.176.85 and 213.135.177.49, how many online shopping sessions has he/she accomplished during August 2020?	<pre>match (a:Internet_User)-[r]->(b) where (a.IP_address="213.135.176.85" or a.IP_address="213.135.177.49") and (left(r.date_time, 4)="2020" and substring(r.date_time, 5, 2)="08") return count(distinct r.session_GUID) as shopping_sessions</pre>

Knowing that e-Customer 'MK2014-hris' has accessed the e-Commerce website from the IP addresses 213.135.176.85 and 213.135.177.49, how many different products has he/she seen during August 2020?	<pre>match (a:Internet_User)-[r:VIEW_ITEM]->(b:Product_Item) where (a.IP_address="213.135.176.85" or a.IP_address="213.135.177.49") and (left(r.date_time, 4)="2020" and substring(r.date_time, 5, 2)="08") return count(distinct b.productID) as viewed_product_items</pre>
How many items did e-Customer 'MK2014-hris' buy instantly so far during all online shopping sessions made from the IP address 213.135.177.49?	<pre>match (a:Internet_User)-[r:BUY_NOW]->(b:Product_Item) where a.IP_address="213.135.177.49" return count(b.productID) as instantly_bought_product_items</pre>
Knowing that e-Customer 'MK2014-hris' has accessed the e-Commerce website from the IP addresses 213.135.176.85 and 213.135.177.49, what is the total amount he/she spent on buying products instantly so far?	<pre>match (a:Internet_User)-[r:BUY_NOW]->(b:Product_Item) where a.IP_address="213.135.176.85" or a.IP_address="213.135.177.49" return sum(b.product_price) as total_amount_spent_instantly</pre>
Regarding all online shopping sessions of e-Customer 'MK2014-hris' made from the IP address 213.135.176.85, what keywords he/she used while searching for products?	<pre>match (a:Internet_User)-[r:SEARCH]->(b:Product_Catalog) where a.IP_address="213.135.176.85" and r.keywords<>"" return r.keywords</pre>
What was the online shopping session duration (in seconds) of e-Customer 'MK2014-hris', with a session_GUID = "4cc7de0930bf4e27b40bbc968f1e2fb7", made from the IP address 213.135.177.49?	<pre>match (a:Internet_User)-[t:ENTER_PAGE]->(c:Home_Page) match (a:Internet_User)-[x:EXIT_PAGE]->(c:Home_Page) where a.IP_address="213.135.177.49" and t.session_GUID="4cc7de0930bf4e27b40bbc968f1e2fb7" and x.session_GUID="4cc7de0930bf4e27b40bbc968f1e2fb7" return duration.inSeconds(localtime(right(t.date_time,12)), localtime(right(x.date_time,12)))</pre>

Numerous other CRM-related questions can be answered by a slight modification of the relatively simple CQL queries presented in Table 1. Moreover, answers to more complex questions (e.g. finding the exact order of invoked e-Commerce functions during a specific online shopping session) can be found using graph traversing algorithms like Breadth-First Search (BFS) or Depth-First Search (DFS), which are often a required first step for many other types of analyses.

5. CONCLUSION

The proposed framework for attaining a 360-degree view of an e-Customer is based on the transformation of states found within a CBMG of a specific e-Commerce website into relationships of a graph database model. In a NoSQL graph database implementation, each particular invocation of an e-Commerce function generates a relationship with its specific attributes that contain the complete information of what, when, and how. This way, the graph database can keep a digital trail of all e-Customers' actions during online shopping sessions, which is in line with the definition of the 360-degree view, according to which it is a complete full-circle view of who they are, and, importantly, it sheds light on every angle of their interaction with the virtual store. It is the biggest benefit of this approach. On the other hand, depending on the e-Customer's behavior, even a moderate online shopping session in terms of the duration and intensity of invoking e-Commerce functions can generate a huge number of relationships in a graph database. Repetitive online sessions accomplished by a single e-Customer can contribute to a dramatic increase in the amount of data and complexity of relationships stored within the graph database, which is the biggest disadvantage. However,

this issue paves the way for engaging other contemporary technologies, such as Big Data analytics, having minded the fact that NoSQL databases, including graph databases, are constituent, yet fundamental parts of such technologies. The proposed approach offers huge potentials for answering practically all relevant questions regarding e-Customers and therefore it can be utilized as a solid basis for building powerful CRM information retrieval systems.

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APPLICATION OF BUSINESS PROCESS MANAGEMENT SYSTEMS IN BULGARIA

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Abstract: This publication discusses the theoretical aspects of the concept of business processes in business organizations. The main stages of business process optimization and management are discussed. The implementation of the business process management systems in Bulgaria has been analyzed as a result of which the advantages and disadvantages of their application have been identified.

Keyword: business process, business systems, optimize the process

1. CONCEPT OF BUSINESS PROCESSES IN THE ORGANIZATION

Business processes and process-oriented management are an integral part of the management practices of modern enterprises. Their rational organization is a decisive factor in turning them into a competitive advantage for the company. However, in order to achieve this, business processes need to be thoroughly analyzed and constantly optimized. This requires managers and managers of organizations to rethink traditional models and configurations for optimizing and managing material, information and financial flows and to focus on modern management models. In this regard, companies are implementing various modules of resource planning systems as a means of streamlining business processes.

There are numerous definitions of the term „business process” in the literature, with the authors focusing on various aspects depending on the subject matter and scope of research. The concept of business process management emerged in the early 20th century, in the writings of *Taylor* (1911). It studies the ongoing processes of companies in a static environment by streamlining work organization and breaking down work tasks into elementary work operations. However, in the present circumstances, the results of *Taylor's* research are not applicable and adequate given the dynamic environment in which businesses operate. Other researchers, such as *Davenport* and *Short*, define the term business process as „a set of logically related tasks that are performed to achieve a particular business result” and note that processes form a business system - the way a business unit or set of units, does its business (1990).

Tudzharov associates the concept of „business process” with „one or more interconnected procedures or operations (functions) that jointly accomplish a particular business task and result in concrete results” (2016). According to him, the business process brings together in practice the flow of activities or functions, employees and equipment

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(resources), the necessary information (knowledge), as well as the rules for performing these activities and functions.

The International Standardization Organization defines the business process as „a set of interconnected and interacting activities that transform inputs into outputs” (2001). *Ishikawa, Deming* and *Juran* also view the organization as a system of processes that must be modeled, refined and controlled (2008).

In the article „A Conceptual Architecture of Business Process Management Systems”, *Filipova* points out that business processes are a set of activities aimed at achieving a specific goal and performed in a coordinated way, which transforms the received input into a user-friendly output according to predefined rules and mechanisms (2013).

Business processes enable the achievement of corporate goals, the use of software to manage interaction with suppliers and customers, consisting of a structured sequence of cross-functional and value-added inter-organizational activities (Becker, Kahn, Schmelzer & Sesselmann, 2011). According to *Antunes* and *Mourao*, business process management is „a collection of technologies capable of translating business process models into computer-supported activities, relinquishing routine management and control tasks from organizational agents” (2011).

Pyon, Woo and *Park* believe that it is „a system that supports business processes using methods, techniques, and software to design, enact, control and analyze operational processes involving humans, organization, applications, documents and other sources of information” (2011). *Muehlen* and *Indulska* define business process management as „The modeling, execution (including automation), and process evaluation is known as business process management” (2009). Business process management is a paradigm that enables the study, design, implementation, execution, maintenance, optimization and analysis of distributed processes that go beyond the boundaries of divisions and enterprises and encompass numerous applications running on different technology platforms (Steblyuk, 2015). Systematic activity for the formation of purposeful behavior of organizations for describing and managing systems of interconnected processes and their resource environment (Steblyuk, 2015).

Based on the analytical review of the scientific literature, it can be said that business processes are a set of repetitive actions in a specific order, which converts incoming resources into a final product in accordance with pre-established rules and creates value for the customer. Business process management can be defined as a systematic approach to continuously improve the organization's operations by identifying, modeling, implementing, executing, measuring, analyzing, and optimizing business processes to meet the goals of an organization.

2. STAGES OF BUSINESS PROCESS MANAGEMENT

Optimization and management of business processes is carried out in several stages - planning, implementation, control and refinement (Figure 1).

2.1. PLANNING THE BUSINESS PROCESS

The planning phase is actually part of the business process analysis phase. The analysis is aimed at identifying different types of activities, what work processes form, how activities and processes are controlled and how they are connected and simulated. At this

stage, it is necessary to plan the processes by describing if they exist, to design if none exist, and to develop an implementation plan, etc. The business process planning stage can be divided into three sub-stages - modeling, imitation and documentation (Tudzharov, 2016).

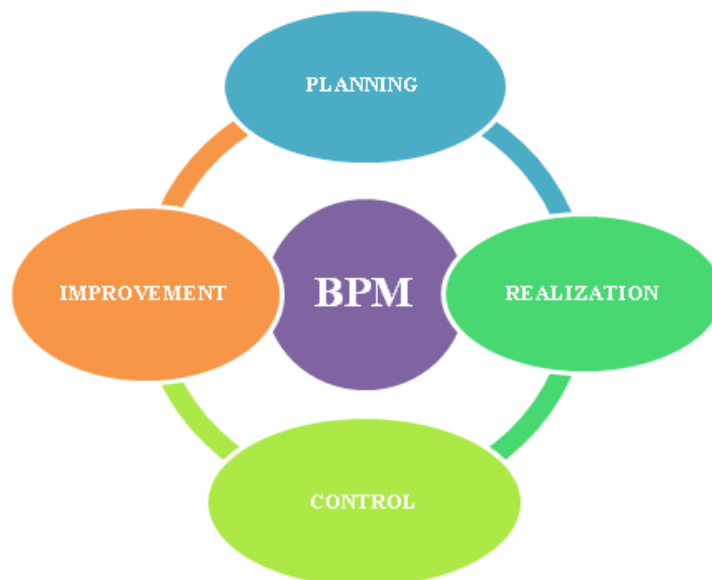


Figure 1. Stages in business process management in an enterprise (Tudzharov, 2016)

2.2. REALIZATION OF THE BUSINESS PROCESS

The processes are implemented in the regular activity, following the implementation plan:

- Implementation of staff procedures and training;
- Defining the requirements and choosing the appropriate information system;
- Development and implementation of the information system;
- Process automation using workflow;

This stage is implemented as a rule using workflow tools.

2.3. CONTROLLING THE BUSINESS PROCESS

Process control includes:

- Fixing the values of performance indicators;
- Comparison of the planned indicators with the fixed ones;
- Analysis of the measured indicators;
- Identify problems and shortcomings.

This step is implemented as a rule using the Business Activity monitoring tool.

2.4. IMPROVEMENT OF THE BUSINESS PROCESS

Once the system has been monitored for some time, the resulting metrics (historical metrics) can be used to further optimize the process. Practice shows that only the automation of the designed business processes provides effective mechanisms for realization at all stages

of the management cycle. In its absence, it can very easily be lost control of business process management and a situation where contractors' work begins to deviate from the regulation. Automation implies the existence of a set of rules, the violation of which is much more complicated than the violation of a regulation or a job description.

3. APPLICATION OF BUSINESS PROCESS MANAGEMENT SYSTEMS IN BULGARIA

Dynamic changes in the market environment are forcing companies to constantly reorganize their operations to deliver better quality products and services, faster and at an affordable cost. The most important reasons for companies to research and optimize their business processes are summarized in Figure 2:

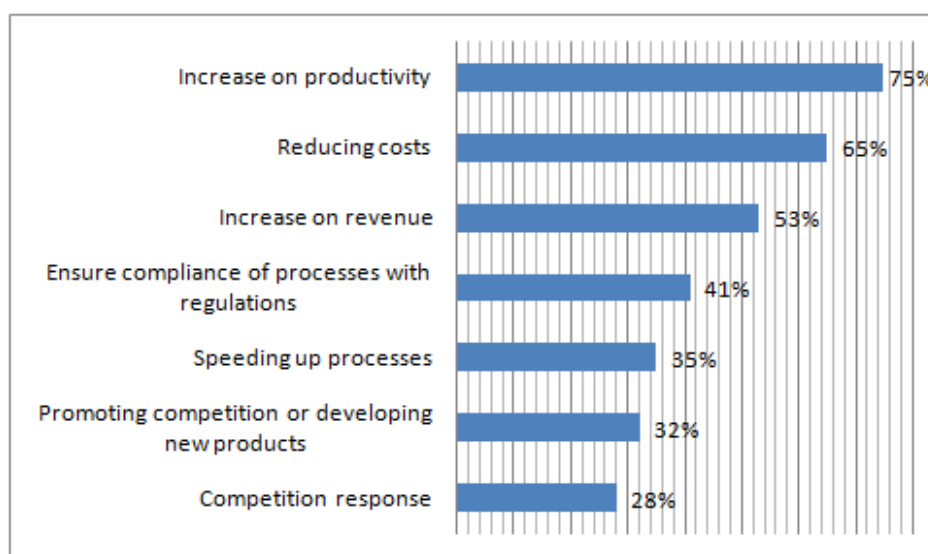


Figure 2. Need to optimize business processes in organizations (National Statistical Institute, 2019)

Data show that 28% of Bulgarian enterprises optimize their business processes to respond to pressure from competitors, and 32% to promote or develop new products. 75% of enterprises implement business process management systems to increase their productivity, 65% to reduce costs and 53% to increase revenue. To meet regulatory requirements and regulations, 41% of enterprises have used business process optimization systems and 35% have used business processes to speed up their production. More and more companies are using various information systems to automate their business processes, such as software solutions for supply chain forecasting and management (SCM), resource planning systems (ERP), customer relationship management systems (CRM), Human Resource Management (HRM) systems, Enterprise Asset Management (EAM), Advanced Planning and Scheduling (APS). Because each of them uses different databases of information about - products, suppliers, customers, staff, etc. - there is a tendency for these systems to be offered as interconnected solutions (so-called Integrated Systems), realizing significantly greater efficiency. Specifically, ERP systems are increasingly being integrated with systems such as SCM, CRM, HRM and more. One of the significant benefits of this integration is that the available information can now be processed and combined in new ways. This gives the business management a much more complete view of the business processes in the company.

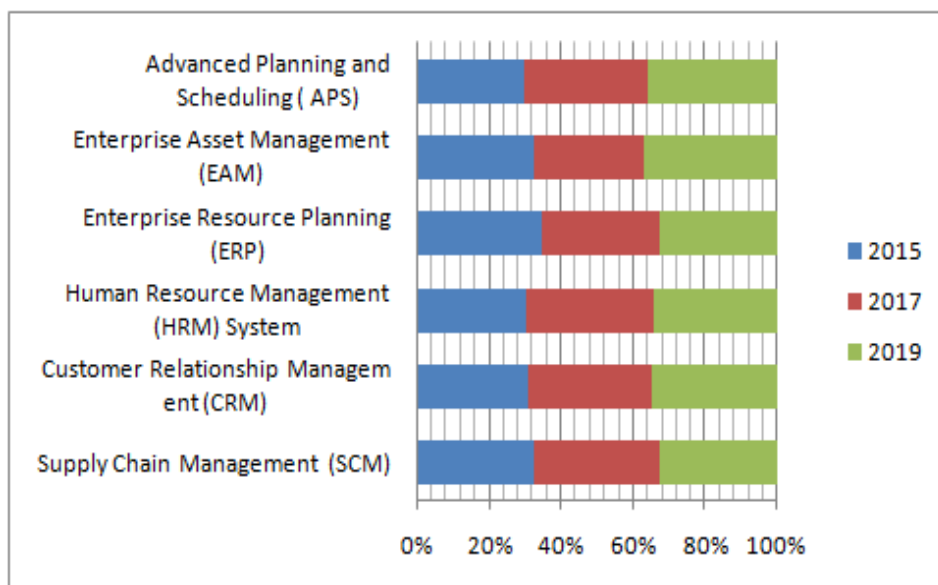


Figure 3. Business Process Management Systems in Bulgarian Enterprises (National Statistical Institute, 2019)

Asset Management System (EAM) in 2015 own 12.25% of the enterprises in the country. The relative share of these enterprises in 2017 decreases to 11.30%, and in 2019 reaches 13.75%. Assets management systems (EAMs) mainly invest in large enterprises that have very long-lived depreciable assets (FTAs), such as buildings, machinery, computer equipment, vehicles, and more. Thanks to the EAM, it is possible to keep the company's fixed assets in maximum readiness, reduce the cost of repairs and hence the downtime. The main users of EAM applications are the companies in the mechanical engineering, metallurgy, chemistry, energy and utility sectors, as well as the financial sector companies - banks and insurance companies. They, on one hand, have a territorially distributed structure of business units and, on the other, control a significant number of buildings. For them, effective real estate and human resource management (HRM) is a priority as they form the main cost items, so the combination of EAM and HRM is in most cases featured in their information architecture. Human Resource Management Systems (HRM) in 2015 have 14.30% of the enterprises. Their relative share increased by 1.7% in 2017. and reaches 16%. The Advanced Planning and Scheduling (APS) production optimization system can optimize production schedules, taking into account all kinds of constraints - from equipment setup times to staff scheduling. This class of systems are able to predict fluctuations in production capacity utilization and reduce inventory levels following the "just-in-time" concept, as well as to provide optimum response in unforeseen circumstances such as equipment damage or over-ordering. The relative share of enterprises with APS system in 2015 are 15.60%, in 2017 - 17.80%, and in 2019 - 18,60%. Supply Chain Management (SCM) in 2019. own 17.20% of the enterprises in Bulgaria. Unlike 2017, when this share reaches 18.60% (Figure 3).

The main benefit of implementing a business process management system is that the company begins to work on a well-defined algorithm, increases the discipline of execution and the organization becomes a well-tuned mechanism. The introduction of BPM accelerates business processes and creates the basis for the use of new best practices and benchmarking. The BPM solutions that contribute to this are:

- consolidation of information from different applications and data warehouses into one system enabling convenient viewing and analysis

- financial applications for budgeting, planning, modeling and analysis with efficient functionality
- a unified management system that integrates the efforts of all planning and forecasting professionals
- significantly reduce the time required to collect data from subsidiaries and affiliates
- a more complete picture of the company's activity, thanks to the ability to monitor a large number of different indicators.

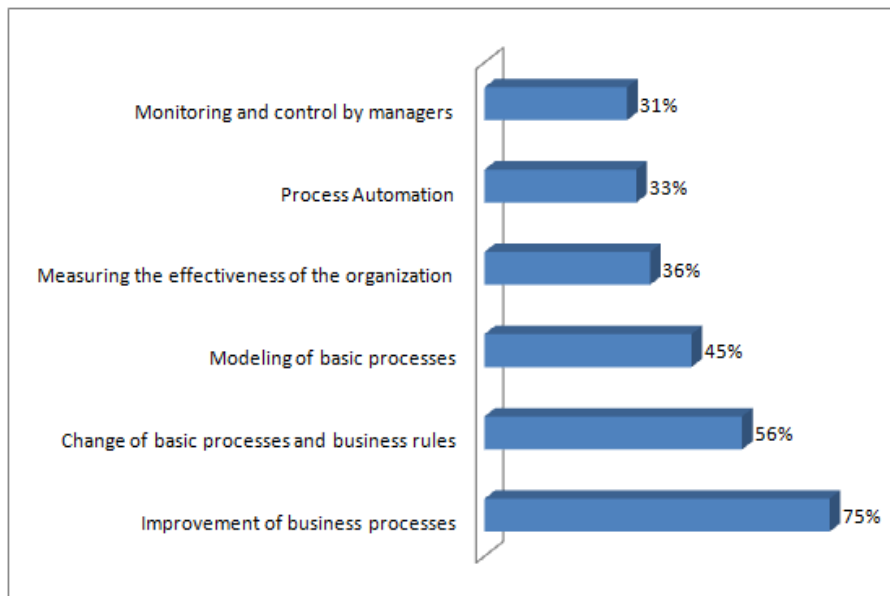


Figure 4. Purpose of Business Process Management Systems (National Statistical Institute, 2019)

75% of enterprises implement business process management systems to improve business processes. 56% of the enterprises indicate that the main purpose of the systems is to change the main processes and the existing business rules, and 45% - to model the basic processes. Business process management systems use 36% of them to measure business efficiency and 33% use automation to automate their processes. 31% of enterprises implement business process management systems in order to monitor and control the activity of senior managers.

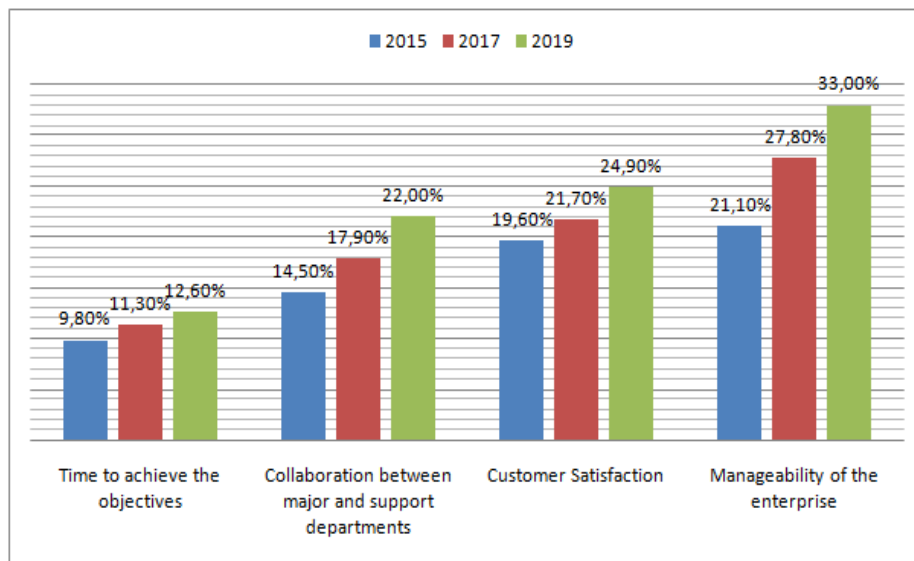


Figure 5. Effects of implementation of business process management systems (National Statistical Institute, 2019)

After the introduction of resource management systems, the time to accomplish the tasks set in the enterprises in 2019 has decreased by 2.8%. In 2019 in 24.90% of enterprises there is an increase in customer satisfaction. This indicator improved by 3.2% compared to 2017. and by 5.3% compared to 2015. There is also a significant improvement in the cooperation between the different units after the introduction of business process management systems in enterprises. In 2017 the improvement is 3.4% compared to 2015, and in 2019 it increased by 4.1% and reached 22%. Enterprise management is also gradually improving. In 2015, 21.10% of enterprises report an improvement in corporate governance, in 2017. - 27.80%, and in 2019 their share reached 33% (Figure 5).

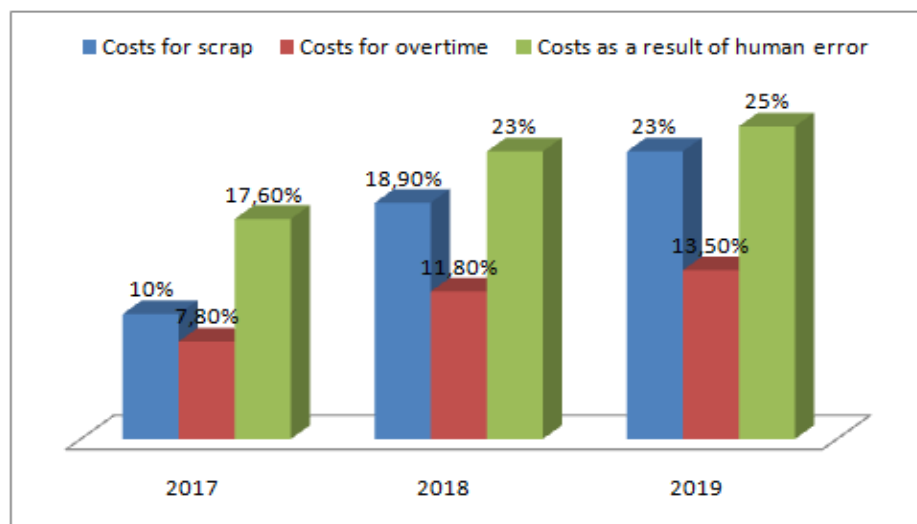


Figure 6. Costs optimization (National Statistical Institute, 2019)

In 25% of the surveyed enterprises in Bulgaria there is a decrease in the cost of human error. In 2019 13.50% of enterprises indicate that they have reduced their overtime costs, which is an increase of 5.7% compared to 2017. Significant reductions are also seen in the

cost of scrubbing after the implementation of resource planning systems. Enterprises indicate that the period from 2017 to 2019 reported a 13% scrap in marriage expenses.

4. CONCLUSION

The implementation of different business process management systems is fraught with many difficulties and challenges for organizations in their quest for improvement. The expected goals for improving the quality of products and services, improving customer orientation or improving overall organizational performance are not always achieved. The reasons can be found in the lack of awareness of the role of business processes, in the desire of managers to seek quick, local solutions to specific problems, in the absence of commitment and support from management. The results of the survey clearly shows that:

- business process management systems in business are a well-known concept among bulgarian companies;

- although aware of the importance and potential of business process management systems, most businesses in bulgaria do not have a comprehensive strategy for their implementation;

- most businesses in bulgaria see business process management systems as a way to optimize the use of resources, automate their production, improve customer-supplier interaction, and integrate production processes;

- at the same time, the business in bulgaria does not have high expectations for increasing profits and reducing the environmental footprint as a result of the implementation of business process management systems;

- employee qualification and the size of the investments are the main obstacles for the bulgarian business in terms of the further introduction of digital technologies and processes in the production. this opinion is shared by almost half of the respondents. in addition, companies are united in the need for greater predictability and clarity regarding the effects and processes of digital technology application in business process management.

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FINANCIAL MANAGEMENT AND DIGITAL TECHNOLOGIES IN BUSINESS ORGANISATIONS

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Abstract: The primary purpose of the present paper is to explore and redefine the decisive role of the financial management through the prism of digital technologies for the purposes of improving the company's overall performance. Provided is a detailed analysis into the very nature of the financial management in order to reveal the vital link between today's digital technologies and the effective administration of the organisation's funds. Conducted, to that effect, was a further study among a number of manufacturing enterprises applying digital technologies for better management of their financial resources. Summarised, subsequently, are the effects of their implementation upon the general economic activities of the surveyed business organisations.

Keywords: business organisations, digital technologies, financial management, investments, profitability

1. INTRODUCTION

Financial management encompasses a vast range of activities and is primarily directed at managing the financial resources and business performance outcomes. Business organisation management focuses not only on the current activities, but also on the future development of the enterprise. Financial management is related to and based on a sequence of units such as capital, turnover, profit, investments, profitability, taxes, etc. It applies a set of rules regarding the very functioning of the business organization in consideration not only of the company's interests, but also of the government regulation mechanisms as well. The main problems businesses face nowadays are most commonly connected with shortage of financial resources, the choice of investment decisions and the returns these investments will make. Maintaining a balance between these two processes obtaining and spending funds is achieved through financial management. Timely provision of sufficient financial means and their effective and efficient utilization is one of the most complicated and challenging objectives of management, without which the existence of a business organization would be totally inconceivable. This, in turn, requires an increasingly large number of companies to enforce the introduction of more effective forms of financial management based on digital technologies.

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2. FINANCIAL MANAGEMENT AND DIGITAL TECHNOLOGIES IN BUSINESS ORGANISATIONS

Financial management is generally defined as a control system built upon a set of principles, methods, and forms of management. Management decision-making completes the previously performed activities of information gathering, transmitting and processing. The creation of financial resources, their effective deployment and proper use is impossible without a distinct and competent financial management system (English, 1990; McMahon et al., 1993).

Presently, financial management appears to be the most pivotal and fundamental connecting piece within the complex system of managing various aspects of the organisation, having a binding role to play in determining the company's position on the market, its competitiveness, sustainability and profitability (Meredith, 2016). The financial mechanism through which the financial management is implemented can be defined as a system of financial methods, comprising the organisation, planning and facilitating the use of financial resources (Karadag, 2013; Nguyen, 2001). The economic theory recognizes four main elements of the financial mechanism:

- a) a state regulatory and legal framework regarding the financial activities of the business organizations;
- b) a market mechanism regulating all the financial activities of the business organizations;
- c) an internal mechanism for financial regulation of the business's activities (financial strategy, internal rules and requirements);
- d) a system of specific methods adopted by the business organization throughout the process of analyzing, planning and monitoring of the respective financial activities (including digital technologies).

With the global development of digital technologies and connectivity around the world, different integrated systems have been established to improve resource management practices of the business organizations. The functional modules of the resource management systems are determined by the particular characteristics of the individual business organisation. Most often they cover activities related to the: supply, production, marketing and sales, finance, accounting, document management along with the specific aspects of the overall business activity, such as fleet management, project management, et al.

Digital financial management technologies are largely dependent on the specific characteristics of the relevant business organization – the size of the enterprises, the annual turnover, the amount of assets, the sector of activity, etc. It is widely acknowledged that there are four main financial management modules (Table 1) according to the estimated needs of the business organisation.

Table 1. Financial process management modules in business organizations (Paramasivan, 2008)

<i>Integrated document management systems</i>	<ul style="list-style-type: none"> • Digital „re-engineering” of business processes • Consideration of regulatory frameworks for document management and archiving • Detailed functional specifications to support system and workflow development • Efficient process monitoring
<i>Electronic storage of accounting ledger</i>	<ul style="list-style-type: none"> • Design and implementation of an electronic ledger storage process
<i>Automatic recording and e-storage of invoices</i>	<ul style="list-style-type: none"> • Higher finance productivity • Reduced operating costs • Improved controls to minimize invoice routing and approval • Alignment with regulatory requirements • Better control over suspect payments Consistent processes across the company
<i>E-invoicing</i>	<ul style="list-style-type: none"> • An e-invoicing process and audit trail • Reduction in administrative costs

The principal module is „***Integrated document management systems***”, covering functional areas related to business process reengineering, updating the regulatory and normative documents, and maintaining the archive data. It contains not only detailed information about the specifications of the individual functional modules of the system and the business workflow but also the possibilities for improved monitoring efficiency. The second module addresses the design and implementation of a system to store accounting documents (ledger). The third module incorporates activities involving generation and storage of financial documents – a pro forma invoice, tax invoice, credit and debit notes. Thus, provision is made for lower operating costs and reduced period of issuing the corresponding financial and accounting documents. The fourth module reports on the process of „***E-invoicing***” which offers less administrative costs and better control over the incoming and outgoing cash flows and leads to continuous monitoring and control of the financial state of the business organisation.

The introduced range of digital solutions has deeply affected both the technological and system integration with a profound impact on the organisational processes as well. Digitilisation, undoubtedly, does not transform the provision of financial services only. Contingent upon the type of the integrated financial management system, its impact will vary over the different functional areas of the business organisation (Figure 1).

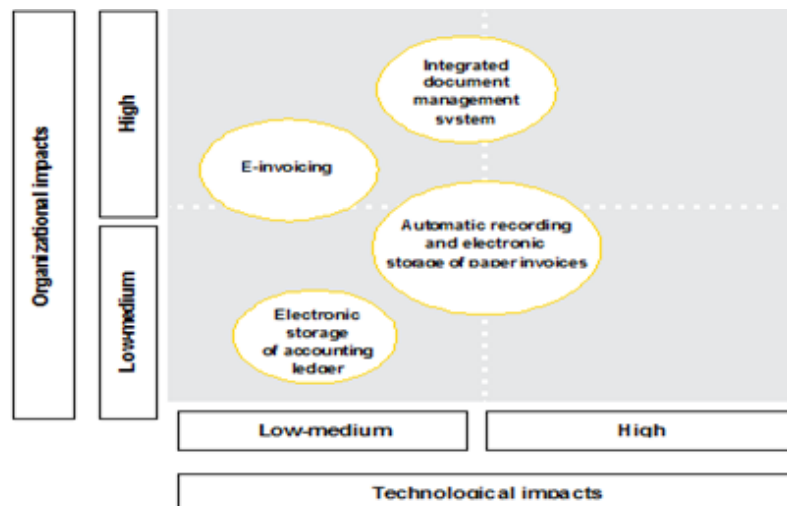


Figure 1. Organisational and technological impacts of digital financial management (Perold, 2004)

The organisational impact of digital technologies can be considered at two levels: low-medium and high. The low impact category pertains to the design and implementation of an accounting document storage system, while the medium one to the generation and storage of financial documents. With a high organizational impact are: the preparation and issuance of electronic invoices, and the reengineering of business processes. An example of a low technological impact is the design and implementation of a system for the storage of accounting documents. With a high impact on technology are the design and implementation of a system for the storage of e-invoices and the subsequent reengineering of the business processes.

The introduction of digital technologies for financial management proves highly beneficial for the following business activities:

- a) cost reduction
- b) faster, easier, and more efficient business processes, including:
 - increased profit gainover time and higher productivity
 - less storage areas for physical archiving
 - lower materials costs
 - higher accuracy due to fewer errors
 - greater ability to control and analyze business processes
 - increased capabilities for customer service
- c) improved business information analysis and better process control
- d) automated processes for collecting and settling receivable payments and liabilities
- e) enhanced processes transparency
- f) exceptional sustainability, better corporate social responsibility, higher efficiency and better environmental performance
- g) increased overall productivity and competitiveness

3. APPLICATION OF DIGITAL FINANCIAL MANAGEMENT TECHNOLOGIES IN BUSINESS ORGANISATIONS

For the purposes of the present paper, the analysis of the practical application of the digital financial management technologies in business organisations is based on quantitative and qualitative methods particularly with regard to the: analysis of statistical information by the National Statistical Institute and Eurostat; online survey conducted via the Internet and online interview conducted using computer-mediated communication. The survey covers 73 manufacturing enterprises located in the North-Eastern region of the Republic of Bulgaria. In an effort to produce more adequate research findings, the surveyed business organisations are grouped under small, medium-sized and large enterprises according to the number of employees criterion. To some of the questions, the surveyed participants provided more than one answer. The submitted analysis, however, contains part of the research, not the entire survey, to comply with the length restriction policy on conference and journal publication.

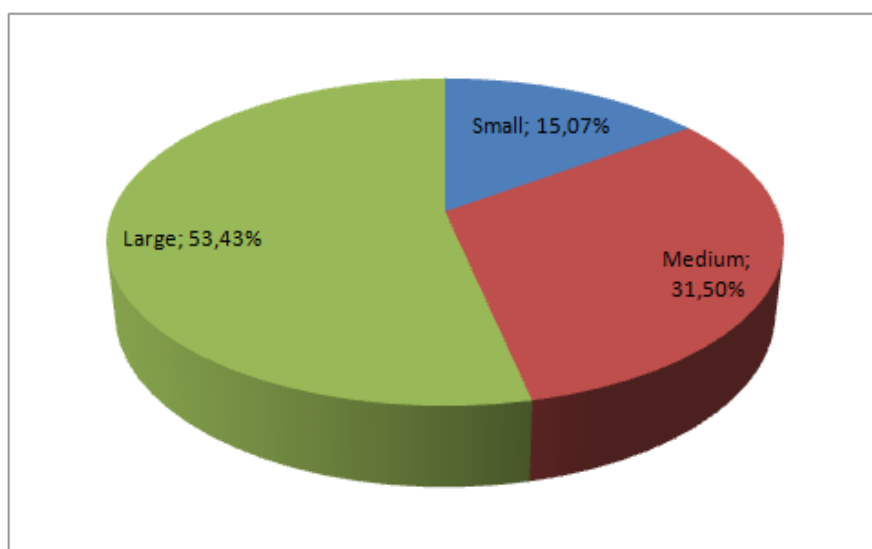


Figure 2. Relative share of enterprises applying digital technologies for financial management (National Statistical Institute, Eurostat)

As clearly displayed in fig. 3, 53,43% of the large companies report extensive usage of digital technologies for financial management. The sectors in which these companies operate are: information and communication technologies, machinery and equipment manufacturing, electrical equipment manufacturing and others. 31,50% of the medium-sized enterprises and 15,07% of the small ones have, in fact, employed digital financial management technologies to transform the way they conduct their business activities. The small and medium-sized enterprises tend to undertake their economic activity in industries such as: textile and textile product manufacturing, chemical products, pharmaceutical products, rubber and plastic, furniture, etc.

In response to the question: „*What kind of digital technologies for financial management do you actually use in your business organization?*” 41,09% of the respondents state that they have, in practice, benefited from the SAPS/4 HANA system. This, indeed, as it turns out, is the most common type of integrated system available in the majority of the examined large SME business organisations. 32% of the surveyed small and medium - sized enterprises (SMEs) have made considerable use of ERP, and 11,32% - have taken relative advantage of the Cloud ERP. 6% of the reviewed business organisations have implemented

SAP Analytics Cloud, and only 2,74% have access to Business Intelligence tools. 5% apply other digital technologies for financial management, and only 1,85% of the companies are connected to the Internet of Things (IoT).

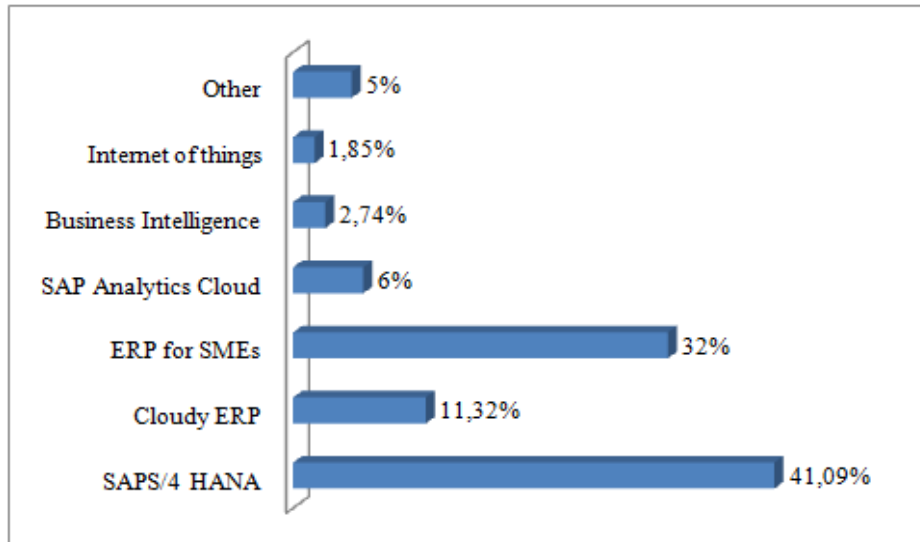


Figure 3. Digital financial management technologies introduced in business organisations

All in all, the introduction of digital financial management technologies in the business organizations under study proved to have a positive impact on their overall business activity. Provided in Figure 4 is a brief summary of the main technological effects on their economic activities.

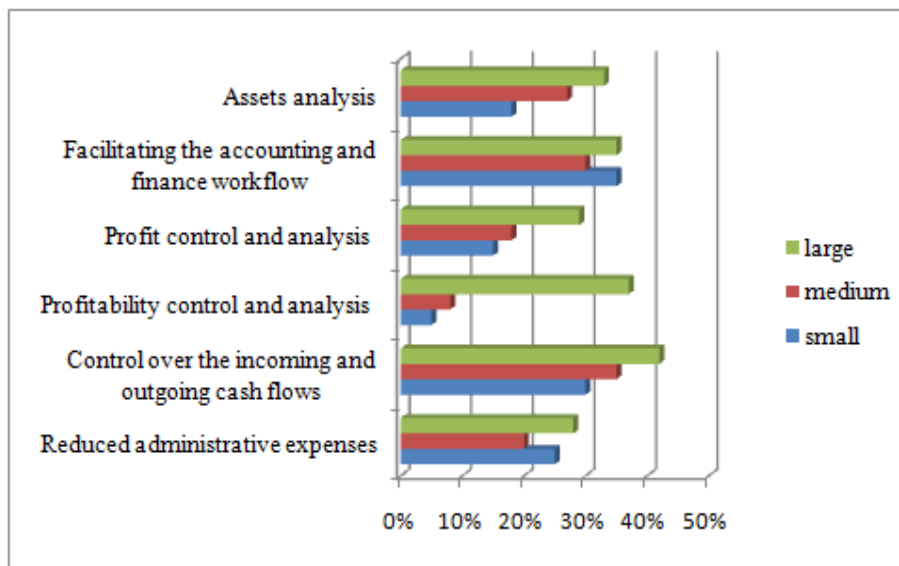


Figure 4. Impact of digital financial management technologies on the organisation's business activity

The analysis of the collected data shows that subsequent to the introduction of digital financial management technologies there follows a marked reduction in the administrative expenses by an average of 23,33% for the companies surveyed. Reported further is that 42% of the large companies have achieved a better control over their incoming and outgoing cash

flows as compared to the 30% improvement for the small ones and 35% - for those of the medium-sized enterprises. As for the profitability, there is 5% growth reported for the small enterprises, 8% - for the medium-sized ones and 37% for the large organisations. 29% of the large-sized enterprises have gained better profit control and analysis, as against 18% attainment by the medium-sized companies and 15% in the small ones. On average, 33,33% of the surveyed enterprises observed an increased ease in the provision of their financial and accounting services. All the surveyed business reported an improved assets analysis after the introduction of digital financial management technologies by about 26% at an average.

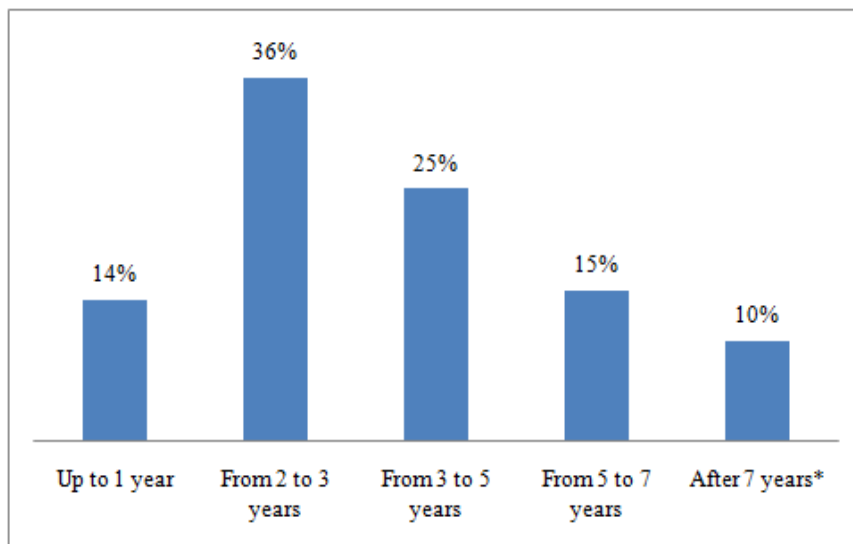


Figure 5. Planned investments in higher-generation digital financial management technologies

14% of the examined business organisations have declared their future plans of introducing financial management technologies within 1 year. 36% of the companies plan to make investments in 2 to 3 years, and 25% - in 3 to 5 years. 15% of the participants plan to invest in digital technologies for financial management. *The enterprises have envisaged that in case of meeting the specified deadlines for the introduction of digital financial management technologies within a range of 3 to 5 years, in the long term, after 7 years, it would be necessary for them to modernise and upgrade the existing technology or, if they had a choice, to introduce the next generation cutting-edge technologies.

The analysis of the application of digital financial management technologies in business organisations in the Northeastern region reveals that:

- Digital technologies for financial management have been mostly introduced by the large enterprises and less represented in small ones. Apparently, one of the main underlying reasons will be the lack of financial resources for the introduction of smart financial management systems.
- Almost half of the large companies invest in state-of-the-art digital technologies for financial management, as opposed to the small and medium-sized enterprises, which are likely to use basic application modifications. Regrettably, most of them do not meet the specific characteristic features of the present-day business organisations.
- The use of basic digital technologies for financial management on the part of the small and medium-sized enterprises is fraught with lower control and less effective profitability and profit analyses.
- 51% of the reviewed enterprises stated they plan to invest in digital financial management technologies over the period of 2 to 5 years. Nonetheless, there are some

business organisations that are pursuing a strategy for the deployment of this type of technology in the long term.

4. CONCLUSION

The development of digital technologies is a leading factor and the basis for constructing a competitive national economy over the coming decades. At the global and European level, the impact of the implementation of digital technologies, more specifically in the manufacturing sector, is one of the main strategic priorities in the Bulgarian Concept for “Industry 4.0.” The digital economy evolves dynamically on a worldwide scale and is considered an important driving force behind recent innovations, competitiveness and growth, with an enormous potential for facilitating the enhancement of entrepreneurship and promoting industrial enterprise development. This requires business organisations in Bulgaria to be more receptive to the changes that constantly occur in the global digital world and adapt accordingly. One of these options, for example, is the introduction of digital financial management technologies in the existing business organisations. The implementation of this type of technology in Bulgarian enterprises will secure a positive impact on their overall business activity. The effects of the implemented digital technologies for financial management can be summarized as follows:

- A complete and comprehensive decision incorporate finance management;
- Covering all the accounting and financial needs of the organisation;
- A real-time revision of the company's financial position and effective process of strategic decision-making based on highly integrated information about the company's finances and productivity;
- Improving the operational efficiency of every type of business;
- Ensuring the short-term profitability of each company and its long-term financial management;
- Improving the relationship and payment experience with the respective business partners, customers and suppliers.

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METHODOLOGICAL APPROACH TO ASSESSING THE DEVELOPMENT OF TECHNOLOGICAL INTEGRATION

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Abstract: The purpose of the research is to develop a methodological assessment approach to the development of technological integration of manufacturing enterprises in the Russian Federation in the context of priority scientific and technological development of the Russian economy. The basic research methods are key provisions of management theory, organization theory, and modern theories of technological development. Methodological basis in the system, process, resource and matrix approaches. There were used a wide range of research methods: description, generalization and abstraction, classification, argumentation, analytical and graphic methods. Theoretical results of the research are the disclosure of specific features of assessing the development of technological integration and the classification of opportunities that will allow assessing the situation regarding the decisions made by all participants of technological integration. The applied results of the research are analytical and graphical assessments of options for the development of technological integration, based on a combination of pricing and technological policy, taking into account the consumed resources and prices. It is proved that the profit is significantly higher when using data on the ratio of supply and demand for all technological transitions: from obtaining the initial resources for the implementation of production activities to the sale of manufactured products to the production market. The article offers a computational and analytical method that allows you to apply operational monitoring, due to the vector orientation of which it becomes possible to promptly make regular adjustments to the key parameters of assessing the impact of technological integration on the results of production activities of manufacturing enterprises.

Keywords: technological integration, methodological approach, assessment, technological transition, manufacturing industry, operational monitoring

1. INTRODUCTION

Manufacturing companies are focused on developing measures to improve and develop new forms of planning and development of their activities. A special place is occupied by the processes of evaluating the level of technological integration development. Priority is given to measures aimed at cultivating such technological integration in production activities, and such an assessment of its state and development, which maximally motivate all subjects of technological integration in the economically expedient and rational use of resources involved

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in the production process, aimed at achieving highly profitable production of manufacturing enterprises.

It should be emphasized that the main production process and its accompanying other processes take place in a certain period. Therefore, the necessary economic calculations must be carried out in strict compliance with these periods. As a rule, all temporary changes should be taken into account. Besides, possible actions related to technical and technological changes should be taken into account (Audretsch et al., 2019). The importance of taking into account all the variety of factors that affect the state of technological integration is also since errors made in economic calculations can lead to a disproportion in production as a result of not accurately determining the amount of production resources consumed. As a result, the delivery time of finished products is disrupted, the production process is destabilized, the confidence of suppliers and consumers is lost, additional costs arise when forming reserve stocks and other unforeseen expenses. Destabilization of the production process leads to an increase in fixed costs, and excess inventory associated with work in progress increases significantly.

These omissions emphasize the need to take into account all possible changes related to the development of technological integration in economic calculations and assess them. Difficulties in assessing the development of technological integration are that there is no single methodological evaluation approach, as both economic theory and practice of managing events associated organizational and structural changes only with the management process, thus do not include in these changes the development of the technological integration.

2. THEORETICAL JUSTIFICATION FOR ASSESSING THE DEVELOPMENT OF TECHNOLOGICAL INTEGRATION

First of all, it is necessary to disclose the specific features that affect the procedure for evaluating technological integration. These features include the development strategy of manufacturing enterprises; subjects of technological integration; decision-making conditions; trends in the development of production activities of subjects of technological integration.

It should be emphasized that the key strategy of manufacturing enterprises should undoubtedly be considered the integration strategy, and its main types: horizontal and vertical. It should also be noted that the production activities of each enterprise are carried out on the terms of interaction, both between the subjects of technological integration, and all external socio-economic and financial institutions. These entities usually include suppliers of material resources; suppliers of equipment that determines the main technological processes; related manufacturing enterprises; consumers of main products; commercial structures focused on leasing production space; financial and credit organizations; research organizations, developers of both new types of modern technologies and prototypes of products; competitors operating in the production market; enterprises and organizations potentially able to become part of an existing high-tech enterprise.

All external socio-economic and financial actors that can influence the production activities of a manufacturing enterprise should be divided into groups. The first group includes those entities that significantly affect the results of the enterprise's production activities by their decisions. The second group consists of entities that are not able to have a significant impact on the production activities of the enterprise. In the first case, equipment suppliers raise prices, which, as a result, may lead to an increase in prices for the company's final products and a possible drop in demand for it. A similar situation can occur with

developers of technological processes that determine the entire production process, which can also change consumer preferences in the production market.

In such conditions, the strategic task of a manufacturing enterprise becomes the need to develop preventive measures that can provide such an impact on all subjects interacting with the enterprise that their decisions do not lead to loss of profit for subjects of technological integration (Veselovsky et al., 2018).

It is important to study and classify those opportunities that will allow assessing the situation regarding the decisions made by all subjects of technological integration. It should be noted that the basic terms of the decisions can be such components as the presence of the aggregate the original data to assess the status of key issues; the availability of alternatives in decision-making; clearly defined criteria for comparison of alternatives directly related to the degree of fulfillment of the strategic objectives of the subjects technology integration; professional qualities of decision-making managers; resources needed for informed decision-making (Colombelli & Quatraro, 2019). In order to make an informed decision, the subjects of technological integration should equally influence the entire set of initial data, as well as the leveling of subjective characteristics of decision-makers, and the process of its adoption.

Trends in the production activities of technological integration entities aimed at establishing relationships between all entities should be classified as follows: communication-purposeful influence on the formation of public opinion due to the information component of the enterprise; lobbying - based on the existing relationships of technological integration entities, their resource policies, and assets, influence the process of forming and making managerial decisions of enterprises-contractors and representatives of state and municipal authorities; integration-the construction of conditions for interaction of subjects of technological integration, focused on the feasibility of forming unidirectional interests and goals, excluding their multidirectional nature. Due to the consistency of interests and goals of subjects of technological integration, to balance their general goals as much as possible (Guerrero et al., 2019).

For the purpose of illustrating the actual processes related to the functioning of the production market, we use the provisions of neoclassical Economics. To model the vectors of changes in set prices, quantities of finished products and allowed costs, it is necessary to fix the following restrictions: in the food market, there are enterprises that supply raw materials for production activities; enterprises that produce the necessary components; enterprises that produce final products. All participants in the production market have the opportunity to adjust prices as the difference between the amount of demand for finished products and the volume of finished products themselves. Information about changes in demand for finished products at the intra-production level is formed based on the fact of sales of these products by the enterprise. In other words, this information is not available to other participants in the production market. Thus, the activity on the production market of enterprises that function due to the existing technological integration between them is open. All subjects of technological integration are informed as much as possible about the facts of sales of finished products of other enterprises. The openness of information within the company helps to optimize pricing processes (Vanderstraeten, 2019). Subjects of technological integration have a real opportunity to make more correct decisions regarding the pricing policy of the enterprise, which allows ensuring the stability of sales vectors.

3. RESULTS OF THE RESEARCH

Research of the commodity flow of manufacturing enterprises by technological transitions «Initial resources for production» → «Enterprises that produce necessary components» → «Enterprises that produce final products» → «Production market», shows that each transition is characterized by the fact that the prices of manufactured products are determined by the transition precedent: the owner of the initial resources for production; enterprises that produce the necessary components; enterprises that produce final products.

The emerging demand for the commodity products of each of the transitions, on the one hand, depends on prices, and on the other – is inversely proportional to the established prices for products. Pricing can be regulated within an enterprise in the following ways:

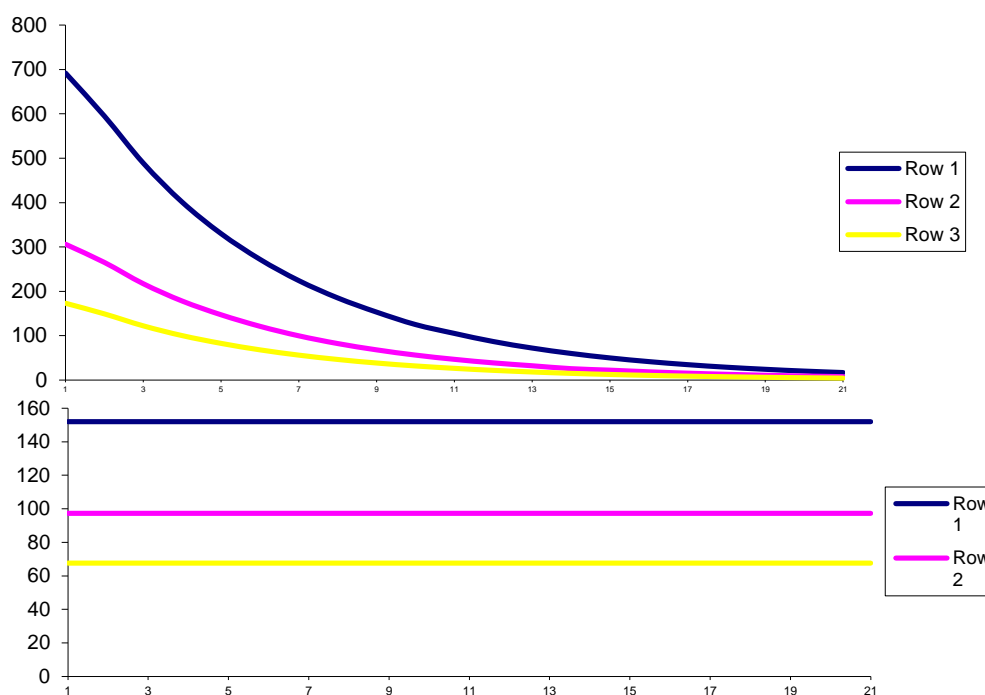
1. Prices do not depend on the availability of supply and demand for products.
2. Prices may be adjusted by a certain amount proportional to the difference between demand and supply for the products of the corresponding transition, equated to the fact of sale of products.
3. Prices may be adjusted by an amount proportional to the difference between supply and demand for the products of the corresponding transition, equated to the fact that the finished product enters the production market.

The key advantage of enterprises operating in the conditions of technological integration in relation to enterprises not connected with it, is the orderly regulation of pricing processes. In particular, the price for the internal transition «production of components» → «production of final products» is formed within the enterprise on the basis of data on the presence of deviations between demand and supply for finished products in the transition related to the production market, but not within the transition «production of components» → «production of final products».

The presence of this advantage in terms of technological integration will allow getting significant savings when evaluating incoming data on both demand and supply; regulating prices for finished products, including in the downward direction; increasing the amount of income of the enterprise significantly.

We investigate probabilistic variants of the price policy of manufacturing enterprises in all directions on the production market. Alternatively, we will evaluate the situation of subjects of technological integration on the example of constant prices.

This evaluation option (figures 1, 2, 3) assumes that all subjects of technological integration set prices based on their own vision of the situation, while prices do not change when demand changes.



Source: the author's development

Figure 1. The vector direction of the demand for final products

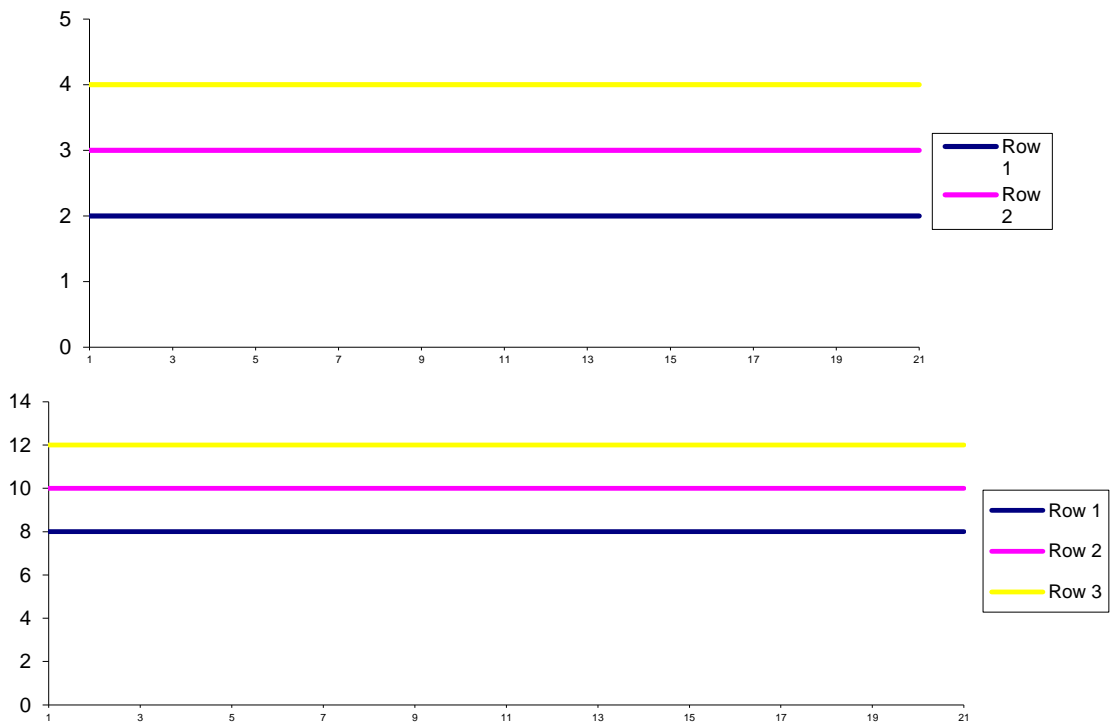
As a methodological approach, it is advisable to use the matrix approach, and as a tool – the mathematical apparatus of John von Neumann (Lopatnikov, 2003) and the equation of intersectoral balance V. Leontiev (Rumyantseva, 2005).

Analytical results obtained during the research are shown in tables 1 and 2.

Table 1. Option for evaluating technological integration entities that produce the necessary components at constant prices

№	Parameters		Subjects of technological integration (a row)		
			1	2	3
1	Components of the matrix, A_i	minimal	0.1		
		average		0.2	
		maximal			0.3
2	Resource consumption, C_i	minimal	0.1		
		average		0.2	
		maximal			0.3
3	Prices, P_i	minimal	2		
		average		3	
		maximal			4
4	Change in the price level, K_{pi}	constant	0		
				0	
					0

Source: the author's development



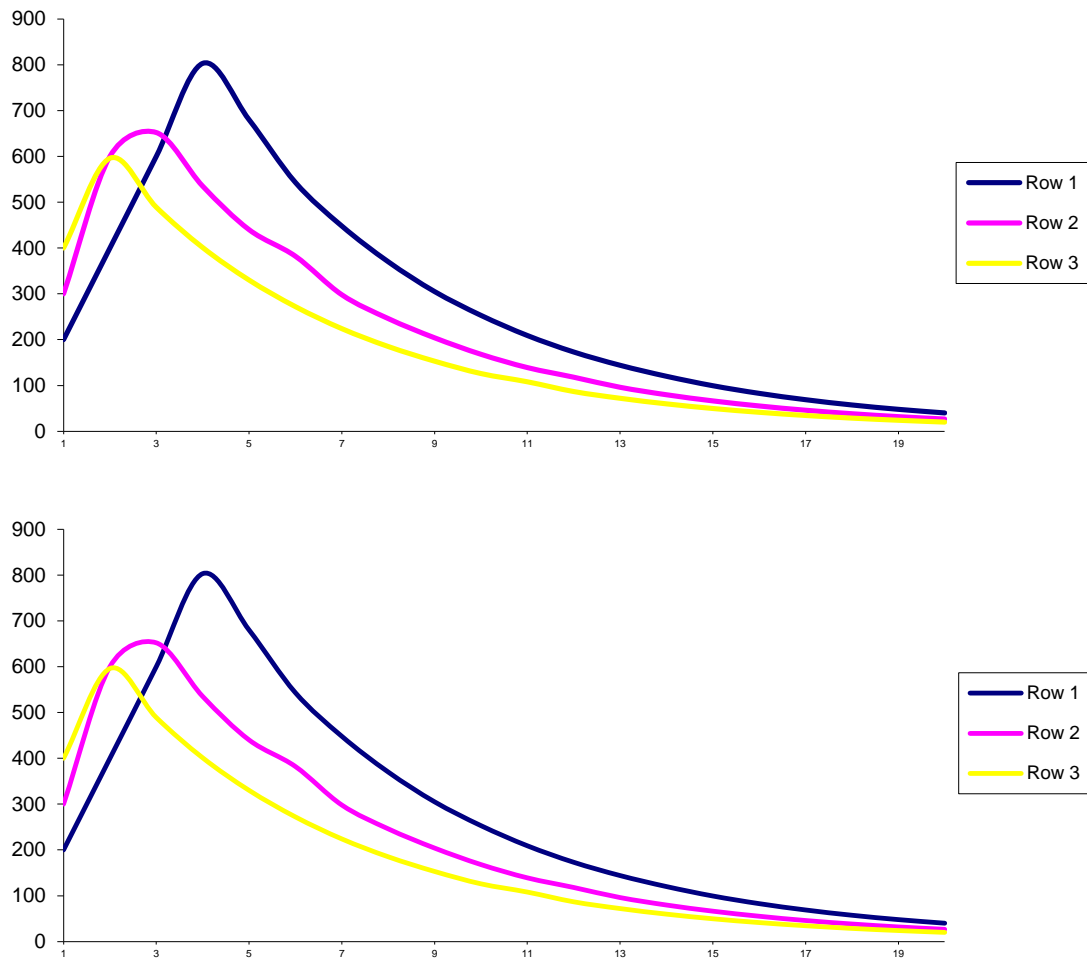
Source: the author's development

Figure 2. Dynamics of the price vector change process

Table 2. Option for evaluating technological integration entities that produce final products at constant prices

№	Parameters		Subjects of technological integration (a row)		
			1	2	3
1	Components of the matrix, A_i	minimal	0.1		
		average		0.2	
		maximal			0.3
2	Resource consumption, C_i	minimal	0.1		
		average		0.2	
		maximal			0.3
3	Prices, P_i	minimal	8		
		average		10	
		maximal			12
4	Change in the price level, K_{pi}	constant	0		
				0	
					0

Source: the author's development



Source: the author's development

Figure 3. Dynamics of the process of changing the profit vector

Thus, based on the calculated values obtained, it should be noted that under the given conditions for evaluating this option, the largest profit will be received by the subject of technological integration, which will set the highest price for its finished products. In this case, the assessment was carried out by setting prices by all subjects of technological integration based on their own vision of the situation, while prices do not change when demand changes. From the calculated values obtained, it follows that under the given evaluation conditions, the largest profit will be received by the subject of technological integration that sets the highest price for its finished products.

The results of evaluating the technological integration that occurs between its subjects suggest that the effectiveness of the profit-making process is significantly higher when using data on the ratio of supply and demand for all transitions: from obtaining the initial resources for the implementation of production activities to the sale of manufactured products to the production market. In other words, the subjects of technological integration will have indisputable advantages in the production market.

The graphical assessment shows that when the prices of the subjects of technological integration are constant (Figure 2), but on the graph, they will be for the subject from which they buy less than others. Similarly, we can interpret the distribution of profits between the

subjects of technological integration (Figure 3). Thus, the subject of technological integration, which has made more sales, but at a significantly lower price, will have the highest profit.

The key role of technical and economic indicators, the variety of calculation methods for their determination, the establishment of a link between the development of technological integration and the main indicators of its subjects, the accounting of the dynamics of their performance is actualized by the unresolved issues of measuring the level and dynamic orientation of indicators of production activities of technological integration subjects in the planning and management process (Kim & Lee, 2019). This indicates first, the lack of systematic formation of technical and economic indicators that reflect the main results of production activities of subjects of technological integration; second, the creation of a situation where the principles of the scientific approach to the formation of the considered system of indicators are violated. In particular, these principles include: the composition of performance indicators should be limited, but optimal; the composition of performance indicators should be diverse, but ensuring that their number fully corresponds to the number of production subsystems; the complementarity of indicators; ease of calculating production performance based on the ratio of the resulting monetary effect and production resources.

Justifying their purpose, economic indicators serve as a scientific representation of the relations occurring in the process of production activity. The absence of an objective assessment of the real connections of the subjects of technological integration can significantly affect the dynamics of any of the main technical and economic indicators. Operational control over their dynamics allows not only rationalizing the production process but also ensuring its smooth functioning.

The system of technical and economic indicators should be built in such a way that it can reflect the economic content of the indicator, reflect both general and specific relationships implemented in the process of joint activities of subjects of technological integration, and ensure their dynamism and stability.

Based on the analytical data (table 3), it follows that the availability of conditions for technological integration allows getting a significantly stable dynamics of changes in the profitability of sales.

Table 3. Dynamics of changes in return on sales

Subjects	Growth rate of return on sales							
	In the absence of technological integration				In conditions of technological integration			
	2017	2018	2019	$\Delta \pm$	2017	2018	2019	$\Delta \pm$
1	118.5	110.4	111.2	+ 8.1	105.2	105.1	104.8	+ 0.4
2	104.5	100.4	102.2	+ 4.1	106.1	106.4	105.9	+ 0.5
3	106.4	109.0	110.4	+ 4.0	102.4	102.1	102.5	+ 0.4

Source: the author's development

This is the case with other technical and economic indicators, which also show the main advantages when manufacturing enterprises, as subjects, are in the conditions of technological integration.

4. CONCLUSION

Thus, the applied computational and analytical method for assessing the impact of technological integration on the results of production activities of its subjects makes it possible to conduct operational monitoring of factors that cause changes in indicators and to minimize the error in the final assessment of the results of their activities.

Industrial enterprises of any industry can be used to assess technological integration development. It allows objectively assessing the vector orientation of the main technical and economic indicators, assessing the dynamics of their changes, both in the short and long-term periods. The undisputed advantage of technological integration development is the possibility of changing approaches to forecasting and planning the production activities of technological integration entities. The development of technological integration encourages the search for new comprehensive forms of evaluating the performance of production activities with timely consideration of possible risk factors.

It should be concluded that the development of technological integration is not always linear. The vector orientation of technological integration can change under the influence of technical, technological and organizational changes in production activities, the action of environmental factors, and goal-oriented managerial influences. Operational monitoring of the vector direction of technological integration development allows regular adjustments of key parameters of production activity of manufacturing enterprises.

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ANALYSIS OF CORPORATE SOCIAL RESPONSIBILITY DIMENSIONS IMPACT ON ORGANIZATIONAL COMMITMENT OF EMPLOYEES IN TEXTILE INDUSTRY

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Abstract: On the way to achieving business goals organizations form a certain image of themselves by conducting their business actions. Corporate Social Responsibility (CSR) emerges as one of the practices that encourage the construction of a positive image of the organization in society. In this paper, special attention is given to employees' perceptions about the CSR of organizations in the textile industry. Employees who identify and share similar beliefs with the organization manifest a high degree of organizational commitment by spreading the good word about the organization and by increasing performance in the workplace. On this basis, a significant impact of the application of CSR practice on the organizational commitment of employees is assumed.

The textile industry is an extremely labour-intensive and resource-intensive branch of the manufacturing industry, in which many issues of CSR arise. A considerable number of questions are directed specifically at employees in the textile industry, so the need for questioning their organizational commitment based on the application of socially responsible business activities is imposed.

The research part of this paper investigates the impact of CSR dimensions on the various manifestations of organizational commitment of employees on the basis of expert assessments. Weight coefficients of CSR dimensions, as criteria in the analysis, were obtained using the AHP method. Prioritization of alternatives was performed using the fuzzy TOPSIS method. Based on the results, it can be concluded to what extent the implementation of the CSR activities influences the willingness of employees to engage more for the sake of organizational success, the adoption of organizational values and beliefs, a sense of belonging to the organization and the recommendation of the organization in which they work.

Keywords: Corporate Social Responsibility (CSR), CSR dimensions, organizational commitment of employees, textile industry, AHP, fuzzy TOPSIS

1. INTRODUCTION

Human resources are exposed to various impacts within labor-intensive industries such as the textile industry. Within this paper, particular attention is paid to human resources,

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towards whom corporate social responsibility (CSR) policy is manifested in the fairness and transparency of decisions that directly affect them (Tziner et al., 2011). In order to meet contemporary requirements in business operations, organizations must create a base of employees who are dedicated to achieving organizational goals (Reilly, 1998). Farooq et al. (2014a) state that mutual trust between employees and organization is the primary outcome of CSR practice implementation. Mutual trust of organization and employees can produce stronger organizational commitment (Ali et al., 2010). Organizational commitment refers to the individual's feelings about the organization as a whole (Joo & Park, 2010; Grego-Planer, 2019; Mercurio, 2015). It is generally regarded as an indicator of an employee's psychological attachment to an organization, which is relevant to work motivation and related to behavior, intention to remain in the organization, alignment of organizational and personal goals and values (Ellemers et al., 2011; Joo, 2010; Dobre, 2013). It is demonstrated by the hard work and efforts of individuals to induce the prosperity of the organization (Rahman et al., 2016).

This paper examines the impact of CSR dimensions on various manifestations of organizational commitment. The research is focused on examining the outcomes of organizational commitment of employees such as willingness to engage additionally (Glavas, 2016), nurturing values and beliefs that the organization nurtures (Lee et al., 2013), developing a sense of belonging to the organization (Farooq et al., 2014b), and recommending the organization to potential job candidates while spreading the good word on organization in society (Raub & Blunschi, 2014).

The paper is structured in such a way that it primarily considers the contribution made so far to the topic of CSR dimensions. Then, the topic of organizational commitment of employees as an outcome of strengthening the dimensions of CSR within organizations, with a particular focus on research devoted to the application of this concept in textile industry organizations, within which the most common CSR topics are related to the human rights and working conditions (Vuković et al., 2017). The research part of the paper analyzes the impact of CSR dimensions on organizational commitment of employees based on expert opinions.

2. LITERATURE REVIEW

CSR is a concept by which organizations take into account the interests of society by taking responsibility for the impact of the outcomes of their business activities on a complete set of stakeholders as well as the environment (Ismail, 2009). It is adopted on the basis of the growing presence of stakeholders' willingness to support organizations' socially responsible initiatives and is based on maintaining stakeholder relationships with the organization (Yoon et al., 2006; Vuković et al., 2016). CSR can have a positive impact on employees' motivation and morale, as well as their commitment and loyalty to the organization. Socially responsible employment practices, fair pay, a clean and safe work environment, training opportunities, health and educational benefits for workers and their families, child care services, flexible working hours and job distribution all contribute to direct benefits through increased morale and productivity, with a decrease in absenteeism and staff turnover (Branco & Rodrigues, 2006; Obrad & Gherheş, 2018; Branco & Rodrigues, 2009).

2.1. DIMENSIONS OF CSR IN TEXTILE INDUSTRY

Among many authors that tried to extract the dimensions of CSR Carroll (1991), who makes the representation of four CSR dimensions, actually four basic forms of social responsibility, through the CSR pyramid, is most notable. The pyramid contains economic,

legal, ethical and philanthropic form of responsibility, and economic responsibility is in its base, philanthropic on the top, while legal and ethical are in the middle (Sharma & Kiran, 2013; Ehie, 2016). This set of responsibilities provides the opportunity for description of nature of the relationship of organizations to the community within which they operate (Carroll, 2016). Recent research suggests that the order of responsibility within the pyramid changes with time and progress and that in the 21st century ethical responsibility is in the base of the pyramid, and it is accompanied by legal, economic and philanthropic activities (Baden, 2016). This order could be different if the specific aspects of a particular industry are taken into account. Considering CSR practices according to specific aspects of different industries Dabic et al. (2016) state that human resources, business ethics, organization and brand image issues are related to the textile industry. Haque and Azmat (2015) find that in Bangladesh garment production, the economic responsibility dimension is the most significant dimension followed by the philanthropic, legal and ethical responsibility dimensions. In addition to the specifics of the industry, this order of responsibilities can also be conditioned by the environment and the region in which the organization operates.

2.2. ORGANIZATIONAL COMMITMENT OF EMPLOYEES IN TEXTILE INDUSTRY

Organizational commitment of employees is manifested through the employee's connection with the organization, the degree of desire to be part of that organization, the acceptance of defined organizational goals, and the commitment to maintain and achieve those goals (Bulut & Culha, 2010). Contemporary business, and the uncertainty it brings with it, condition the need to strengthen employee commitment, however, organizational commitment is slowly evolving among employees (Radosavljević et al., 2017; Fard & Karimi, 2015). The fairness of the organization (Bakhshi et al., 2009) and the support that the organization provides to the employees (Tansky & Cohen, 2001), play an important role in developing the organizational commitment of employees.

In accordance with the technical and technological requirements of the textile industry a number of questions related to the application of CSR in this industry arise (Stefanović et al., 2019). The whole process, from production to sale and use of textile products, produces different impacts on society and the environment. In addition to the use of chemicals in the treatment of fabrics, waste production, overuse of water and energy occur in the manufacturing processes of the textile industry. Human rights violations and inadequate working conditions are some of the problems that arise in this industry (Książak, 2016). In a research paper on the link between HRM practices and the organizational commitment of employees in the textile sector, Hassan and Mahmood (2016) emphasize that employees manifest a high level of commitment through sharing the same values and beliefs with the organization, through a willingness to further engage and a strong desire for long-term by working in that organization.

3. METHODOLOGY

Socially responsible business of organizations can make a direct influence on organizational commitment of employees, but also the indirect influence through development of sense of unity with organization (D'Aprile & Talò, 2015). The degree of organizational commitment grows when employee feels proud to work in organization that has good reputation on the market (Shabnam & Sarker, 2012). Organizations demonstrate their social responsibility by disclosure of their CSR activities (Bayoud & Kavanagh, 2012). This leaves

the impression on stakeholders that the organization is reliable. Accordingly, a questionnaire was formed within which experts can evaluate the importance of each CSR dimension (philanthropic, ethical, legal and economic) within the textile industry based on five criteria related to CSR reporting. This includes the environment, community relations, diversity, employee relations and human rights (Hou & Reber, 2011). The evaluated criteria and sub-criteria for prioritization of CSR dimensions are presented in Table 1.

Table 1. Criteria and sub-criteria for prioritization of CSR dimension

Criteria	Criteria code	Sub-criteria	Sub-criteria code
Environment	C1	Organizations try to reduce negative impacts on environment.	C1.1.
		Organizations obey the regulations.	C1.2.
Community	C2	Organizations are devoted to build a better community.	C2.1.
		Organizations make various donations.	C2.2.
		Organizations participate in various volunteer activities.	C2.3.
		Organizations sponsor sports and cultural events.	C2.4.
Diversity	C3	Organizations promote gender or ethnic equality.	C3.1.
		Organizations provide equal promotion possibilities.	C3.2.
Employees	C4	Organizations respect employment laws.	C4.1.
		Organizations apply a fair wage payment policy.	C4.2.
		Organizations promote social dialog with employee representatives.	C4.3.
Human rights	C5	Organizations tend not to violate human rights.	C5.1.
		Organizations follow ethical guidelines.	C5.2.

Employees can express their commitment in different ways, and this paper covers four types of organizational commitment: willingness to engage additionally (OC1), sharing same values and beliefs with the organization (OC2), sense of belonging to the organization (OC3), and recommending the organization to others (OC4). The experts had the opportunity to evaluate these elements of the analysis within the second part of the questionnaire. In order to distinguish the most likely form of organizational commitment in textile industry organizations, this research primarily relies on the ranking of influential CSR dimensions in the business of textile industry organizations and the calculation of their weight coefficients using the Analytic Hierarchy Process (AHP) method. It then proceeds to evaluate the impact of ranked CSR dimensions on the stated alternatives to express organizational commitment, in line with the estimates of textile industry experts using fuzzy logic in the Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) calculation.

3.1. ANALYTIC HIERARCHY PROCESS (AHP) METHOD

The AHP method contributes to the decision-making process by decomposing the problem into elements and forming a hierarchical structure of the decomposed elements (Bertolini et al., 2006). Decision makers' opinions are very important, and hierarchical reasoning helps them to focus their attention on each individual element in their assessment (Angelou & Economides, 2009). The procedure for applying the AHP method involves

constructing a hierarchical tree, gathering data on comparative judgments of decision makers to compare pairs of elements of the hierarchical structure, and calculating the overall priority of the considered alternatives (Chen, 2006). For the evaluation of criteria and sub-criteria within the hierarchical structure, Saaty's nine-point scale is used, in which grade 1 evaluates the equal importance of the two considered criteria / sub-criteria, and grade 9 the absolute significance of one of the two considered criteria / sub-criteria (Bertolini et al., 2006). Pairwise comparison is an important part of the AHP method. Decision makers' answers are entered into the comparison matrix $A_{n \times n}$, where a_{ij} is the outcome of comparison and results in an assessment of the significance level of x_i in relation to x_j . This method allows validation of results with the help of a degree of consistency (CR) (Taherdoost, 2017).

3.2. TECHNIQUE FOR ORDER PREFERENCE BY SIMILARITY TO THE IDEAL SOLUTION (TOPSIS) METHOD

The TOPSIS method is one of the most commonly used multicriteria decision-making methods, and is based on the principle that the chosen alternative should be the closest to the positive ideal solution and the farthest from the negative ideal solution (Ashtiani et al., 2009; Puška et al., 2018). The uncertainty and imprecision associated with decision making using this method can be reduced by applying fuzzy logic. Fuzzy logic is derived from fuzzy set theory to solve the problem of estimating opinions that are approximate rather than precise (Amiri, 2010; Kutlu & Ekmekçioğlu, 2012). The multicriteria decision procedure using the fuzzy TOPSIS method consists of following steps (Önüt & Soner, 2008):

1. Assigning linguistic grades to alternatives relative to criteria.
2. Calculation of the weighted normalized fuzzy decision matrix.
3. Identification of positive ideal (A^+) and negative ideal (A^-) solutions using formulas:

$$A^+ = \{\tilde{v}_1^+, \dots, \tilde{v}_j^+\} = \{(max v_{ij} \mid i \in I'), (min v_{ij} \mid i \in I'')\},$$

$$i = 1, 2, \dots, n, \quad j = 1, 2, \dots, J, \quad (1)$$

$$A^- = \{\tilde{v}_1^-, \dots, \tilde{v}_j^-\} = \{(max v_{ij} \mid i \in I'), (min v_{ij} \mid i \in I'')\},$$

$$i = 1, 2, \dots, n, \quad j = 1, 2, \dots, J. \quad (2)$$

4. Calculation of the distance of each of the alternatives from A^+ and A^- by applying the formula:

$$D_j^+ = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^+), j = 1, 2, \dots, J \quad (3)$$

$$D_j^- = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^-), j = 1, 2, \dots, J \quad (4)$$

5. Calculation of relative proximity to the ideal solution using the formula:

$$CC_j = \frac{D_j^-}{D_j^+ + D_j^-}, j = 1, 2, \dots, J. \quad (5)$$

6. Ranking alternatives based on the CC_j value calculation, in descending order.

4. RESEARCH RESULTS

Based on the defined plan for conducting the research, it is possible to collect expert assessments regarding the dimensions of CSR and organizational commitment of employees. Eight experts participated in the research, six of them are professors and researcher in the field of textile industry, one of which is coordinator of textile engineering department, and two managers from organizations that manufacture women, children and men apparel and sports cotton garment products on the territory of Republic of Serbia. The processing of the

collected data begins with the calculation of the weighting coefficients of the CSR dimensions using the AHP method. Figure 1 illustrates a model for prioritization of the defined CSR dimension.

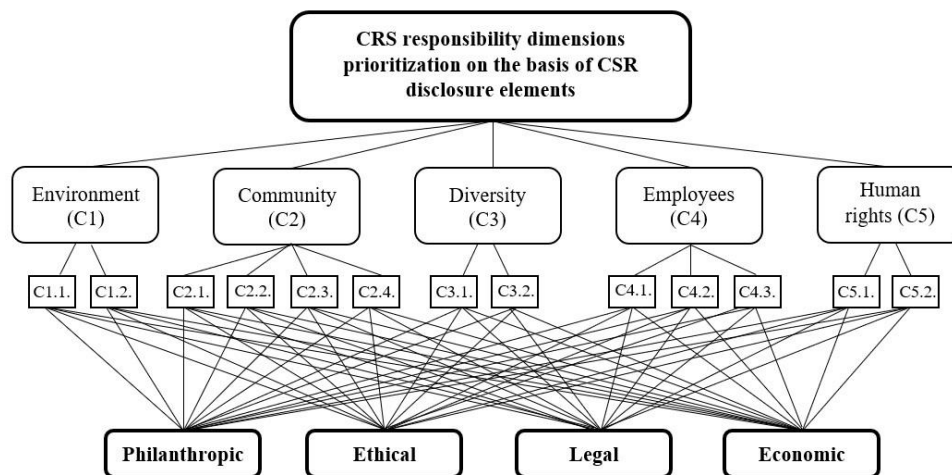


Figure 1. AHP model for prioritization of CSR dimensions in textile industry on the basis of CSR disclosure elements

Comparison of the defined criteria and sub-criteria pairs yields estimates of local and global significance presented in Table 3, with achieved consistency rates of less than 0.10 in all comparison cases.

Table 2. Determining the significance of criteria and sub-criteria using the AHP methodology

Criteria	Criteria significance	Sub-criteria	Sub-criteria significance within the group	Overall significance
C1	0.222	C1.1.	0.500	0.111
		C1.2.	0.500	0.111
C2	0.222	C2.1.	0.250	0.056
		C2.2.	0.250	0.056
		C2.3.	0.250	0.056
		C2.4.	0.250	0.056
C3	0.111	C3.1.	0.667	0.074
		C3.2.	0.333	0.037
C4	0.222	C4.1.	0.413	0.092
		C4.2.	0.260	0.058
		C4.3.	0.327	0.073
C5	0.222	C5.1.	0.667	0.148
		C5.2.	0.333	0.074

Based on experts answers, it is estimated that disclosure of activities connected to the environment, relationships with community, relationships with employees and human rights makes an influence on ranking of CSR dimensions, while the influence of activities on respect for diversity is estimated as weaker. While assessing the significance of sub-criteria within

groups, experts equally assess the activities of organizations related to the environment and community relations, while in terms of diversity, promotion of equality (C3.1. = 0.667) is more important, in terms of respect for employment relations, respecting employment laws (C4.1 = 0.413) is more important, and in terms of human rights, not to violate human rights (C5.1. = 0,667) is more important. The final result of the calculation by the AHP method is reflected in the ranking of the considered alternatives based on the weighting coefficients presented in Table 3.

Table 3. Weighting coefficients and ranking using AHP methodology

CSR dimensions	Weighting coefficients	Rank
Philanthropic dimension	0.434	1
Ethical dimension	0.177	4
Legal dimension	0.195	2
Economic dimension	0.195	3

The AHP method assesses the strongest impact of the philanthropic dimension, which involves trying to reduce the negative environmental impacts of the business of textile industry organizations, and demonstrating different types of support and collaboration with the community through various forms of sponsorship. In addition to analysing the prioritization of the impact of CSR dimensions within the textile industry on the territory of the Republic of Serbia, the obtained weight coefficients are useful as input to the next research step, which relates to the prioritization of manifestations of organizational commitment of employees in the textile industry based on expert evaluations within the second part of the questionnaire. Using the fuzzy TOPSIS calculation procedure, based on input data made up of fuzzified expert responses and weight coefficients of CSR dimensions from the previous part of the research, the most relevant form of organizational commitment of employees in the textile industry is highlighted. Table 4 presents the ranking results using the fuzzy TOPSIS method.

Table 4. Results of the ranking of organizational commitment manifestations using the fuzzy TOPSIS method

Alternative	Code	D_j^+	D_j^-	CC_j	Rank
Willingness to engage additionally	OC1	0.001155	0.060622	0.981308	1
Nurturing same values and beliefs	OC2	0.025158	0.000033	0.001323	4
Sense of belonging to organization	OC3	0.025126	0.000135	0.005331	3
Recommending the organization	OC4	0.000479	0.000175	0.267584	2

The values of the coefficient of relative closeness presented in Table 4. emphasize that the readiness for additional engagement for the success of the organization is a priority alternative, that is, the most manifested form of organizational commitment among the textile industry employees in accordance with the already mentioned values of the impact of the CSR dimensions. Which should mean that respecting philanthropic dimension of the CSR in the business of the textile industry organizations strengthens organizational commitment and encourages workers to engage more. The lowest ranked form of organizational commitment, based on expert evaluation, is sharing the same values and beliefs with the organization.

5. CONCLUSION

Using the methods of AHP and fuzzy TOPSIS, based on expert opinions, the influence of different dimensions of CSR on the four defined types of expression of organizational commitment of employees was examined. It is estimated that under the influence of different dimensions of CSR, especially the philanthropic dimension, as the first-ranked and with the strongest degree of influence, employees can express their commitment through their willingness to engage and make significant efforts beyond expected. The results of this analysis can help decision makers in the textile industry organizations, and the application of fuzzy logic in calculation provides a higher level of reliability of the information provided to decision makers based on this analysis. Future research will need to include the responses of the employees themselves in the analysis of these impacts and to compare the responses received from the expert group and the group of employees in order to draw as accurate conclusions as possible about the real nature of the impact of the CSR on the organizational commitment of employees in the textile industry.

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MARKETING CHALLENGES AND CONSUMERS PURCHASING BEHAVIOUR TOWARDS ORGANIC NUTRITIONAL PRODUCTS

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Abstract: The contemporary marketing paradigm of consumer purchasing behaviour regarding the choice of products in nutrition is determined by various factors. The factors that influence consumer choice and behaviour when shopping are numerous and are related to their attitude towards health and healthy lifestyle, products knowledge and eating habits, beliefs, education, but also about marketing factors related to price, distribution and marketing communication of those products, but also social and psychological factors. With the rapid development and application of science and technology customers become more aware, but also more concerned about their health, quality of life and natural environment in general. Better quality of life is associated with healthy lifestyle and healthy appearance and organic food represents one of the basic contributions to modern lifestyle and trend of present generations.

The primary research was conducted in the city of Banja Luka and it was focused on consumer behaviour towards organic nutrition products. In prospective survey participated 220 respondents, half of them were organic food consumers, and other half were consumers of inorganic food.

The data collected were processed in the IBM SPSS v23 statistical programme by using the hi square test and multivariate analysis of variance (MANOVA).

The results of the study showed that the factors such as gender, family income, education, professional status differentiate consumers of organic and inorganic nutritional products. The most important factors were determined, which influence purchasing decisions, what kind of food is the most commonly consumed by organic customers, and what kind by the consumers of inorganic food; psychological factors such as attitude, perception, belief and intention have shown positive results for the group of consumers of organic food; and the most common problems that the consumers face up with were determined when choosing organic nutrition products.

Keywords: consumers purchasing behaviour, organic nutrition products, healthy food marketing

1. INTRODUCTION

The basic role of modern marketing concept is not to sell a product or to provide a service at any cost, but to provide the highest possible value, satisfaction and the level of

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satisfaction to the end consumer, to the buyer of the product or to the service user. The greatest responsibility is on marketing managers to make decisions when conducting decisions about promotional activities (Tešanović, 2018). This responsibility gets totally new dimension when it comes to the promotion of food products, because they directly have impact on human health. We are witnessing that some diseases are getting terrifying proportions, and they are caused only by unhealthy nutrition. Before all, we think about cardiovascular diseases, heart and blood vessels disease and diabetes. The greatest responsibility of marketing managers is when they make the decision to advertise their products or services, in striking television terms, because then they directly encourage the poor eating habits of a wide audience. Marketing professionals should respect ethical standards and follow the laws of nature in order to promote economic, cultural and socially healthy living and healthy living habits. On the other hand, there is a clear increase in the world's population and with that the increase in needs that should be met, so exploitation of natural resources is also increased, as well as the usage of scientific and technological achievements and innovations, in order to maximise food production and make it more accessible. Due to fact that organic food is completely natural, free of chemicals and preservatives, so it represents healthy alternative to conventional food products. Therefore health food marketing plays a very important role because it aims to offer the consumer the highest possible value of healthy food, and above all health.

Consumer buying behaviour towards organic food plays a very important role. Healthy food purchasers need to be innovative and flexible in order to meet the diverse and changing behaviours of healthy food purchasers in an urban areas. For many years, the significance, role and influence of organic products on human health has been neglected or put aside. Therefore, it is necessary, especially in urban areas, to redirect consumers as much as possible to consumption of healthy organic food, and as a result to achieve environmental sustainability. Purchasers are aware that the organic product is above all safe, healthy and high quality product, and it is necessary to provide a wider range of such products, increase total income for the middle class of the population, develop and invest in retail capacities, and encourage private initiatives and innovations in the healthy food production. Organic food is packed in biodegradable packaging that is not contaminated with any substance that could compromise the integrity of the product, or which could have a contaminated and harmful effect on the product or the environment.

The main problem is that consumers are not sufficiently aware and they are often confused with the relationship itself with organic and conventional products, so their expectations towards these products are different. Because of that it is necessary to raise awareness among consumers about vital influence on health and benefits of organic food.

The aim of the research is to examine and investigate consumer buying behaviour towards selected food products, identify various factors that influence purchasing behaviour through demographic variables of the respondents, discover the respondents' attitudes towards certain food products, identify the problems they face during purchasing of organic food and suggest the solutions to these problems.

2. REVIEW OF LITERATURE

There are different definitions of healthy and organic food in the literature. Healthy food represents the products that contribute to the physiological and psychological balance of the body and optimal resistance to stress, infections and diseases (Watson, 2000). The term healthy food means organic food and healthy food. Organic food is produced on the soil that

has not been treated with artificial additives for years and has not been treated with pesticides, fertilizers and that it is not biotechnological product that is it does not contain genetically modified organisms (Deliana, 2012). Organic food is the food that is produced, stored and processed without the usage of the most conventional pesticides, artificial fertilizers, bioengineering and ionizing radiation (Čengić-Džomba at all., 2014). Organic food production does not disturb the natural balance, it is sustainable, does not pollute the environment and helps in maintaining of human health, and it is placed on the market with a certificate of conformity as healthy and safe food (Michaelidou, 2007). Healthy food is food which satisfies with its quality, storage conditions, with preparation and distribution (Živković, 2000). We are aware of the fact that today is almost impossible to produce absolutely healthy food, because there are no areas where the air is not at least slightly polluted. This certainly does not diminish the importance of healthy food consumption and its impact on human health within our optimal possibilities of production (Lovrić, 2003). Based on the results of a survey called „Total Food Market“ it has been confirmed that the customers prefer to buy and consume healthy organic food that are rich in freshness and healthy ingredients, thus avoiding the impact of agricultural chemicals and genetically modified food products (Winter & Davis, 2006). Customers are not very familiar with the range of organic products on the market. Some consumer groups have a more positive attitude towards organic products, and show a strong willingness to pay higher prices for those products in order to get safe and healthy product. Therefore, marketing strategies of organic food producers and distributors should be targeted at segments of such customers (Radman, 2005). With joint efforts it is necessary to promote preventive activities and healthy lifestyle, and particularly moral and realistic promotions which will customers find relevant and that will increase awareness about organic food products

3. RESEARCH METHODOLOGY

In this research paper, the subject of the research is the purchasing behaviour of organic and inorganic products and identification and measurement of factors that influence purchasing behavior for both observed groups of respondents. A prospective survey was conducted in February 2020 on the territory of the city of Banja Luka, by random selection on a sample of 220 respondents of whom are: 110 respondents are organic food purchasers and 110 respondents are the purchasers of conventional or inorganic food.

The form of a structured interview was used as a research instrument to conduct the primary research. Respondents from both groups were asked the identical questions, and that is in our case used in order to accurately divide the answers in two categories, and both categories contained subcategories, that is the questions focused on consumption of organic or conventional food, such as taste, freshness, quality, availability, health, variety of offer, confidence and price relationship. Respondents were asked to express themselves on a five-point scale in a multidimensional scaling technique, that they state from strongly agree (5) to completely disagree (1). Through a structured interview designed in this way, with specifically separate categories and questions for organic and inorganic purchasers, we will get more detailed picture of the purchasing behaviour, attitudes, expectations, beliefs, intentions and perceptions of customers towards organic food. The correlation between these two categories was examined by using the Chi-square test (χ^2 test), in order to determine the association between certain demographic status and the level of consciousness of the respondents and multivariate analysis of variance for testing multiple dependent variable variables, and they were processed by using the statistical programme IBM SPSS Version 23.

The results of the survey are summarized precisely below, on the basis of which the conclusions were drawn about marketing challenges and consumer purchasing behavior towards organic food products

4. RESULTS OF RESEARCH AND DISCUSSION

The primary research was conducted in the inner city area of the city of Banja Luka and it was focused on consumer behaviour towards organic food products. A prospective survey involved 220 respondents (total sample), which we divided into two groups. The first group consisted of 110 respondents who were customers of organic food, and the second group also consisted of 110 respondents who were the customers of inorganic or conventional food. Demographic characteristics of the total sample of customers: mostly women or 60% (132), the predominant age of the respondents was from 30-45 years old or 40% (88), most respondents had secondary education or 36,4% (80), 60% of them were employed (132) while majority of respondents stated that they had below average monthly income or 50,9% (112). Table 1.

Table 1. Demographic characteristics - Case Processing Summary

		N	Marginal Percentage
Group	Organic food purchasers	110	50.0%
	Inorganic food purchaser	110	50.0%
Gender	Women	132	60.0%
	Men	88	40.0%
Age	20-30	44	20.0%
	31-40	88	40.0%
	41-50	56	25.5%
	51-60	22	10.0%
	+60	10	4.5%
Level of education	primary	76	34.5%
	secondary	80	36.4%
	high	52	23.6%
	postgraduate studies	12	5.5%
Occupation	unemployed	4	1.8%
	unskilled	16	7.3%
	entrepreneur	40	18.2%
	employed	132	60.0%
	retired	28	12.7%
Monthly income	Below average	112	50.9%
	average	84	38.2%
	Above average	24	10.9%
Valid		220	100.0%
Missing		0	
Total		220	

For all listed demographic characteristics the p-value of the Chi-square test was 0.000 so we can conclude that there is certain statistical correlation between the level of awareness and demographic characteristics of the respondents.

There are many different healthy products available at organic food outlets, but in the survey we selected the following product groups: oil; fruits and vegetables; rice, legumes and cereals; sugar; herbal products and tea; fruit and vegetable products; dairy and cocoa

products. The main problem is that consumers are not sufficiently aware and they are often confused about the attitude itself towards organic and conventional products, so their expectations from these products are different. Customers' attitude towards organic food products is almost unique because the 94,5% (208) of respondents showed their willingness to buy, which is in line with the confirmed characteristics. The main characteristics of organic food are: natural breeding stated about 54,1% (119) of respondents, that it wasn't treated with pesticides and doesn't contain chemicals stated 22,3% (49) of respondents, that it was low in calories stated 13,2% (29) of respondents, that it was more nutrient rich stated about 10,5% (23) of respondents. Table 2.

Table 2. Basic characteristics of organic food

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Naturally grown	119	54.1	54.1	54.1
	Without chemicals and pesticides	49	22.3	22.3	76.4
	Low-calorie	29	13.2	13.2	89.5
	More nutritient rich	23	10.5	10.5	100.0
	Total	220	100.0	100.0	

When asked how well were they informed about healthy food and its impact on the health, the respondents answered on three possible answers, so 22,7% (50) of respondents confirmed that they were very little informed, 58,2% (128) of respondents confirmed that they were informed and 19,1% (42) stated that they were fully informed about organic food products and their impact on the health. As the largest source of information 33,6% (74) of respondents stated that for them they were professional journals and books, friends and members of the family for 26,4% (58) of respondents, professional journals for 17,3% (38) of respondents, radio and television for 12,7% (28) of respondents, while 10% (22) of respondents stated that the Internet was the greatest source of information about organic food products.

A group of respondents 22,7% (50) of them who buy organic food stated that they have used it in the last four years, 17,7% (39) of respondents for the last two years, and over four years 9,5% (21) of respondents. Table 3.

Table 3. Time period of using of organic food

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	up to 2 years	39	17.7	35.5	35.5
	from 2 to 4 years	50	22.7	45.5	80.9
	over 4 years	21	9.5	19.1	100.0
	Total buyers of organic food	110	50.0	100.0	
Total	System	110	50.0		
Total		220	100.0		

In terms of the frequency of organic food purchase 22,7% (50) of respondents that buy organic food have a habit of buying the organic food twice a month, weekly 10,9% (24) of respondents, monthly 7,3% (16) of respondents, daily 6,8% (15) of respondents, and occasionally 2,3% (5) of respondents. Organic food purchasers prefer to buy organic food in specialized organic food stores or 22,3% (49) of respondents, on departments with healthy

food in drugstores 8,2% (18) of respondents, in hypermarkets 6,8% (15) of respondents, while the least of them buys organic food in pharmacies and on line. Table 4.

Table 4. Place of purchase of organic food

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	stores for organic food	49	22.3	44.5	44.5
	hypermarkets	15	6.8	13.6	58.2
	drugstores	18	8.2	16.4	74.5
	Green market	10	4.5	9.1	83.6
	pharmacies	5	2.3	4.5	88.2
	directly from small manufacturers	9	4.1	8.2	96.4
	On Internet	4	1.8	3.6	100.0
	Total Buyers of organic food	110	50.0	100.0	
Total	System	110	50.0		
Total		220	100.0		

The decisions about the purchase of organic food mostly they alone make 68,2% (75) of respondents, and for 31,8% (35) of respondents in deciding participate also the members of their families. When asked what kind of organic food they usually buy, group of organic food purchasers stated that 10% (11) of them buys oil, 16,4% (18) of respondents buys fruit and vegetables, 14,5% (16) of respondents buys rice, legumes and cereals, 14,5% (16) of respondents buys sugar, 9,1% (10) of respondents buys herbal products and teas, 14,5% (16) of respondents buys already prepared fruit and vegetable products, and 20,9% (23) of respondents buys dairy and cocoa products. Figure 1.

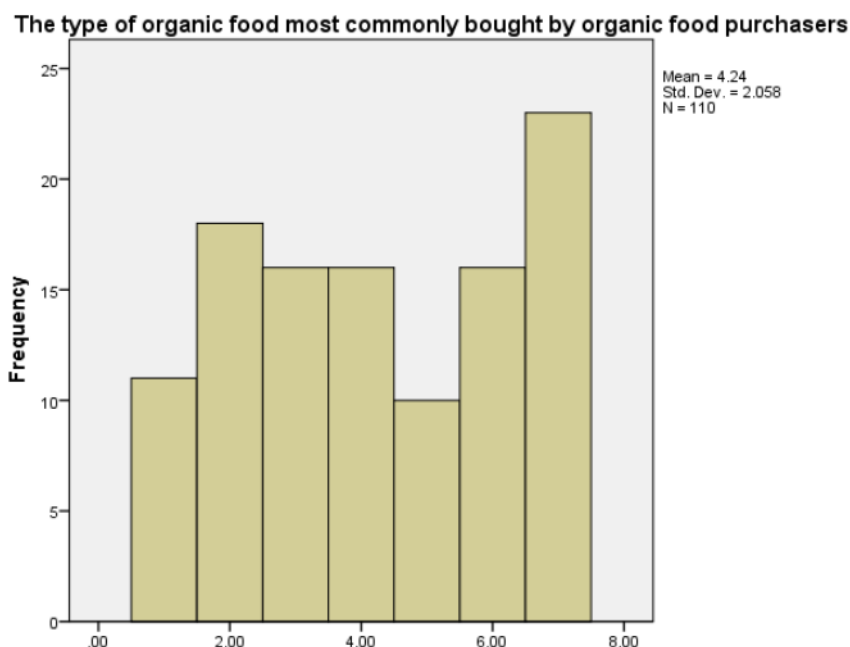


Figure 1. The type of organic food most commonly bought by organic food purchasers

When they were asked about what kind of food they buy the most the purchasers of conventional food answered – a group of inorganic food purchasers stated that 18,2% (20) of them buys fruit and vegetable, 14,5% (16) of them the most frequently buys eggs, 24,5% (27) of them meat and meat products, 20% (22) of them buys milk and dairy products, and 22,7% (25) of respondents most frequently buys bakery products. Figure 2.

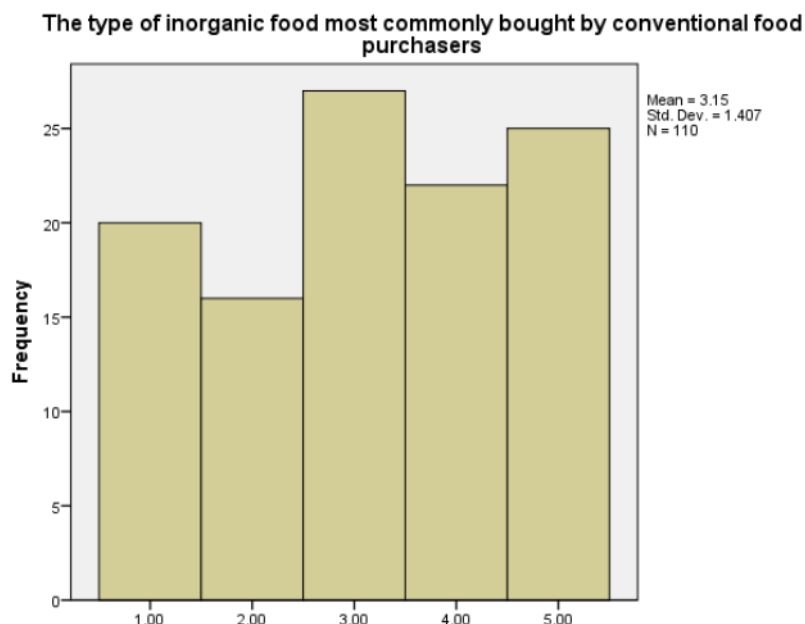


Figure 2. The type of inorganic food most commonly bought by conventional food purchasers

The analysis of psychological factors such as attitude, perception, belief and intention confirmed that they have a great influence on the type of customers. A group of organic food buyers or 85% (94) of respondents stated that they have a high level of awareness about organic products, middle and high level of perception confirmed 88,2% (97), high level of belief in organic products has 92,7% (102) of respondents, while high level of intention to buy organic food products confirmed 96,4% (106) of purchasers of organic food $p < 0,05$.

Table 5. Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.314	2	.000
Likelihood Ratio	35.423	2	.000
Linear-by-Linear Association	26.233	1	.000
N of Valid Cases	110		

The main reason for purchasing organic food products is the level of awareness of the impact of organic food on the overall health and health of each individual. Even if they consider organic products healthy some respondents did not buy them because of high prices and the lack of confidence in their quality and their originality. That is why healthy food producers and traders need to find ways to win and build trust in order to improve their purchase intentions. The main reasons for purchasing organic food products or the factors that influence on respondents were: product freshness, health and positive impact on health, taste,

quality of ingredients, recommendation of acquaintances and friends, and availability and promotional activities.

Table 6. Impact factors / Reasons to buy organic food

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	freshness of groceries	20	9.1	18.2	18.2
	taste	19	8.6	17.3	35.5
	quality of ingredients	16	7.3	14.5	50.0
	availability	11	5.0	10.0	60.0
	positive impact on health	19	8.6	17.3	77.3
	recommendation	16	7.3	14.5	91.8
	promotion	9	4.1	8.2	100.0
Total		110	50.0	100.0	

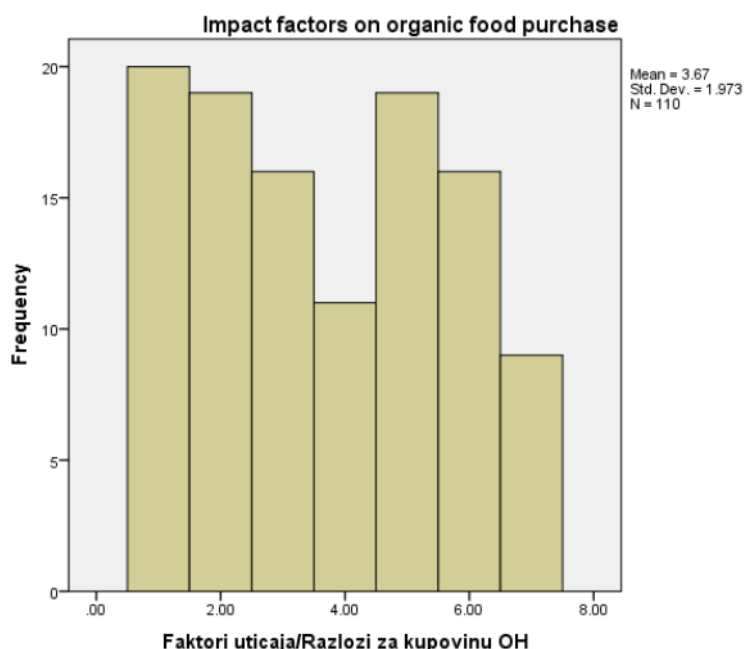


Figure 3. Impact factors on organic food purchase

We ranked the problems that the purchasers of organic food most commonly encounter. The first three ranked problems are: lack of promotional activities related to healthy food advertising, low level of awareness and high prices. Certainly, organic food purchasers as significant problems state the lack of confidence associated with the offer of unbranded products that are unfamiliar to them, short product expiration date and unavailability of products. $p < 0,05$.

Table 7. Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	43.466 ^a	10	.000
N of Valid Cases	110		

Table 8. Problems of organic food purchasers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High price	17	7.7	15.5	15.5
	Unavailability of products	10	4.5	9.1	24.5
	Lack of advertising	22	10.0	20.0	44.5
	Low level of consciousness	18	8.2	16.4	60.9
	Offer of unbranded products	15	6.8	13.6	74.5
	Lack of confidence	16	7.3	14.5	89.1
	Short product expiration date	12	5.5	10.9	100.0
Total		110	50.0	100.0	

5. CONCLUSION

Content marketing has emerged as a marketing challenge, with the help of which companies have tried to solve their sales hardships or problems in a way that they would place some better story. Content marketing slowly decreases in value to customers for one simple reason because it is not personalized enough and it does not offer the experience that customers will find relevant, perhaps memorable and inspiring. While marketing teams are swimming in the sea of information and data, the companies that are digital will thrive in the new world. The future depends on creativity and application of experience design which should represent the next frontier of trust and brand building and it is directly related to consumer behavior towards the purchase of any product.

With our research we confirmed that consumer behavior plays very important role in the organic food industry. Producers, distributors and sellers of organic food products need to be innovative, flexible, continuously monitor the changes in the behavior of organic food purchasers. They should develop their offerings and products in accordance with the specific needs and preferences of behavior of each consumer group in the target market. The majority of respondents who consume organic food believe that it was produced without pesticides and that it was not chemically treated, while the respondents who consume conventional food stated that they were natural products. The main reason for buying organic products is health and awareness of healthy lifestyle. The offer of organic food products on the territory of the city Banja Luka is currently limited because the demand for healthy food products has increased. Producers and distributors of organic food products should work to increase production capacities, sales capacities and availability, to increase and expand supply and the size of packaging of healthy food products, and government institutions to increase living standards of agricultural producers and the general population as well. With joint efforts it is necessary to promote preventative activities and healthy lifestyle, especially moral and realistic promotions that customers will consider relevant, and that will increase awareness of organic food products. It is important to mention that customers believe that conventional food contains harmful ingredients for human health and the environment, so this information is very important for the policy makers, business subjects and marketing professionals in the segment of organic food production and sales.

Elements of customer motivation such as brand, product label information along with psychological factors such as attitude, perception and intention influence consumers' buying behavior and are very important when designing a sales strategy. By increasing the level of consumer satisfaction we can develop sustainable and profitable production of organic products.

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M – LEARNING AS A TREND IN EDUCATION BETWEEN STUDENTS IN SERBIA

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Abstract: M-learning is the latest trend and new form of e-learning in higher education. The integration of mobile devices in the educational system presents enormous opportunities stretching from improved efficiency to accessibility of education to communities living in remote areas. This study investigates students' awareness of intention to adopt M-learning, by examining the factors which affecting on students' intention to use m-learning for education process as an addition to the standard learning process. Perceived easy to use, perceived usefulness, lecture influence and service quality are among the most important elements that directly affect on the students' intention to use m-learning. For this purpose, a conceptual model of positive effects has been developed with four hypotheses. The method of the questionnaire was used to collect data. This empirical study includes 247 university students from the University of Belgrade. Statistical data processing and modelling were performed using software program SPSS v.17.0. The results of this paper can help policymakers on University in Belgrade to overcome the challenges of the using M-learning and advance the teaching process.

Keywords: M-learning, Students, Higher education

1. INTRODUCTION

Various technologies and their usage have affected the individuals' lives from different facets. Diverse advancements in terms of informatics and technologies lead educational fields to include and apply them in learning and instructional processes result in the advent of the notion of e-learning and mobile learning (M-learning) (Khan et al., 2015; Alioon et al., 2015; Alshahrani et al., 201). The emergence of the knowledge economy and integration of mobile devices into the academic settings has produced everlasting impact on the modern learning system. Learning is no more confined to the classroom and directed by instructors, instead it has moved to a new horizon of anywhere, any time and by anyone using mobile devices called M-learning (Khan et al., 2015).

M-learning is defined as a form of E-learning that specifically uses mobile devices (e.g., personal digital assistants, cell phones, smart phones, notebooks, or tablet personal computers) to deliver learning content and supports. Essentially, M-learning is based on the use of mobile devices anywhere at any time, and the prevalent use of portable technologies

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makes it easier for learners to learn when and where they intend to access the learning materials (Evans, 2008; Cheng, 2015).

Learners readiness, students' feedback and types of M-learning applications are among the considered issues in terms of M-learning and addressed in various researches and studies which shed light on importance of learners' readiness for M-learning and its acceptance by students (Kennedy et al., 2008; Abas et al., 2009; Liaw et al., 2010; Milošević et al., 2015; Sabah, 2016).

This aim of this study is based on exploring the factors that effect on the intention to use M-learning by the opinion of the students for the University of Belgrade (Serbia). The paper analyses the existing researches conducted in this regard and make comparison with the obtained results of the conducted study in Serbia.

The rest of the paper is organized into five sections: introduction, literature review, methodology, results and discussion, and conclusion. While the introduction presents an overview of M-learning in higher education institutions by students and objective of the study, the literature review consists of four factors for the intention to use M-learning, and their discussion in the light of the current educational scenario in Serbia. Section 3 describes the experimental part and formulation of the methodological framework for defining a research topic; Section 4 presents a discussion of the obtained results and analyses the contribution and finally the conclusions and guidelines for the future work are presented in Section 5.

2. LITERATURE REVIEW

New students' generations are technology dependents and they are expected to use M-learning in their studies because they may associate technology more with education (Sarrab et al., 2012). Therefore, this study aims to investigate students' awareness and perceptions of M-learning, as well as to investigate factors influencing students' behavioral intention to use M-learning at the University of Belgrade. The key factors which are investigated in this study are perceived easy to use, perceived usefulness, lecture influence and service quality.

2.1. PERCEIVED EASY TO USE

Perceived Ease of Use (PEOU) as the degree to which a person believes that using a technology will be free from effort (Davis, 1989). In the context of this study, PEOU refers to the extent to which students believe that their continued use of M-learning is free of effort. If a system is relatively easy to use, individuals will be more willing to learn about its features and finally intend to continue using it. Studies indicate that PEOU is positively associated with intention of students to use M-learning (Althunibat, 2015; Sabah, 2016). Therefore, it is hypothesized:

Hypothesis H1. Perceived ease to use positively effects on intention to use M-learning.

2.2. PERCEIVED USEFULNESS

Perceived usefulness (PU) is one of the independent constructs in the Technology Acceptance Model (TAM). It is the degree to which a person believes that using a particular

system would enhance his or her job performance (Davis, 1989). For this purpose, five items were used to measure the perceived usefulness. Shee and Wang, (2008) argued that an e-learning system offers professors and students’ possibilities”, instead of “ready to use” resources. In this regard, while the effectiveness of a general information system is based on the performance of individuals, an E-learning system’s effectiveness largely depends on collaboration between individuals (both professors and students) (Najmul, 2013). Previous studies indicate that PU is positively associated with intention to use in the context of M-learning (Cheng, 2015; Milošević et al., 2015; Sabah, 2016). Thus, we can define next hypothesis as:

Hypothesis H2. *Perceived usefulness positively influences on intention to use M-learning.*

2.3. THE INFLUENCE OF THE LECTURER

One of the most important parts of classroom management is the relationship between students and their lecturer. Improving this relationship can have positive and long-lasting implications on students’ academic and social development and can support students in attaining higher levels of achievement (Adeyele et al., 2012). As a result, students show more engagement with their learning and perform better academically (Lasky & Estes, 2009; Alshahrani et al., 2017). Therefore, the following hypothesis is proposed:

Hypothesis H3. *Lecture influence positively affects on intention to use M-learning.*

2.4 SERVICES QUALITY

M-learning refers to the use of mobile wireless communication technology for producing learning environment within the educational institutions, irrespective of the time or place. Mobile technologies enable the students, lecturers and universities ‘staff, to effectively and efficiently access, manipulate and accomplish their needs by rendering mobile services from anywhere, at any time (Sabah, 2016). Hence, the following hypothesis is proposed:

Hypothesis H4. *Services quality positively influences on intention to use M-learning.*

Based on the predefined factors that influence or can influence the intention to use mobile learning, as well as the defined hypotheses, Figure 1 presents a defined conceptual model.

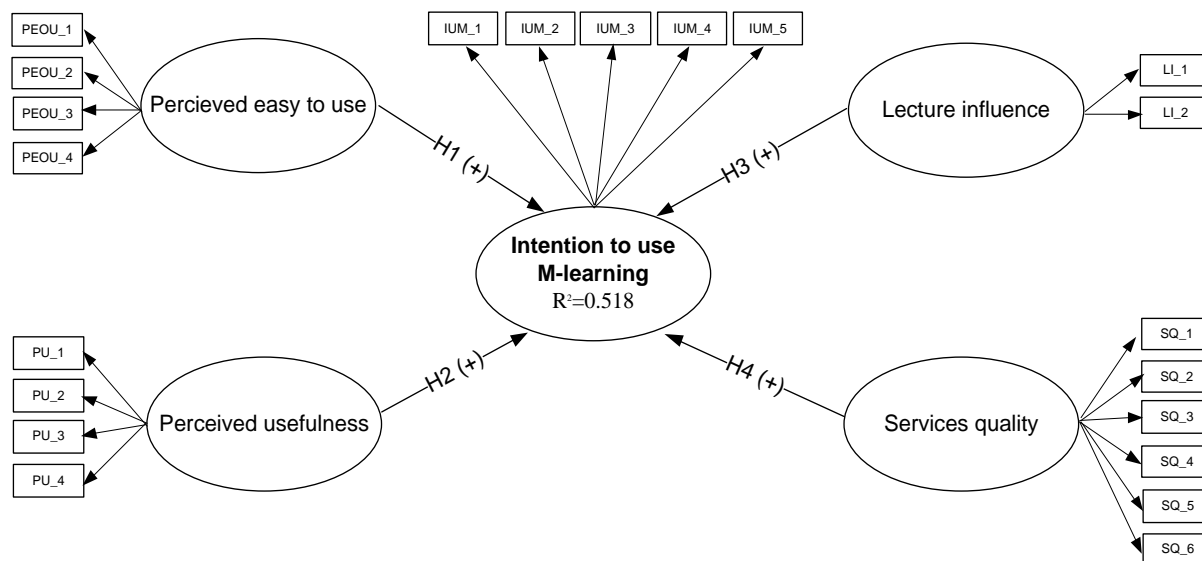


Figure 1. Conceptual model

3. METHODOLOGY

For data collecting, survey method has been chosen as a widely used technique in social science.

The survey method used is based on random approach. The randomly chosen individuals are deemed to fit in the decided age group for the survey conduction. Moreover, the participants were familiar with the aspects of M-learning.

Having in mind that the questionnaire plays a big role on the responses, the suggestions from literature Ahmad and Love, (2013), Milošević et al., (2015) have been taken into consideration by preparing the form. The research was conducted from May 2019 to December 2019. The online form of the questionnaire was sent to the students from the University of Belgrade (Serbia).

The survey was anonymous, and the data collected from the survey conducted included the responses of 247 participants that were properly completed the online questionnaire. The questionnaire consisted of two major parts. The first part captured the demographic information of respondents (gender, age, M-learning knowledge, level of mobile usage, and frequent use of M-services). The second part measured respondents' awareness and perceptions of M-learning, which is measured via a 5-point Likert-type items ranging from 1 (strongly disagree) to 5 (strongly agree).

The questionnaire contains 7 questions of the demographic character and 21 questions describing elements of the concept of M-learning: Perceived Ease to Use (PEU), Lecture Influence (LI), Perceived usefulness (PU); Services Quality (SQ) and Intention to Use M-learning (IUM). A model is proposed that contains four independent latent variables marked as PEU, LI, PU, SQ and one dependent latent variable marked as IUM.

4. RESULTS AND DISCUSSION

Direct oblimin rotation, exploratory factor analysis and linear regression analysis were performed using software program SPSS v.17.0 to evaluate the factor structure of the

variables. Each scale had satisfactory reliability, with a Cronbach's alpha coefficient, and all the values of the factor loadings are greater than 0.4 (Hair et al., 1995). The analysis results include the demographic statistics, factor analyses, correlation matrix and regression analyses (Ho, 2006). The demographic statistics of the survey respondents are given in the Table 1.

Table 1. Characteristics of participants' demographic profiles

Variables	Category	Frequency	Percentage (%)
Gender	Male	99	40.1
	Female	148	59.9
Age	18-21	83	33.6
	22-25	143	57.9
	26-30	19	7.7
	Over 31 years	2	0.8
E-learning knowledge	Moderate	57	23.1
	Good	140	56.7
	Very good	50	20.2
Experience of smart phone	Less than 2 years	7	2.8
	2-4 years	48	19.4
	More than 4 years	192	77.7
Using M-learning	Yes	150	60.7
	No	97	39.3
Frequency using m-services for learning	N/A	96	38.9
	1-5 (times per day)	132	53.4
	6-10 (times per day)	17	6.9
	More than 10	2	0.8
M-learning knowledge	Poor	38	15.4
	Moderate	70	28.3
	Good	110	44.5
	Very good	29	11.7

The descriptive characteristics of the usable respondents are depicted in Table 2. A total of 247 usable questionnaires were analyzed in this study. Among the usable respondents, 99 respondents (40.1%) were men, and 148 respondents (59.9%) were women. The distribution of age (in years) was as follows: under 21 (33.6%), 22-25 (57.9%), 26-30 (7.7%), and over 31 (0.8%). Students' knowledge of e-learning has the following distribution: 57 respondents have moderate (23.1%), 140 respondents (56.7%) has good, and 50 respondents (20.2%) have very good knowledge about e-learning. Experience with a smart phone less than 2 years has 7 respondents (2.8%), from 2 to 4 years of experience has 48 respondents (19.4%), and more than 4 years of experience has 192 respondents (77.7%). A total of 247 respondents, 60.7% of the respondents using M-learning in educational purposes. In addition, the distribution of frequency of usage M-services for learning was as follows: Not Available (38.9%), from 1 to 5 times per day (53.4%), from 6 to 10 times per day (6.9%) and more than 10 times per day (0.8%). Distribution of students' knowledge of M-learning was as follows: poor knowledge (15.4%), moderate (28.3%), good (44.5%) and very good (11.7%).

Before testing the structural model, it was defined the correlation model, which establishes correlating connections among defined groups of questions, in order to confirm that the 21 measurable variables reflect the 5 latent variables in a reliable manner. The means,

standard deviations (S.D.), One-dimension factor (%), Cronbach's alpha coefficient (Alpha), and correlations for the latent variables are shown in Table 2.

Table 2. Descriptive statistics of factors, factor analysis, Cronbach's alpha coefficient and correlations

	<i>Mean</i>	<i>S.D.</i>	<i>One-Dimen. Factor (%)</i>	<i>Alpha</i>	<i>PEU</i>	<i>LI</i>	<i>PU</i>	<i>SQ</i>	<i>IUM</i>
Perceived Ease to Use (PEU)	3.84	0.76	70.208	0.855	-				
Lecture Influence (LI)	3.58	0.75	55.929	0.656	0.358*	-			
Perceived usefulness (PU)	3.38	0.75	70.208	0.855	0.590*	0.365*	-		
Services Quality (SQ)	3.70	0.61	61.345	0.710	0.457*	0.292*	0.338*	-	
Intention to Use M-learning (IUM)	3.61	0.89	70.846	0.896	0.604*	0.412*	0.644*	0.376*	-

*Sig <0.001

The Internal consistency of a group of statements, which are related to the concepts included in the research, was tested. For the assessment of internal consistency, Cronbach's coefficient was used (Cronbach, 1951). It was suggested within each group of questions (Nannally, 1978) that the value $p \geq 0.7$ would be considered as a priority, while the value $p \geq 0.60$ (Hair et al., 1995) would be considered acceptable. Cronbach's alpha factor for the total population is 0.810, while the values of the groups are shown in Table 2. After having determined the acceptable alpha coefficient for the all groups of questions, it was turned to do regression tests. Linear regression analysis was used to test the hypotheses.

The values of the coefficients of the determination (R^2) are shown in the dependent variable field. The value of $R^2=0.518$ indicates that the effect of the latent predictors PEU, LI, PU and SQ on the latent endogenous variable IUM can be calculated with a 51.8%, variance. The value of the regression coefficient (β) and the values of the t-test are given in Table 3, and the asterisk indicates the level of statistical significance.

Table 3. Summary of hypothesized results

Number theory	The relationship or path	Standardized regression coefficient (β)	T-value	Result
Hypothesis H1	PEU → IUM	0.284	4.667**	Supported
Hypothesis H2	PU → IUM	0.408	7.048**	Supported
Hypothesis H3	LI → IUM	0.113	2.304*	Supported
Hypothesis H4	SQ → IUM	0.080	1.515 ^{ns}	Slightly supported

Notes: ns - not significant; $p^* < 0.05$; $p^{***} < 0.001$.

First of the four hypotheses of this study pointed to the positive influence of the perceived ease to use on intention to use m-learning. Intention to use M-learning latent variable consists of the indicators: I plan to use m-learning in my studies, I predict that I will use m-learning frequently, I will enjoy using m-learning systems, I intend to increase the use of mobile services in the future and I would recommend others to use m-learning systems. Perceived ease to use latent variable is built by the indicators: I would find a M-learning system flexible and easy to use, learning to operate a M-learning system does not require much effort, my interaction with a M-learning system would be clear and understandable and I can easily become skilled at using M-learning. According to correlation matrix there are positive relationship between perceived ease to use and intention to use m-learning, and the regression analysis show positive relationship at 0.001 significance level. Thus, the hypothesis H1 is supported, because the following values are obtained $\beta = 0.284$, $t = 4.667$ and $p < 0.001$. The result implicates that if students can self-explore directly through the content and interface screens over the mobile-based interactive learning environments at any time in any location, they will be more likely to regard M-learning as both useful and easy to use. That will further facilitate their intention to use M-learning when they are preparing for classes or for examines. The findings are consistent with the views of previous studies (Yoon & Kim, 2007; Murali & Manimekalai, 2012; Cheng, 2015; Milošević et al., 2015; Sabah, 2016).

The second hypothesis proposed that the perceived usefulness positively influences on intention to use M-learning. The perceived usefulness latent variable is consisted of: m-learning is useful for my studies, M-learning enables me to accomplish learning tasks more quickly, using M-learning will increase my learning productivity, M-learning improve my collaboration with instructors and colleagues. According to the correction matrix, there is a positive relationship between context perceived usefulness and intention to use M-learning. The regression analysis shows a positive relationship at a level of statistical significance greater than 0.001. Therefore, the hypothesis H2 is confirmed, accepted and statistically significant, since the results of the regression analysis are as follows: $\beta = 0.408$, $t = 7.048$ and $p < 0.001$. Based on the obtained results it can be concluded that this is because students tend to use the system if it is easy to use and if they perceive that M-learning is useful in enhancing their learning environment. Similar results can be found in the papers (Jairak et al., 2009; Althunibat, 2015; Sabah, 2016).

Also, lecture influence has a significant influence on the intended behavior of students in the use of m-learning. The lecture influence latent variable is consisted of two indicators: I would use m-learning if it was recommended to me by my lecturers and I would like to use M-learning if my lecturers supported the use of it. According to correlation matrix there is positive relationship between lecture influence and intention to use M-learning, and regression analysis has shown a positive relationship at 0.05 significance level. The hypothesis H3 is confirmed, accepted and statistically significant, since the results of the regression analysis are as follows: $\beta = 0.113$, $t = 2.304$ and $p < 0.05$. The relationship between students and lecturers is essential to learning (Venkatesh, 2000; Davis, 2003). This relationship is rapidly and radically transforming with the popularity and easy access to online learning resources (Martin, 2008; Freeman et al., 2013). Using Mobile devices as a tool for learning in classrooms by professors create more interactive and collaborative relationship between professors and students, instead of lecturer dominant (Alshahrani et al., 2017).

The last hypothesis of this study proposed that there is positive relationship between service quality and intention to use M-learning. The services quality latent variable is consisted of: it is important for M-learning services to increase the quality of learning, I would prefer M-learning services to be accurate and reliable, it is preferable that M-learning

services are easy to navigate and download, it is important that M-learning services are safe to use, for M-learning is important speed of searching the Internet and getting information quickly, communication and feedback between professor and student would be easy using the M-learning system. According to correlation matrix there is positive relationship between service quality and intention to use M-learning. The hypothesis H4 has slightly supported, because the results are not statistically significant ($\beta=0.080$, $t=1.515$ and $p>0.05$). People are usually similar in terms of disinclination and unwillingness to use the system that once resulted in improper or poor response time based on frequent disconnection. Additionally, the deficient of access, and particularly the privacy concerns become the additional constructs of don't attaining the individuals' attention (Althunibat, 2015). The services being rendered to improve the learning standards and environment of the individuals must be of utmost quality, else the future existence of the implemented technological modifications remains at risk. According to Lin and Lu (2000) the Information System must govern the perfect accordance with the destined purpose, by considering the quality of information excellence, response time and system accessibility services.

5. CONCLUSION

This paper describes the study of factors that affect the intended behavior of students in the acquisition of M-learning at the University of Belgrade (Serbia). The results demonstrated that the all tested hypotheses indicate positive direction to intention of use M-learning.

Based on obtained results of the present study it can be concluded M-learning inspires student activity and, thus, is worth adopting as a teaching tool in future teaching practice. Whereby, it necessary to take care about perceived ease to use, lecture influence, perceived usefulness and quality of services which are key factors that have influence on intention to use M-learning, which this study confirms.

The conceptual model with hypotheses, developed in this paper, is considered useful for researchers, because the results of this study can be compared with the results of researches in other countries. Results obtained by comparative analyzes could lead to the establishment of universal correlations that could be important for further development of the concept of M-learning in Serbia.

The results should be viewed considering some limitations. First, the sample size in this study is relatively small and includes only one part of students at the University in Belgrade. Students' experiences, perceptions, and expectations at the University of Belgrade may differ from other students who study at other state or private faculties in Serbia or abroad. Consequently, the results may not be identical if generalized beyond a similar situation.

This study was a cross-sectional analysis of intention to use m-learning. It may be desirable to explore a complete picture of the intention to use m-learning with students that have increased experience in using M-learning. The future research may extend the study of analysis different factors, by considering the evolution of M-learning acceptance over time.

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INVENTORY MANAGEMENT: LITERATURE REVIEW AND PAPERS CLASSIFICATION

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Abstract: Logistics plays a vital role in the country's economy, not only by providing the functioning of various economic sectors but also through income that contributes to society. The functioning of a logistic system results in the flow of materials and related information. It is based on the application of various logistic strategies, the use of a wide range of resources and services both internally and outside of individual companies. Logistics is responsible for the flow of materials through a supply chain. In contrast to the physical flow of materials, inventories are formed by different measures in the supply chain and they can also slow down this flow. The focus of this paper is on different approaches and models for inventory management. Inventory management problems have been studied for long, but there are still new approaches that are being developed in literature and put into practice. The aim of this paper is to create a review of existing literature and classification of related papers with inventory management topics, which were published in the main logistics journals.

Keywords: inventory management, logistics, supply chain management, literature review

1. INTRODUCTION

The functioning of the logistics system results in the flow of materials and related information and is based on the application of various logistics strategies and the use of a wide range of resources and services within and outside individual companies. Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, material handling, order execution, logistics network design, inventory management, supply and demand planning, and management of third-party logistics service providers. Logistics management is the part of supply chain management, which plans, implements and controls the efficient and effective movement and storage of goods, services and related information between the place of origin and the place of consumption in order to meet customer requirements. Supply chain management includes the planning and management of all activities involved in procurement, production and distribution within the supply chain. It also includes coordination and cooperation with partners, who can be suppliers, intermediaries, third-party service providers and customers. In essence, supply chain management integrates supply and demand management within and outside companies (CSCMP).

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Logistics and supply chain management deal with the management of material or service flows, from supplier to customer and along the supply chain in which companies have supplier and customer roles. Supply chain management is a set of approaches used to effectively integrate suppliers, manufacturers, warehouses and stores, so that goods are produced and distributed in the right quantities, at the right location and at the right time, to minimize costs while meeting service level requirements (Simich-Levi et al., 2003, Fedorko et al. (2018)). The overall goal of supply chain management is the integration of organizational units and the coordination of material, information, and money flows to improve supply chain competitiveness (Stadtler, 2005, Groznik and Maslaric (2009)). Logistics is responsible for the amount of material moving through the supply chain. Unlike the physical flow of materials, stocks are formed by different models in the supply chain and can slow down the flow through the chain itself.

Logistics management integrates very different areas and seeks to reconcile their individual (often conflicting) interests in the flow of materials and goods. In doing so, it faces challenges to improve operational efficiency and integrate supply, production and distribution processes through different components of the supply chain. The various areas involved in the planning, implementation and management of logistics and supply chains are being developed independently but also within their application in logistics. In addition, in response to changes taking place in the modern market, existing concepts are being refined and new concepts are being developed within logistics. All this only confirms that the management of logistics and supply chains is extremely complex, dynamic and constantly under review.

In this context, it is necessary to understand this paper, which aims to, based on research papers in leading logistics journals (reviewed about 50 issues of various journals in the period from 2008 to 2019), highlight the most commonly studied problems related to inventory management, as one of the components of logistics and supply chain management.

2. MATERIAL INVENTORY MANAGEMENT

Inventories are all quantities of materials, energy and information that have been excluded from the process of production or use (consumption) for a certain period of time in order to be able to be used at the time of the indicated need (Vukićević, 1995). In supply chains, stocks can be formed by different participants (suppliers, manufacturers, distributors, wholesalers, retailers) in order to ensure the continuity of their business and provide better service to customers. Material inventory management is implemented to avoid the shortage of required materials when they are needed (Arnold et al., 2008). On the other hand, stocks cause significant costs and slow down the flow of goods through the supply chain, which negatively affects its efficiency. Owning stocks, depending on the sector, can cost between 20 and 40% of their annual value (Ballou R.H., 1998). In total logistics costs, about 33% are caused by inventories (Williams and Tokar, 2008). Therefore, adequate inventory management that seeks to strike a balance between product availability and costs that allow for a defined level of availability is a very important component of the cost-effective business.

Inventory management is affected by a number of factors (sector, product characteristics, inventory replenishment and consumption characteristics, constraints, objectives, etc.) that must be considered in each individual case. However, in any case, when creating a stock management policy, the following questions should be answered: which products should be in stock, when to order them and how many to order. The choice of quantities through which inventories are managed defines the inventory management policy, that is the rules according to which inventories are replenished. These are usually the

following sizes: quantity of the product to be procured (quantity of procurement), level of stock at which it is ordered, the period between two adjacent purchases, time of delivery, the maximum level of stock.

Inventory management problems have been researched for a long time (Ford W. Harris: *How Many Parts to Make at Once* was published in 1913), and they gained more importance at the end of the last century with the adoption and spread of the concept of supply chain management. Fundamental changes in the understanding of inventories, together with advanced technologies (primarily information and communication) and improved processes, have encouraged and enabled the development of new approaches and models of inventory management. New approaches, through various forms of cooperation between participants and the exchange of information, allow companies to move goods quickly through the supply chain and to provide their customers with services of the same level with much smaller stocks.

Despite all this, it is difficult to determine the best guidelines for inventory management. There is no ideal way to organize stocks, but there is a clear trend towards their reduction. The first step in finding good solutions for individual situations is to research previous ideas that have been processed in a large number of papers related to inventory management.

3. LITERATURE REVIEW

In this paper, research and analysis of papers dealing with inventory management is limited to the leading logistics journals published in the period from 2008 to 2019. The issues of the five journals that have the highest citations in terms of citations were considered, ie the papers in the following journals were reviewed: *International Journal of Logistics Management (IJLM)*, *Journal of Business Logistics (JBL)*, *Transportation Journal (TJ)*, *Transport Research Part E (TRE)* and the *International Journal of Physical Distribution and Logistics Management (IJPDLM)*.

The course of the analysis conducted in this paper is shown in Figure 1.

This section consists of two parts. The first part analyzes the total number of published papers on topics related to inventory management, individually by journals and by years. The second part gives a brief overview of the content of selected papers.

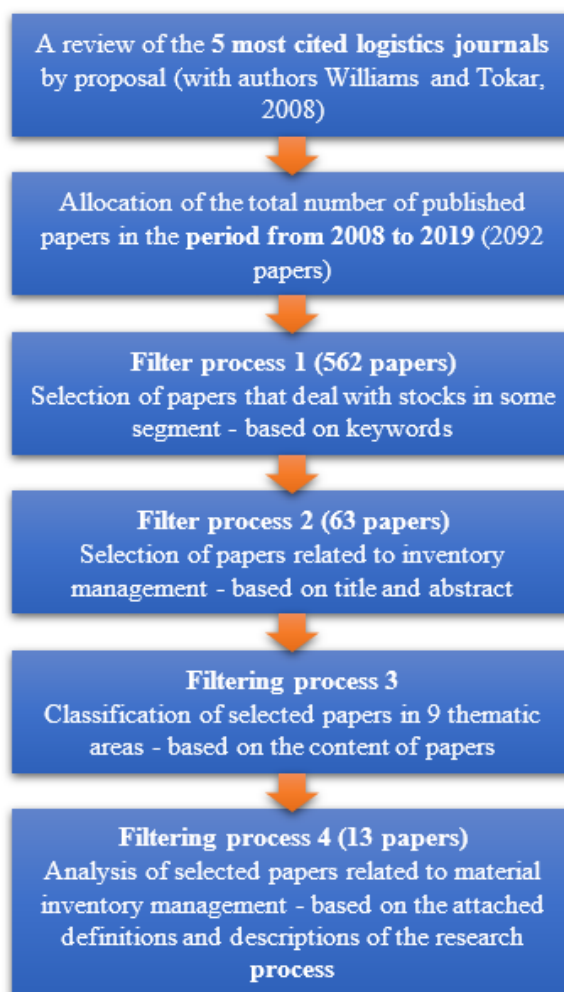


Figure 1. Literature review process

3.1 ANALYSIS OF PAPERS IN JOURNALS

All journals that have been the subject of this analysis deal with different aspects of logistics and supply chains, but each has its own areas of focus, which may explain to some extent the different representation of inventory management work.

The International Journal of Logistics Management focuses on those papers that deal with applicable theory and techniques. This journal mainly publishes papers that provide new knowledge and guidelines for the design, interpretation or application of logistic approaches in the supply chain, so that the most common are papers that contain various empirical research.

The Journal of Business Logistics is focused on researching the operational, strategic and financial impact of logistics on business success. Research and theoretical papers are published, as well as papers that bring together best practices in the field of logistics and supply chains.

The Transportation Journal primarily covers areas related to various modes of transport and from that aspect also deals with logistics, physical distribution, supply chain management, information management, computer applications and the like, so that works dealing with inventory management can also be found.

Transportation Research is a journal with a wide range of areas to study. It is divided into 6 parts, from A to F, and each represents one thematic unit. Part E of this magazine focuses on logistics and transportation activities.

The International Journal of Physical Distribution and Logistics Management publishes papers with current information, discussions and case studies related to physical distribution and logistics management. It focuses on cutting-edge research linking the areas of enterprise management, physical distribution, business logistics, marketing channels and supply chain management.

In the observed period, the studied journals published a total of 2092 papers, of which a total of 63 papers were identified that deal with issues in the field of inventory management, which is about 3% of the total number of published papers. The distribution of identified papers by journals in the observed period is shown in Figure 2. It can be noticed that by 2016 the number of published papers is relatively even, after which there is a decline.

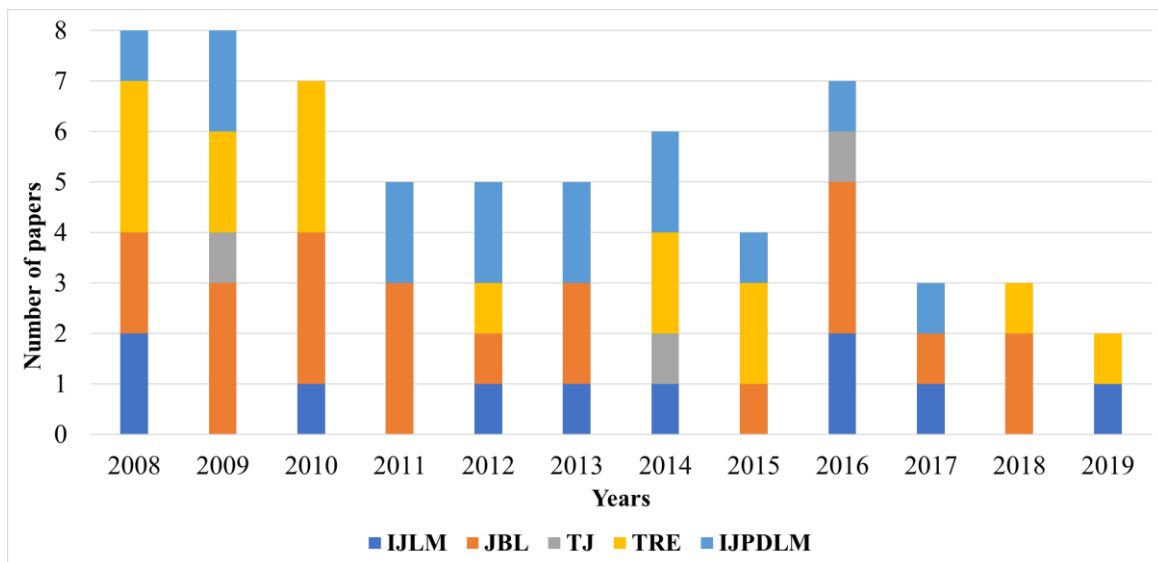


Figure 2. Number of published papers by journals and by years

The distribution of the total number of published papers by individual journals for the analyzed period is shown in Figure 3. The largest number of papers was published in the journal JBL, which together with papers in the journals IJPDLM and TRE makes about 80%.

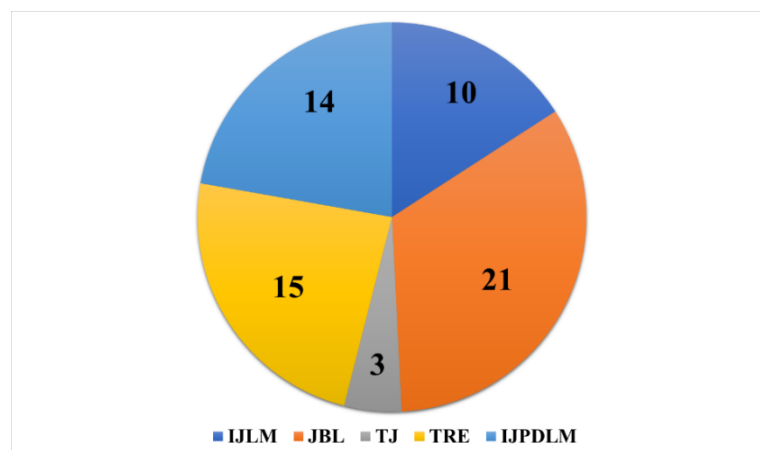


Figure 3. Distribution of papers by journals for the analyzed period

3.2 CONTENT OF PUBLISHED PAPERS

All papers in the field of inventory management are classified into nine areas according to the focus of the research. The classification of papers was performed in order to identify the most important and currently current research topics. There were some doubts due to the fact that all **papers** cover several differentiated areas. The affiliation of a work to a certain area was determined on the basis of the problem that was solved, and the result of this classification is shown in Table 1.

Table 1. Presentation of works by thematic areas

Thematic area	Number of papers	Participation (%)
Literature review	1	1.6
Finished goods inventory management	17	27.0
Material inventory management	13	20.6
Return flow inventory management	1	1.6
Integration of transport and supplies	12	19.0
Stock visibility	4	6.3
Inventory costs	9	14.3
Coordination of stocks in the supply chain	3	4.8
Demand forecasting	3	4.8
In total	63	100,0

It is noticed that works that investigate the problems of managing stocks of materials for the needs of production and stocks of finished products in distribution dominate. In addition, the integrated study of transport and supplies is attracting a lot of attention.

Waller et al. (2008) analyzed a model that performs periodic inventory review at time T and procurement when inventory levels fall below R . It was observed that companies often deviate from a fixed inventory review interval when trying to achieve more efficient transportation. This paper aims to determine the standard deviation of demand during the protection period, where the review interval is stochastic. In this way, depending on the different demand, different intervals of inventory review would be applied, and thus, with the change of the interval, the size of orders of the observed product would change. In particular, this model creates stochastic review intervals and procurement sizes based on whiplash effect analysis. Applying this approach would significantly reduce the stocks of materials in production and free up storage space for finished products.

Blankley et al. (2008) analyzed the application of supply chain management software and concluded that its application can provide a reduction in inventory and reduce unnecessary costs. This software strives to optimize inventory at the system level, which leads to a reduction in inventory costs. In order to examine the efficiency of the software, the authors created an analytical model for inventory optimization, then analyzed the model by a numerical experiment and finally, compared the obtained results with a real system. Empirical tests have shown that the application of software on the part of the company does not reduce costs, but significant results can be achieved at the company level.

LeBlanc et al. (2009) analyzed the cost-effectiveness of delaying production versus inventory costs. The test was performed for one manufacturer that can realize its production in two different modes. The first regime requires longer working hours and cooperation with foreign suppliers, but causes lower costs. Production materials are procured from cheaper

suppliers, the total procurement costs are lower, but it takes longer to transport the materials to the place of production. In the second mode, the manufacturer procures materials from more expensive, domestic suppliers, the time required to procure materials is significantly reduced but the total procurement costs are higher. The result of this work is a model that aims to perform demand forecasting in certain conditions with a higher degree of reliability. By applying the created model, the optimal balance between the increased costs of deferred production and the costs incurred due to the possession of stocks can be examined. In this way, the level of inventory that would cause a maximum reduction in costs can be determined.

The realization of the production process generally requires different materials that are procured from different suppliers. In the production process, these materials are transformed into value-added products, and shipped to the next participant in the supply chain where their production or personal consumption takes place. Each of the participants in the supply chain often forms stocks in order to secure its own business and readily respond to the demand for materials of the next participant in the chain. This way of doing business is characterized by high stocks of various materials and high stock costs. In order to minimize inventory costs throughout the system, it is necessary to coordinate inventories within the supply chain. In their work, Seliaman & Rahman (2009) performed an analysis of inventory coordination in a multiphase supply chain, applying algebraic methods for allocating inventory between individual participants in the supply chain. Using already existing expressions, they created an algorithm for the distribution of stocks between individual participants. In this paper, in addition to theoretical processing, a simple procedure is presented that can help in the distribution of profits based on the costs incurred due to the coordination of stocks. This procedure is carried out to encourage all participants to adopt a stock coordination mechanism. Finally, a numerical example is attached to illustrate the described solutions.

Çomez and Kiessling (2012) in their work investigated a stock management strategy that takes into account stock prices in a system with continuous review. They focused on the (R, Q) stock policy, which means that when the stock level drops to the R level, the amount of Q is ordered. They created a model that contains two algorithms. One algorithm monitors the change in the price of inventories, and the other the change in the state of inventories. An analysis of the realized profit was performed if these two algorithms are applied separately, first one, then the other, and then in the case when they are applied simultaneously. Through extensive numerical analyzes, it has been determined that there can be a potential price increase, if the problem of price and stock is solved simultaneously, and not consecutively. Although there are several studies that have shown the benefits of dynamic analysis instead of fixed prices, there are still not many findings on the benefits of joint price and inventory optimization.

In case there is not enough storage space, and there are needs for stocks, it is necessary to manage stocks with a good organization of the transport system. Natarajarathinam et al. (2012) conducted a case study of one manufacturing company that has needs for different parts but does not have enough storage capacity near production facilities. To solve this problem, they proposed two heuristic models. The first model begins with an iteration of routing that maximizes savings by grouping suppliers on individual routes by ignoring storage constraints, and then determines order sizes while respecting constraints. The second model iteratively executes routing and in the same step determines the size of the order while respecting the set limits of storage space. It has been found that the use of traditional models that do not take into account transport in inventory management can lead to inefficient logistics operations, the creation of excess inventory and the use of longer inefficient routes.

When supplying, there can often be disturbances that also cause disturbances in the functioning of one of the following members in the supply chain. Son and Orchard (2013) in their work investigated the impact of supply disruptions in the chain, through an analysis of the effectiveness of two stock-based policies. The first policy is based on the preservation of strategic reserves (policy R), and the second is based on the application of ordering larger quantities of stock (policy K). Deterministic demand is assumed, which mainly occurs with stocks of materials for the production process. In order to assess the effectiveness of the defined policies for mitigating the impact of supply disruptions in different scenarios, an analytical model was developed and numerical experiments were conducted. The results showed that in case of longer duration of supply disruption, the R policy gave better results in terms of product availability. The policies created have practical application in reducing the negative impact of supply disruptions.

Azzi et al. (2014) in their paper illustrate the calculation of inventory costs for different types of storage systems that can be used to store materials in the production process. Two cases are observed: one relates to a forklift storage system and the other to an automated storage system. In both cases, an analysis was performed for five companies, to determine whether different storage systems affect the way inventory costs are calculated. The aim of this paper was to better understand the costs of inventories and determine their exact structure. Models developed to determine all structural costs can be applied in different industries with similar characteristics.

In the production process, materials with lower turnover but high critical values for the production process can be used, as a result of which their presence in the warehouse is mandatory. The characteristics of stocks of such materials are most similar to the stocks of spare parts, and for that reason the analysis that includes the problem of stocks of spare parts is included in the analysis. In order to minimize the cost of storing spare parts with low turnover, a stock model was created based on a coalition of several companies (Wenbin and Shuai, 2015). Companies located in the same geographic area can benefit from a coalition to share the cost of storing spare parts, which can be stored as a single unit with just one company. For this situation, a simulation model has been developed that uses two variables (the number of companies in the coalition and the level at which the emergency order is made) and combines several different types of costs (inventory costs, transport costs to individual companies and downtime costs). total costs per company and per unit of time. The model analyzes several different variants and suggests the optimal one.

Goyal et al. (2016) investigated the impact of RFID technology application on inventory management. The authors conducted 3 field trials at Fortune 500. The application of RFID tags resulted in a significant drop in record inaccuracies. The reduction in the inaccuracy of product records was very large, mostly for products in the retail space. In contrast, there were no significant improvements in the inaccuracy of inventory records in retail warehouses and production material warehouses. It is recommended that retailers focus on inventory management in the sales area when they want to increase visibility with the help of RFID tags. The paper presents the results obtained on the basis of 3 experiments that quantify changes in the case of the introduction of RFID systems.

Swanson et al. (2016) investigated the relationship between transportation costs and inventory costs and the possibility of compensation between them. For example, when stocks are ordered less frequently, the total cost of transportation is likely to be lower due to the size of the volume of transport, but the cost of stock will be higher. The study used data on transportation costs and inventory costs obtained from individual companies in the United States in the period from 1960 to 2013. Based on these data, a model was created that has the task of establishing a balance between these costs, so that the total costs are optimal. One of

the conclusions of this paper is that inventory costs are adjusted for changes in transportation costs, but the reverse is not true.

Suppliers can often affect the level of service a company provides and its profitability. Research has been conducted and a model has been created to measure service levels and profitability that is affected by different supplier capabilities (Bendoly et al., 2018). Consistency and recovery were adopted as two relevant options. Consistency implies the ability of the supplier to realize delivery several times in a defined period, and recovery means that the supplier fulfills the order even after the expiration of the defined time. The analysis was performed based on data obtained from two retail chains. In order to show the impact of these two possibilities, a retail chain is modeled in which procurement is performed by two competing suppliers with different levels of consistency and recovery. The model anticipates uncertain demand to make the effect of supplier capabilities easier to measure. The simulation was performed on a defined model that was calibrated according to the data measured in the field. As a result of this research, a significant impact of increasing retail profits in the case of greater consistency and recovery of suppliers was found. For this reason, the application of this model in practice and the initiation of future research in this direction are implied.

Most research on the level and impact of security stocks is based on one type of material. The impact of two common safety stock models on system effects for different material groups was investigated by Jonsson and Mattsson (2019). Due to the complexity and impossibility to express all connections analytically, simulation was used in the research. It has been found that if a model of safety stocks provides good system performance for one type of material, this need not be the case when determining safety stocks for different types of materials. As a conclusion of the study, the importance of assessing the performance of individual models of safety stocks is stated, but at the system level, and not at the level of only one material. It was found that in this way a significantly higher level of service can be achieved, as well as a reduction in inventory costs.

4. CONCLUSION

Inventory management issues have been investigated for a long time but are still current. Fundamental changes in the understanding of inventories, together with advanced technologies and improved processes, have encouraged and enabled the development of new approaches and models of inventory management.

This paper presents a brief analysis and review of papers that study various problems related to inventory management. The analysis is limited to papers published in five leading logistics journals published between 2008 and 2019. A total of 63 papers were singled out (about 3% of the total published papers) in which the focus is on inventory management. The papers were read and classified into nine thematic areas in order to single out the most important and currently current research topics. It can be stated that works aimed at managing stocks of materials and goods for the needs of production and distribution dominate, which is most often achieved through the exchange of information and various forms of cooperation between participants. In addition, a large number of papers use simulation modeling as a tool to investigate inventory problems.

This paper provides insight into recent research related to inventory management, which can help company managers to more easily solve practical problems, and can point out to researcher's topics that can be researched in this area.

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ECOLOGOHELMINTHOLOGICAL INVESTIGATIONS AND CIRCULATION OF ARSENIC IN THE SYSTEM WATER – SEDIMENTS – *CHONDROSTOMA NASUS* – *CONTRACAECUM* SP., LARVAE FROM THE DANUBE RIVER

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Abstract: The aim of the study is to provide data on the content and the circulation of arsenic (As) in the system water – sediments – *Chondrostoma nasus* – *Contracaecum* sp., larvae from the Danube River, Kudelin biotope, Bulgaria. For this purpose, during 2019, 113 specimens of common nase, *Chondrostoma nasus* (Linnaeus, 1758) from Danube River (Kudelin biotope) were collected. An ecologoparasitological study on the captured specimens of common nase was carried out. It was found that the nematode *Contracaecum* sp. larvae were the dominant parasite species. Data for arsenic concentration in skin and muscle samples of common nase were provided, respectively $2.87 \pm 2.14 \text{ mg.kg}^{-1}$ wet weight and $1.09 \pm 0.54 \text{ mg.kg}^{-1}$ wet weight; as well as in water and sediments samples, respectively $0.05 \pm 0.05 \text{ mg.l}^{-1}$ and $39.30 \pm 56.09 \text{ mg.kg}^{-1}$ dry weight. Positive linear correlations were found between As content in skin and muscle of common nase, in its parasite *Contracaecum* sp., larvae in samples of water and sediments ($r_{\text{sWaters}} = 0.94-0.99$ and $r_{\text{sSediments}} = 0.96-1.0$ at $p < 0.05$). For the first time, this study reports data on the content of As in *Contracaecum* sp., larvae of *C. nasus* from the Danube River, Kudelin biotope, western Bulgaria.

Keywords: arsenic, Bulgaria, *Chondrostoma nasus*, *Contracaecum* sp., Danube River

1. INTRODUCTION

The Danube River flows through many urban areas, which are the source of various pollutants, including heavy metals (Ilie et al., 2017). Heavy metals are dangerous to organisms because they do not degrade and remain in the environment (Javed & Usmani, 2017). Fish accept heavy metals in various ways, for example, through the skin, gills or food (Onără et al., 2013). Fish are good water quality indicators (Petkovšek et al., 2012). Other organisms which accumulate heavy metals and are used as bioindicators are fish parasites (cestodes, acanthocephalans, nematodes) (Sures, 2001; Nachev et al., 2010; Sures et al., 2017). Various authors carried out studies on the content and circulation of heavy metals in the parasite – fish host system from the Bulgarian section of the Danube River (Chunchukova & Kirin, 2017; Chunchukova & Kuzmanova, 2017; Chunchukova et al., 2017a, 2017b; Kirin & Chunchukova, 2017; Chunchukova, 2018).

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The aim of this study is to provide data on the content and the circulation of arsenic (As) in the system water – sediments – *Chondrostoma nasus* – *Contracaecum* sp., larvae from the Danube River, Kudelin biotope, western Bulgaria.

2. MATERIALS AND METHODS

The research was conducted in 2019. For the study, 113 samples of common nase, its parasites, six samples of water and six samples of sediments from the Danube River near the village of Kudelin (referred to as Kudelin biotope) were collected. The village of Kudelin (44° 11' 30" N, 22° 40' 5" E) is located in Vidin area; to the Bulgarian-Serbian border (Figure 1).

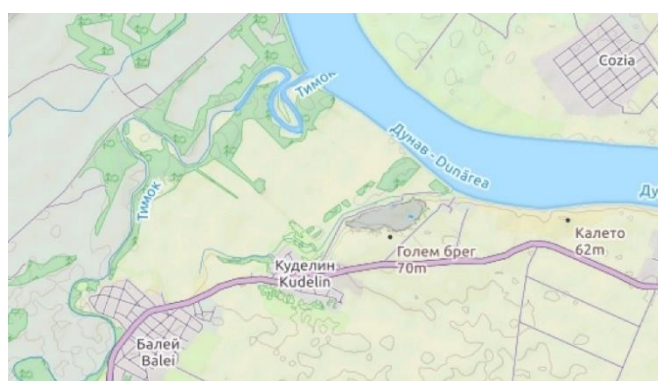


Figure 1. Danube River (Kudelin biotope), Vidin area [ViewRanger]

The fish were caught with different fishing devices, according to a permit issued by the Executive Agency for Fisheries and Aquaculture. The maximum length (L) and width (H) of the body, as well as weight (g), in centimeters and grams, respectively were recorded for all caught specimens of common nase. The mean values for L, H and g were 29.38 cm, 6.40 cm and 239.01 grams, respectively.

A helminthological investigation of all specimens of *C. nasus* (Petrochenko, 1956; Zashev & Margaritov, 1966; Kakacheva-Avramova, 1983; Bauer (Ed.), 1987; Moravec, 2013) was performed.

Composite samples of fish tissue (skin and muscle), parasites of *C. nasus*, as well as samples of water and sediments from the Danube River, were prepared and sent for chemical analyzes in an accredited laboratory at the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria. The bioconcentration factor (BCF), bioaccumulation factor (BAF), and linear correlation coefficient of Spearman (r_s) were calculated.

3. RESULTS AND DISCUSSIONS

3.1. MODEL FISH SPECIES

The common nase, *Chondrostoma nasus* (Linnaeus, 1758) is selected as a model fish species. The common nase is a freshwater, cyprinid fish. On the territory of the Republic of

Bulgaria, the species is widespread in the Danube River and in other rivers that flow into it. *C. nasus* is one of the fishery species (Karapetkova & Jivkov, 2006).

3.2. HELMINTHOLOGICAL INVESTIGATIONS

At the helminthological examination, a total of 113 specimens *C. nasus* from the Danube River (Kudelin biotope) 8 parasites were identified, as of them the nematode *Contracaecum* sp., larvae were the dominant species in the parasite communities of common nase. In the study, an overall 1701 specimens *Contracaecum* sp., larvae were found in 75 of the 113 examined *C. nasus* specimens.

In the last five years in Bulgaria, few authors have reported the nematode *Contracaecum* sp. on fish inhabiting the Danube River section in Bulgaria. Chunchukova & Kirin (2018) found 43 specimens *Contracaecum* sp., larvae in 13 out of 92 examined specimens *Barbus barbus* (Linnaeus, 1758). Chunchukova et al. (2019) reported eight specimens *Contracaecum microcephalum* (Rudolphi, 1809), larvae in 4 out of 91 studied specimens *Alburnus alburnus* (Linnaeus, 1758). Chunchukova et al. (2016) discovered 17 specimens *C. microcephalum*, larvae in 7 out of 47 specimens *Abramis brama* (Linnaeus, 1758). All three fish species (*B. barbus*, *A. alburnus* and *A. brama*) were caught in the lower part of the Bulgarian section of the Danube River. Chunchukova et al. (2016) also found four specimens *C. microcephalum*, larvae in only 1 out of 29 specimens *A. brama* caught by Srebarna Lake, which falls in the Danube basin. Shukerova & Kirin (2019) reported *C. microcephalum*, larvae in 3 out of 158 specimens *Rutilus rutilus* (Linnaeus, 1758), again from Srebarna Lake.

Cakic et al. (2008) found *Contracaecum sinipercae* (Dogiel & Achmerov, 1959) and *Contracaecum bidentatum* (Linstow, 1899) in a study of 517 specimens *Acipenser ruthenus* (Linnaeus, 1758) from the Serbian section of the Danube River.

Representatives of the genus *Contracaecum* have been reported by different authors in lakes located in Turkey. İnnal et al. (2020) found *Contracaecum rudolphii* (Hartwich, 1964), larvae in only 1 out of 38 specimens *Carassius gibelio* (Bloch, 1782) from Karataş Lake, Burdur-Turkey. Demir & Karakişi (2016) reported *Contracaecum* sp. in 5 out of 168 specimens *C. gibelio* from Marmara Lake, Turkey. Demir & Karakişi (2014) examined 111 specimens *C. nasus* from Tahtalı Dam Lake, Turkey and reported *Contracaecum* sp. larvae in 16 fish. Karakişi & Demir (2012) detected larvae of nematode *Contracaecum* sp. in 8 out of 47 examined specimens *Cyprinus carpio* (Linnaeus, 1758) from Tahtalı Dam Lake, Turkey. Selver et al. (2009) found one larva of *Contracaecum* sp. in 1 out of 113 examined specimens *Rutilus rutilus* (Linnaeus, 1758) caught by the Kocadere stream in Bursa, Turkey. In Bulgaria and Turkey, species of the genus *Contracaecum* have been reported by other authors in earlier studies.

3.3. CONTENT AND CIRCULATION OF ARSENIC (AS)

Composite samples of skin and muscle of *C. nasus*, as well as its dominant parasite *Contracaecum* sp., larvae were analyzed for a presence of arsenic (As). As content in samples of water and sediments from the Danube River was also studied. Mean values for arsenic concentrations are presented in the study. Concentrations of As found in skin samples ($2.87 \pm 2.14 \text{ mg.kg}^{-1}$ wet weight) of *C. nasus* were higher than these found in muscle samples ($1.09 \pm$

0.54 mg.kg⁻¹ wet weight). The reported concentrations of As in water samples were 0.05 ± 0.05 mg.l⁻¹ and in sediments samples – 39.30 ± 56.09 mg.kg⁻¹ dry weight (Table 1).

Table 1. As content in skin and muscle of *C. nasus*, *Contracaecum* sp., larvae, water and sediments from the Danube River, Kudelin biotope

<i>Chondrostoma nasus</i>		Min – Max	Mean ± SD
Skin	mg.kg ⁻¹ wet weight	0.95 – 7.75	2.87 ± 2.14
	mg.kg ⁻¹ dry weight	2.39 – 17.39	7.46 ± 4.60
Muscle	mg.kg ⁻¹ wet weight	0.37 – 1.99	1.09 ± 0.54
	mg.kg ⁻¹ dry weight	1.54 – 7.59	4.27 ± 1.97
<i>Contracaecum</i> sp.	mg.kg ⁻¹ wet weight	27.96 – 96.25	70.77 ± 37.30
	mg.kg ⁻¹ dry weight	123 – 308.33	190.46 ± 102.44
Water	mg.l ⁻¹	0.01 – 0.13	0.05 ± 0.05
Sediments	mg.kg ⁻¹ dry weight	12.00 – 153.54	39.30 ± 56.09

The bioconcentration of As is much higher than the As content in the water samples compared to the content in the sediments samples. BCF is highest for *Contracaecum* sp. relative to the As content of the examined water samples. The parasite bioaccumulates 2.63 times more As from the muscle than from the skin (Table 2).

Table 2. Bioconcentration factor (BCF) and bioaccumulation factor (BAF)

BCF		BAF	
<i>Contracaecum</i> sp. – Water	1415.4	<i>Contracaecum</i> sp. – Skin	24.65
Skin – Water	57.40		
Muscle – Water	21.80		
<i>Contracaecum</i> sp. – Sediments	4.85	<i>Contracaecum</i> sp. – Muscle	64.93
Skin – Sediments	0.19		
Muscle – Sediments	0.11		

Positive linear correlations were found between As content in skin and muscle of common nase, in its parasite *Contracaecum* sp., in samples of water and sediments ($r_{sWaters} = 0.94-0.99$ and $r_{sSediments} = 0.96-1.0$ at $p < 0.05$).

3.4. EXCEEDANCES OF ARSENIC (AS)

The standard for As determined in Ordinance No. 31 on the maximum levels of contaminants in foodstuffs is 1 mg/kg. This study found that the concentrations of arsenic in skin and muscle samples of *C. nasus* exceeded this standard 2.87 and 1.09 times, respectively.

The As standards specified in Ordinance No. 18 on the quality of water for irrigation of crops and Ordinance No. H-4 on the characterization of surface water are 0.1 mg/dm³ and 0.025 mg/l, respectively. The content of As in water samples exceeded the specified standard only in Ordinance No. H-4 by twofold.

The standard for As determined in Ordinance No. 3 on the norms for permissible content of harmful substances in soils is 25 mg/kg, and the Dutch target values are 29 mg/kg.

The concentrations of As in the sediments samples exceeded the standard in Ordinance No. 3 (by 1.57 times) and Dutch target values (by 1.36 times).

4. CONCLUSION

An ecologoparasitological study of *Chondrostoma nasus* revealed that the nematode *Contracaecum* sp., larvae are the dominant species in helminth communities. The results of the chemical analyzes of tissues (skin and muscle) of common nase showed higher concentrations of As in skin samples ($2.87 \pm 2.14 \text{ mg.kg}^{-1}$ wet weight) and lower in muscle samples ($1.09 \pm 0.54 \text{ mg.kg}^{-1}$ wet weight). The circulation of As in the water, sediments, tissues of common nase and its parasite *Contracaecum* sp., larvae in the ecosystem of the Danube River was tracked. Accumulation of As was highest in the parasite *Contracaecum* sp. The skin and muscle of common nase as well as its parasite *Contracaecum* sp. accumulated many times more As from water than from sediments. Positive linear correlations were found between As content in skin and muscle of common nase, in its parasite *Contracaecum* sp., in samples of water and sediments ($r_{\text{Waters}} = 0.94-0.99$ and $r_{\text{Sediments}} = 0.96-1.0$ at $p < 0.05$). For the first time, this study reports data on the content of As in *Contracaecum* sp., larvae of *C. nasus* from the Danube River, Kudelin biotope, western Bulgaria.

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HELMINTH COMMUNITIES OF *CHONDROSTOMA NASUS* (LINNAEUS, 1758) AND THEIR BIOINDICATOR ROLE FOR THE ACCUMULATION OF CADMIUM FROM THE DANUBE RIVER, BULGARIA

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Abstract: The results of studies on the content of cadmium (Cd) in liver and muscle of common nase, *Chondrostoma nasus* (Linnaeus, 1758) and its parasite *Contracaecum* sp., larvae, as well as in water and sediments from the Danube River (Kudelin biotope), Vidin area, northwestern Bulgaria are presented here. The circulation of the element in the freshwater ecosystem is tracked. The content of Cd in the samples of liver and muscle is $C_{CdLiver} = 0.32 \pm 0.25 \text{ mg.kg}^{-1}$ and $C_{CdMuscle} = 0.07 \pm 0.05 \text{ mg.kg}^{-1}$, wet weight, respectively. The reported concentrations of cadmium in water and sediments are $C_{CdWater} = 0.004 \pm 0.008 \text{ mg.l}^{-1}$ and $C_{CdSediments} = 15.75 \pm 35.84 \text{ mg.kg}^{-1}$ dry weight, respectively. The highest bioconcentration of Cd relative to its content in water samples was found for *Contracaecum* sp. (BCF = 890), and the lowest for muscle samples (BCF = 17.5). The parasite bioaccumulates 4.57 times more Cd from the muscle than from the liver. Positive linear correlations were obtained between Cd content in water/sediments and this in liver and muscle samples of common nase ($r_{sWater} = 0.91-0.97$ and $r_{sSediments} = 0.93-0.97$ at $p < 0.05$).

Keywords: Bulgaria, cadmium, *Chondrostoma nasus*, *Contracaecum* sp., Danube River

1. INTRODUCTION

The Danube River flows through many European countries, resulting in it is exposed to contamination from different sources (Ilie et al., 2017). Heavy metals released into the aquatic environment are a threat to all aquatic organisms (Ionescu et al., 2015). Fish accumulate heavy metals either from the environment or through food and accumulate them in their tissues and organs. Different species of fish are often used as bioindicators to determine the degree of pollution in the aquatic environment (Authman et al., 2015). Some of their parasites can also accumulate heavy metals. Concentrations of heavy metals in parasites are reported to be much higher than in their fish host (Sures et al., 1997a, 1997b; Sures et al., 1999; Sures, 2001; Chunchukova & Kirin, 2017; Chunchukova & Kuzmanova, 2017; Chunchukova et al., 2017a, 2017b; Kirin & Chunchukova, 2017; Chunchukova, 2018).

The purpose of the present study is to report findings on the content and the circulation of cadmium (Cd) in water, sediments, liver and muscle of common nase and its parasite

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Contracaecum sp., larvae of the freshwater ecosystem of the Danube River, Kudelin biotope, Bulgaria.

2. MATERIALS AND METHODS

During 2019, 113 specimens of *C. nasus* were captured, and a total of 12 water and sediment samples were collected from the Danube River near the village of Kudelin (denoted as the Kudelin biotope). The village of Kudelin (44° 11' 30" N, 22° 40' 5" E) is located in Vidin area, northwestern Bulgaria and is the first village along the Danube River in Bulgarian territory. It is situated about 2 km from the border with the Republic of Serbia. It is located at 40-50 meters above sea level (Figure 1).



Figure 1. Danube River (Kudelin biotope), Vidin area, northwestern Bulgaria [ViewRanger]

The species of collected fish was determined (Karapetkova & Jivkov, 2006; Kottelat & Freyhof, 2007). All specimens *C. nasus* were measured and weighed, and maximum body length (L), maximum body width (H) and weight (g) were recorded (Table 1).

Table 1. Body length, body width and weight of the collected *C. nasus* from the Danube River, Kudelin biotope

<i>Chondrostoma nasus</i>		Min – Max	Mean ± SD
L	centimetres	18 – 35.5	29.38 ± 3.72
H	centimetres	4.3 – 8.5	6.40 ± 0.87
g	grams	59 – 435	239.01 ± 87.15

All collected specimens of *C. nasus* from Kudelin biotope were subjected to parasitological studies (Petrochenko, 1956; Zashev & Margaritov, 1966; Kakacheva-Avramova, 1983; Bauer (Ed.), 1987; Moravec, 2013). The samples of liver and muscle of common nase, samples of its parasite *Contracaecum* sp., as well as samples of water and sediments were examined for cadmium (Cd) content by ICP “Optima 7000” Perkin-Elmer in an accredited laboratory at the Institute of Biodiversity and Ecosystem Research, Bulgarian

Academy of Sciences (BAS), Sofia. The bioconcentration factor, the bioaccumulation factor and the linear correlation coefficient of Spearman were determined.

3. RESULTS AND DISCUSSIONS

3.1. STUDIED FISH SPECIES

The subject of this study is the common nase (*Chondrostoma nasus* (Linnaeus, 1758); family Cyprinidae) from the Danube River (Kudelin biotope). The common nase is a freshwater, benthopelagic, potamodromous species of fish. In Bulgaria, it inhabits the Danube River and all Danubian tributaries. The common nase is recognized by the location and shape of the mouth. The species feeds mainly on algae (Karapetkova & Jivkov, 2006; Kottelat & Freyhof, 2007).

3.2. ECOPARASITOLOGICAL STUDIES OF *CHONDROSTOMA NASUS* FROM THE DANUBE RIVER (KUDELIN BIOTOPE), BULGARIA

In the research of 113 specimens of common nase eight species of parasites were identified (two species of trematodes, one species of cestode, one species of acanthocephalan and four species of nematodes). Of them, the nematodes *Contracaecum* sp., larvae and *Raphidascaris acus*, larvae are core species for its parasite communities. The other six parasite species are accidental. *Contracaecum* sp., larvae (Anisakidae) has the highest prevalence (P% = 66.37). This motivated more detailed study as well as subsequent investigations on the significance of *Contracaecum* sp., larvae as bioindicator.

First intermediate hosts of *Contracaecum* sp. are different invertebrates (gastropods, copepods, amphipods and many others). Second intermediate or paratenic hosts are different species of fish, and definitive hosts are a large number of fish-eating birds and mammals (Moravec, 2013; Shamsi, 2019). Mainly ten species of the genus *Contracaecum* have been reported in Europe. It is considered that the morphology of the larvae isolated from different fish species has not been enough studied and therefore, there is not enough information for identification of their species (Moravec, 2013). In Bulgaria, for the last 15 years *Contracaecum* sp., larvae have been reported as a component parasite species (P% = 14.1) of *Barbus barbus* (Linnaeus, 1758) from the Bulgarian section of the Danube River near the village of Vetren (Chunchukova & Kirin, 2018). The authors indicated that this was the species *Contracaecum microcephalum* (Rudolphi, 1809). The parasite was also reported for *Abramis brama* (Linnaeus, 1758) from the Danube River (near Vetren village) and Lake Srebarna, with a prevalence respectively P% = 14.89 and P% = 3.45; for *Alburnus alburnus* (Linnaeus, 1758) from the Danube River (Vetren village) with a prevalence P% = 4.40 (Chunchukova et al., 2016; Chunchukova et al., 2019). *C. microcephalum*, larvae were also found in prussian carp, *Carassius gibelio* (Bloch, 1782); common carp, *Cyprinus carpio* (Linnaeus, 1758); perch, *Perca fluviatilis* (Linnaeus, 1758) and roach, *Rutilus rutilus* (Linnaeus, 1758) from Lake Srebarna in Bulgaria. The prevalence (P%) of *C. microcephalum* in *C. gibelio*, *C. carpio*, *P. fluviatilis* and *R. rutilus* was respectively P% = 16.67, P% = 35.71, P% = 1.1 and P% = 1.90 (Shukerova, 2005; Shukerova, 2006; Shukerova et al., 2010; Shukerova & Kirin, 2019). *Contracaecum bidentatum* (Linstow, 1899), larvae were reported for wels catfish, *Silurus glanis* (Linnaeus, 1758) from the Ivaylovgrad Reservoir with a prevalence P% = 43.27 (Kirin & Kuzmanova, 2014). *Contracaecum* sp., larvae were also

reported as a parasite of pumpkinseed sunfish, *Lepomis gibbosus* (Linnaeus, 1758) from Lake Atanasovsko Wetland, with a prevalence P% = 1.87 (Stoyanov et al., 2018).

3.3. CADMIUM CONTENT IN LIVER AND MUSCLE OF *CHONDROSTOMA NASUS*, WATER AND SEDIMENTS FROM THE DANUBE RIVER (KUDELIN BIOTOPE), BULGARIA

In the examined samples of muscle and liver of *C. nasus* the highest Cd values were found in the liver and then in the muscle, respectively $C_{CdLiver} = 0.32 \pm 0.25 \text{ mg.kg}^{-1}$ wet weight and $C_{CdMuscle} = 0.07 \pm 0.05 \text{ mg.kg}^{-1}$ wet weight. The reported concentrations of cadmium in water and sediments are respectively $C_{CdWater} = 0.004 \pm 0.008 \text{ mg.l}^{-1}$ and $C_{CdSediments} = 15.75 \pm 35.84 \text{ mg.kg}^{-1}$ dry weight (Table 2-3).

Table 2. Cd in liver and muscle of *Chondrostoma nasus* (mg.kg^{-1} wet weight) and water (mg.l^{-1}) from the Danube River (Kudelin biotope)

<i>Chondrostoma nasus</i>		Cd
Liver	Min – Max	0.03 – 0.76
	Mean \pm SD	0.32 ± 0.25
Muscle	Min – Max	0.01 – 0.12
	Mean \pm SD	0.07 ± 0.05
Water	Min – Max	0.0004 – 0.02
	Mean \pm SD	0.004 ± 0.008

Table 3. Cd in liver and muscle of *Chondrostoma nasus* (mg.kg^{-1} dry weight) and sediments (mg.kg^{-1} dry weight) from the Danube River (Kudelin biotope)

<i>Chondrostoma nasus</i>		Cd
Liver	Min – max	0.09 – 1.75
	Mean \pm SD	0.93 ± 0.63
Muscle	Min – max	0.04 – 0.38
	Mean \pm SD	0.20 ± 0.13
Sediments	Min – max	0.37 – 88.91
	Mean \pm SD	15.75 ± 35.84

3.4. CADMIUM EXCEEDANCES IN LIVER AND MUSCLE OF *CHONDROSTOMA NASUS*, WATER AND SEDIMENTS FROM THE DANUBE RIVER (KUDELIN BIOTOPE), BULGARIA

The cadmium content in liver and muscle of *C. nasus* from the Danube River was compared to the norm specified in Ordinance No. 31 and the maximum value for cadmium given by FAO – $C_{Cd} = 0.05 \text{ mg/kg}$ and $C_{Cd} = 0.2 \text{ mg/kg}$, respectively. The reported cadmium concentrations in liver and muscle of common nase exceeded the norm for Cd specified in Ordinance No. 31, 6.46 and 1.38 times, respectively. Cadmium in samples of the liver also exceeded 1.62 times the maximum value indicated by FAO (Figure 2).



Figure 2. Cadmium exceedances in liver and muscle of *C. nasus* from Danube River, Kudelin biotope

The content of cadmium in water from the Danube River was juxtaposed with the norms specified in Ordinance No. 18 and Ordinance on environmental quality standards for priority substances and certain other pollutants – $C_{Cd} = 0.01 \text{ mg/dm}^3$ and $C_{Cd} = 0.0009 \text{ mg/l}$, respectively. The cadmium in the analyzed water samples exceeded only the norm specified in the Ordinance on environmental quality standards by 4.44 times (Figure 3).

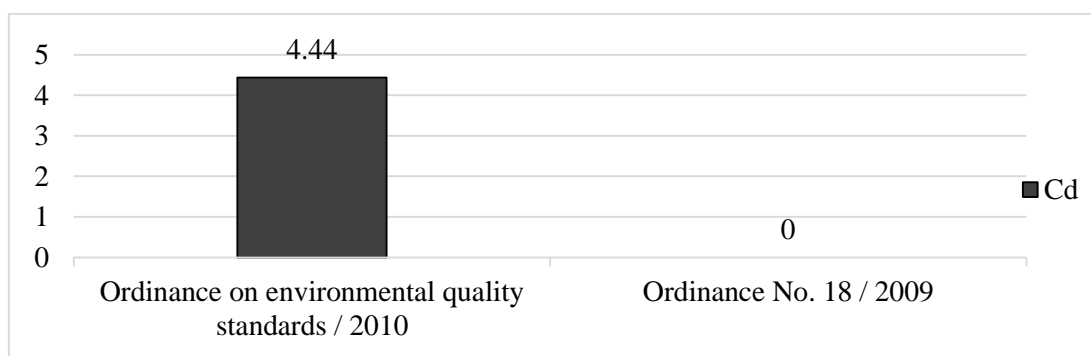


Figure 3. Cadmium exceedances in water from Danube River, Kudelin biotope

The cadmium content in sediments from the Danube River was compared with the norm in Ordinance No. 3 and the Dutch target values – $C_{Cd} = 3 \text{ mg/kg}$ (at $\text{pH} > 7.4$) and $C_{Cd} = 0.8 \text{ mg/kg}$, respectively. The cadmium in sediments samples exceeded 19.69 times the Dutch target values. Exceedances were also reported against the norm for Cd indicated in Ordinance No. 3 by 5.25 times (Figure 4).

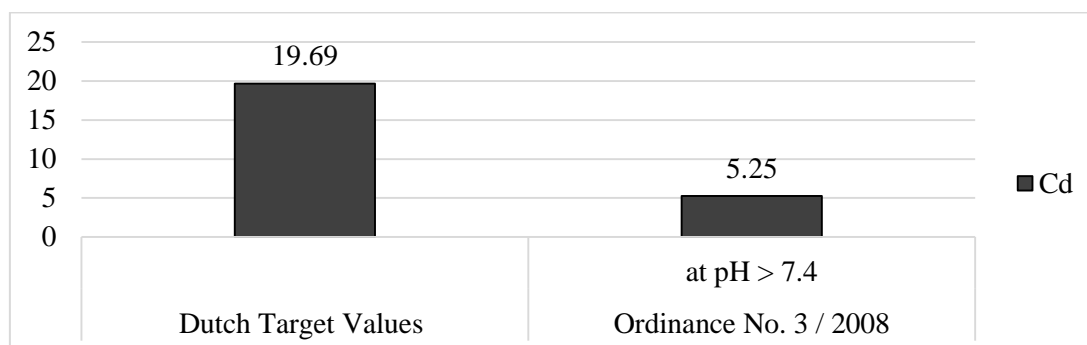


Figure 4. Cadmium exceedances in sediments from Danube River, Kudelin biotope

The highest bioconcentration of Cd relative to its content in water samples was found for *Contracaecum* sp. (BCF = 890), and the lowest for muscle samples (BCF = 17.5). The parasite bioaccumulates 4.57 times more Cd from the muscle than from the liver (Table 4).

Table 4. Bioconcentration factor (BCF) and bioaccumulation factor (BAF)

BCFWater		BCFSediments		BAF	
<i>Contracaecum</i> sp. - Water	890	<i>Contracaecum</i> sp. - Sediments	0.67	<i>Contracaecum</i> sp. - Liver	11.12
Liver - Water	80	Liver - Sediments	0.06	<i>Contracaecum</i> sp. - Muscle	50.86
Muscle - Water	17.5	Muscle - Sediments	0.01		

The bioconcentration factor was low for all of the tracked cases relative to the content of the element in the sediment samples (Table 4).

The obtained linear correlations between Cd content in water/sediments and in liver and muscle samples of common nase were positive ($r_{sWater} = 0.91-0.97$ and $r_{sSediments} = 0.93-0.97$ at $p < 0.05$).

4. CONCLUSION

Data on the content and the circulation of cadmium (Cd) in the systems water – sediments – liver and muscle of *Chondrostoma nasus* – its parasite *Contracaecum* sp. from the Danube River, Kudelin biotope were presented. Higher Cd content was found in samples of liver ($C_{CdLiver} = 0.32 \pm 0.25 \text{ mg.kg}^{-1}$ wet weight) compared to samples of muscle ($C_{CdMuscle} = 0.07 \pm 0.05 \text{ mg.kg}^{-1}$ wet weight) of common nase. The reported concentrations of Cd in liver samples exceeded the norms specified in Ordinance No. 31 and FAO, while the concentrations of Cd in muscle samples exceeded only those indicated in Ordinance No. 31. The highest bioconcentration of Cd relative to its content in water samples was found for *Contracaecum* sp. (BCF = 890), and the lowest for muscle samples (BCF = 17.5). The parasite bioaccumulates 4.57 times more Cd from the muscle than from the liver. The obtained linear correlations between Cd content in water/sediments and in liver and muscle samples of common nase were positive ($r_{sWater} = 0.91-0.97$ and $r_{sSediments} = 0.93-0.97$ at $p < 0.05$).

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PARASITE COMMUNITIES AND A CONTENT OF CADMIUM IN THE SYSTEM WATER - SEDIMENTS - *ABRAMIS BRAMA* FROM THE DANUBE RIVER, BULGARIA

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Abstract: For the study, forty specimens of freshwater bream (*Abramis brama*, Linnaeus, 1758) were collected from the Danube River (near the Kudelin village), Vidin region, northwestern Bulgaria. New data on parasites and parasite communities of *A. brama* from the same section of the river were presented. Six parasite species were identified: *Asymphylogora imitans* (Mühling, 1898); *Nicolla skrjabini* (Ivanitzky, 1928); *Posthodiplostomum cuticola* (von Nordmann, 1832); *Sphaerostomum bramae* (Müller, 1776)); *Pomphorhynchus laevis* (Müller, 1776) and *Contracaecum* sp., larvae. The studied section of the Danube River is a new habitat for all parasites found in freshwater bream. *A. brama* was announced as a new host for *Sph. bramae* from the Danube River. *A. imitans* was identified as a core species ($P\% = 25.00$) in the component community of freshwater bream from the Danube River (near the Kudelin village). The study also aims to provide new information on the content of cadmium (Cd) in liver, skin and muscles of freshwater bream, water and sediments from the Danube River. The content of Cd in tissues and organs of *A. brama* was highest in liver samples (wet weight $C_{CdLiver} = 0.80 \pm 0.67 \text{ mg.kg}^{-1}$) and decreased in order: liver>skin>muscle.

Keywords: *Abramis brama*, Bulgaria, cadmium, Danube River, parasite communities

1. INTRODUCTION

The Danube River is one of the rivers with a great variety of plant and animal species, including fish (Polačik et al., 2008). A large percentage of the fish inhabiting the whole current of the Danube River are also found in the Bulgarian section of the river (Stefanov & Vassilev, 2006). Heavy metal pollution is one of the main threats to the species diversity of the organisms in the aquatic ecosystems (Hanzelová et al., 2009). Fish are hosts to many species of parasites (Amer, 2014). The fish parasites can also be affected by the pollution of the aquatic environment (Sures et al., 2017). In the last few years, few authors have examined the content of heavy metals and the species diversity of *A. brama* parasites from the Danube River in Bulgaria, and these studies mainly relate to the lower current of the river about the territory of the country (Kirin et al., 2013; Kirin et al., 2014; Chunchukova et al., 2016; Chunchukova et al., 2017; Kirin & Chunchukova, 2017).

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The purpose of this study is to present data on parasites and parasite communities of the freshwater bream, as well as the results of studies on the content of cadmium in the system water – sediments – freshwater bream in the ecosystem of the Danube River (near the Kudelin village), northwestern Bulgaria.

2. MATERIALS AND METHODS

Fish, water and sediment samples were examined for cadmium content. The parasites of the caught fish specimens and the structure of the parasite communities were studied. The samples were collected in 2019 from the Danube River in an area adjacent to the Kudelin village, Vidin region, northwestern Bulgaria. The village of Kudelin is located on the 844 kilometers marker on the Danube River and is the first Bulgarian village on the river after Timok River enters the Danube River (Figure 1).



Figure 1. Danube River (near the Kudelin village), Vidin region [ViewRanger]

Forty specimens of freshwater bream, *Abramis brama* (Linnaeus, 1758) and a total of 12 water and sediment samples from the Danube River were examined. The scientific name of the species was recorded (Froese & Pauly, 2019). For all caught specimens L (maximum body length in centimetres); H (maximum body width in centimetres) and g (weight in grams) were indicated (Table 1).

Table 1. L, H and g of the studied specimens of *Abramis brama*, the Danube River (near the Kudelin village)

<i>Abramis brama</i>	L	H	g
Min – Max	8.1 – 28	2 – 9	3 – 247
Mean ± SD	19.46 ± 4.26	5.7 ± 1.48	87.15 ± 49.04

The freshwater breams were examined for parasites (Petrochenko, 1956; Zashv & Margaritov, 1966; Kakacheva-Avramova, 1983; Bauer (Ed.), 1987; Moravec, 2013). The prevalence (P%), mean intensity (MI) and mean abundance (MA), as well as the structure of the component parasite communities of *A. brama*, were determined (Kennedy, 1993; Bush et al., 1997). The following indicators were also shown: total number of species, the mean number of parasites, the Brillouin's diversity index (HB) to describe the infracommunities of *A. brama* (Magurran, 1988).

Liver, skin, and muscle samples of freshwater bream, as well as water and sediment samples from the Danube River, were examined for cadmium (Cd) content. ICP "Optima 7000" Perkin-Elmer performed the chemical analyzes. Based on the obtained results of chemical analyzes for Cd, the bioconcentration factor and the linear correlation coefficient of Spearman were determined.

3. RESULTS AND DISCUSSIONS

3.1. PARASITE COMMUNITIES STRUCTURE OF *ABRAMIS BRAMA* FROM THE DANUBE RIVER

The subject of the ecoparasitological study were 40 specimens of freshwater bream, *Abramis brama* (Linnaeus, 1758). The freshwater bream is a cyprinid fish, common in Europe and Asia. It is found in medium to large rivers (including the Danube River), as well as in some lakes. It feeds on plant and animal foods (plankton, insects, crustaceans and others) (Karapetkova & Jivkov, 2006).

In this study, parasites were detected in nineteen *A. brama* specimens. Six parasite species were identified: four species of trematodes (*Asymphylodora imitans* (Mühling, 1898); *Nicolla skrjabini* (Ivanitzky, 1928); *Posthodiplostomum cuticola* (von Nordmann, 1832) and *Sphaerostomum bramae* (Müller, 1776)); one species of acanthocephalan (*Pomphorhynchus laevis* (Müller, 1776)) and one species of nematode (*Contracaecum* sp., larvae).

3.2. COMPONENT COMMUNITY OF *ABRAMIS BRAMA* FROM THE DANUBE RIVER

During the study, the most detected species were trematodes (4 species). They also were the largest number of specimens (more than 889 specimens). One species of acanthocephalan with 7 specimens and one species of the nematode with 2 specimens were isolated. The trematode *A. imitans* was a core species with a prevalence of 25.00%, and the other five parasites were accidental species in the parasite community of freshwater bream. The highest mean intensity (MI) was found for the trematode *P. cuticola* (MI = 100.00), followed by that of *A. imitans* (MI = 77.10). *A. imitans* also had the highest mean abundance (MA = 19.28) (Table 2).

Table 2. Parasite diversity and ecological terms of the parasites and the parasite communities of *Abramis brama* from the Danube River (near the Kudelin village)

Parasite species	N = 40					
	n	p	MI	MA	P%	Range
<i>Asymphylodora imitans</i> (Mühling, 1898)	10	771	77.10	19.28	25.00	1 – 395
<i>Nicolla skrjabini</i> (Ivanitzky, 1928)	3	12	4.00	0.30	7.50	1 – 10
<i>Posthodiplostomum cuticola</i> (von Nordmann, 1832)	1	>100	100.00	2.50	2.50	>100
<i>Sphaerostomum bramae</i> (Müller, 1776)	1	6	6.00	0.15	2.50	6
<i>Pomphorhynchus laevis</i> (Müller, 1776)	3	7	2.33	0.18	7.50	1 – 4
<i>Contracaecum</i> sp., larvae	1	2	2.00	0.05	2.50	2

N – number of investigated hosts, n – number of infected hosts, p – number of fish parasites, MI – mean intensity, MA – mean abundance, P% – prevalence.

3.3. INFRACOMMUNITY OF *ABRAMIS BRAMA* FROM THE DANUBE RIVER

Of the examined 40 *A. brama* specimens from the Danube River, 22 specimens were not infected, 17 specimens were infected with only one parasite species, and 1 specimen was infected with two parasite species (Table 3).

Table 3. Infracommunity of *Abramis brama* from the Danube River (near the Kudelin village)

Number of specimens <i>Abramis brama</i>	Number of parasite species		
	0	1	2
Number of specimens <i>Abramis brama</i>	22	17	1
Total number of species (Mean number of species \pm SD)	6 (0.48 \pm 0.55)		
Total number of specimens (Mean number of specimens \pm SD)	> 898 (22.45 \pm 65.81)		
Brillouin's diversity index (HB)	0.75 \pm 1.08		

In the infracommunities of *A. brama* from the Danube River (near the Kudelin village), the number of parasite specimens varied from 1 to 395 per host. More than 898 parasites specimens were the subject of this study. The Brillouin's diversity index (HB) was relatively high (HB = 0.75), determined by the presence of six parasite species and more than one species with high abundance (Table 3).

3.4. CONCENTRATIONS AND EXCEEDANCES OF CADMIUM IN *ABRAMIS BRAMA*, WATER AND SEDIMENTS FROM THE DANUBE RIVER

In the study of freshwater bream from the Danube River (near the Kudelin village), the highest Cd content was found in liver samples (wet weight $C_{Cd} = 0.80 \pm 0.67 \text{ mg.kg}^{-1}$), followed by that of skin samples (wet weight $C_{Cd} = 0.10 \pm 0.04 \text{ mg.kg}^{-1}$) and muscle samples (wet weight $C_{Cd} = 0.05 \pm 0.02 \text{ mg.kg}^{-1}$). The content of Cd decreased in the order: liver > skin > muscle (Table 4-5).

Table 4. Content of Cd (mg.kg^{-1} wet weight) in liver, skin and muscles of *A. brama* and water (mg.l^{-1}) from the Danube River (near the Kudelin village)

<i>Abramis brama</i>	Cd	
	Min – Max	Mean \pm SD
Liver	0.12 – 2.13	0.80 ± 0.67
Skin	0.05 – 0.16	0.10 ± 0.04
Muscle	0.02 – 0.07	0.05 ± 0.02
Water	0.0004 – 0.02	0.004 ± 0.008

Table 5. Content of Cd (mg.kg^{-1} dry weight) in liver, skin and muscles of *A. brama* and sediments (mg.kg^{-1} dry weight) from the Danube River (near the Kudelin village)

<i>Abramis brama</i>	Cd	
	Min – Max	Mean \pm SD
Liver	0.40 – 7.14	2.59 ± 2.19
Skin	0.20 – 0.61	0.30 ± 0.15
Muscle	0.05 – 0.27	0.17 ± 0.07
Sediments	0.37 – 88.91	15.75 ± 35.84

The levels of Cd in liver, skin and muscles of *A. brama* from the Danube River (near the Kudelin village) were compared to the norm in Ordinance No. 31 of 2004 on the maximum levels of contaminants in foodstuffs (0.05 mg/kg). The cadmium in liver and skin exceeded by 15.9 and 1.9 times the norm for Cd specified in this ordinance, respectively. The concentrations of Cd in liver, skin and muscles of *A. brama* were also compared to the value indicated by the Food and Agriculture Organization (FAO) (0.2 mg/kg). The cadmium in liver samples exceeded 3.98 times this value. Exceedances of Cd were not detected in muscle samples of freshwater bream (Figure 2).

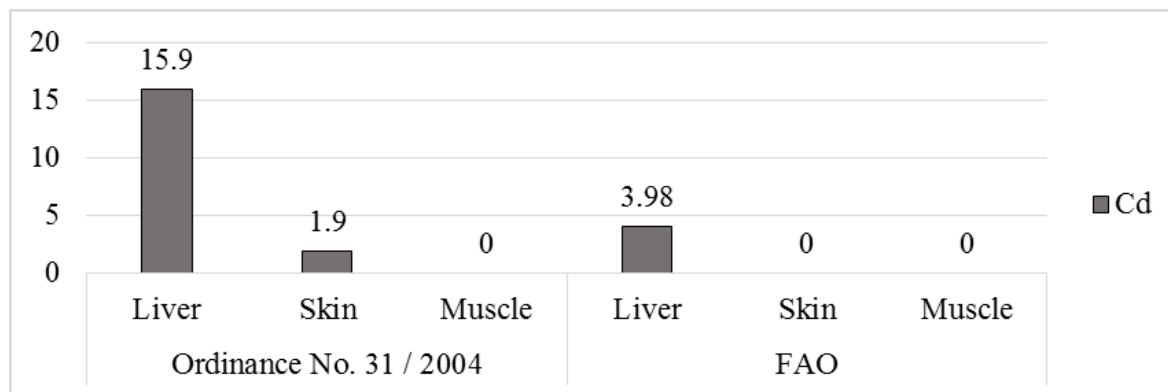


Figure 2. Exceedances of Cd in tissues and organs of *Abramis brama* from the Danube River (near the Kudelin village)

The Cd content in the water samples was $C_{Cd} = 0.004 \pm 0.008 \text{ mg.l}^{-1}$ and in the sediment samples was $C_{Cd} = 15.75 \pm 35.84 \text{ mg.kg}^{-1}$ dry weight (Table 4-5). The cadmium in water samples was 4.44 times higher than the norm specified in Ordinance on environmental quality standards for priority substances and certain other pollutants (0.0009 mg/l) but did not exceed the norm in Ordinance No. 18 of 2009 on the quality of water for irrigation of crops (0.01 mg/dm³). The cadmium in sediment samples was 19.69 times above the Dutch Target Values (0.8 mg/kg). The reported Cd concentrations also exceeded 5.25 times the norm in Ordinance No. 3 of 2008 on the norms for the permissible content of harmful substances in soils (3 mg/kg at pH>7.4).

The highest Cd bioconcentration from the river water was found for liver (BCF = 584.7) and the lowest for the muscle (BCF = 9.94) of the freshwater bream. The Cd bioaccumulation of the sediments was much lower but followed the same trend (Table 6). Positive linear correlations between the content of Cd in liver, skin, muscles of *A. brama* and that in water and sediments of the studied river section were found ($r_s = 0.88-0.98$; $p < 0.05$).

Table 6. Bioconcentration factor (BCF)

BCF _{Cd}			
<i>Abramis brama</i> / Water		<i>Abramis brama</i> / Sediments	
$C_{\text{liver}}/C_{\text{water}}$	584.7	$C_{\text{liver}}/C_{\text{sediments}}$	0.16
$C_{\text{skin}}/C_{\text{water}}$	22	$C_{\text{skin}}/C_{\text{sediments}}$	0.02
$C_{\text{muscle}}/C_{\text{water}}$	9.94	$C_{\text{muscle}}/C_{\text{sediments}}$	0.01

Kirin et al. (2014) identified three parasites species (2 species of class Monogenea and 1 species of class Acanthocephala) in the study of *A. brama* from the Danube River, Silistra biotope. The authors examined the muscles, bones, intestines, and liver of freshwater bream for a presence of lead (Pb), copper (Cu), and zinc (Zn). They detected the highest content of Pb and Zn in the intestines and the highest content of Cu in the liver. The concentrations of all three elements were the lowest in the muscle of *A. brama*.

Chunchukova et al. (2016) examined freshwater bream from the Danube River (Vetren biotope) for a presence of parasites and a content of lead. The authors found seven parasites species (2 species of class Monogenea, 1 species of class Digenea, 1 species of class Cestoda, 2 species of class Acanthocephala and 1 species of class Nematoda). They found that the concentrations of Pb decreased in the order: skin > liver > muscles.

Chunchukova et al. (2017) studied *A. brama* from the Danube River (Vetren biotope) for a presence of parasites and a content of Pb in liver, skin and muscles of freshwater bream. The authors found five species (1 species of class Trematoda, 3 species of class Acanthocephala and 1 species of class Nematoda). The authors found the lowest content of Pb in muscles of freshwater bream.

Kirin & Chunchukova (2017) examined tissues and organs (liver, skin, muscles) of *A. brama* from the Danube River for nickel (Ni) content. The authors found higher levels of Ni in the skin of freshwater bream.

4. CONCLUSIONS

In the study of 40 specimens of *A. brama* from the Danube River (near the Kudelin village), six parasites species (with more than 898 specimens) were identified, referring to 3 classes of parasites: class Trematoda (*A. imitans*, *N. skrjabini*, *P. cuticola* and *Sph. bramae*), class Acanthocephala (*P. laevis*) and class Nematoda (*Contracaecum* sp., larvae). The studied section of the Danube River is a new habitat for all parasites found in *Abramis brama*. *A. brama* was announced as a new host for *Sph. bramae* from the Danube River. In the component community of freshwater bream from the Danube River (near the Kudelin village), the trematode *A. imitans* was a core species (P% = 25.00) and had the highest mean abundance (MA = 19.28). With the highest mean intensity was *P. cuticola* (MI = 100.00). The Brillouin's diversity index (HB) was relatively high (HB = 0.75), determined by the presence of 6 parasite species and more than one species with high abundance.

The study provides new data on the content of Cd in liver, skin and muscles of *A. brama* from the Danube River (near the Kudelin village), northwestern Bulgaria. The liver of freshwater bream had the highest Cd content (wet weight $C_{Cd} = 0.80 \pm 0.67 \text{ mg.kg}^{-1}$) and the muscles had the lowest Cd content (wet weight $C_{Cd} = 0.05 \pm 0.02 \text{ mg.kg}^{-1}$). Exceedances of Cd were found in liver (according to national and international legislation) and the skin (according to national legislation). The highest Cd bioconcentration from the river water was found for liver (BCF = 584.7) and the lowest for the muscle (BCF = 9.94) of the freshwater bream. The bioaccumulation of Cd from sediments was much lower, but with the same trend as from the water. Positive linear correlations between the content of Cd in liver, skin, muscles of *A. brama* and that in water and sediments of the studied river section were found ($r_s = 0.88-0.98$; $p < 0.05$).

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PARASITE COMMUNITIES OF *ABRAMIS BRAMA* AND ACCUMULATION OF SOME POLLUTANTS FROM DANUBE RIVER, NORTHWESTERN BULGARIA

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Abstract: In 2019, 16 specimens of freshwater bream, *Abramis brama* (Linnaeus, 1758) from the Danube River (805-810 river km), Vidin region, northwestern Bulgaria were collected. The fish were examined for the presence of parasites and content of copper (Cu), cadmium (Cd) and arsenic (As). The ecoparasitological examination revealed five species of parasites: *Asymphyrodora imitans* (Mühling, 1898); *Nicolla skrjabini* (Ivanitzky, 1928); *Posthodiplostomum cuticola* (von Nordmann, 1832); *Caryophyllaeides fennica* (Schneider, 1902) and *Pomphorhynchus laevis* (Müller, 1776). The investigated section of the river is a new habitat for *A. imitans*, *P. cuticola* and *C. fennica*. *A. imitans* is a core species (P%=56.25) in the parasite community of *A. brama*. In tissues and organs of freshwater bream, the highest levels of all three elements were detected in the liver samples ($C_{Cu}=11.43\pm 5.92 \text{ mg.kg}^{-1}$; $C_{As}=4.31\pm 1.53 \text{ mg.kg}^{-1}$ and $C_{Cd}=0.23\pm 0.14 \text{ mg.kg}^{-1}$), followed by those in skin and muscles. In liver samples, the levels of the elements decreased in the order: Cu>As>Cd, and in skin and muscle samples, they decreased in the order: As>Cu>Cd. The study provides new data on parasites and parasite communities of freshwater bream from the Danube River, Vidin region, as well as for the content of some heavy metals/metalloids in water, sediments and *A. brama*.

Keywords: *Abramis brama*, Bulgaria, Danube River, heavy metals, parasites

1. INTRODUCTION

The Bulgarian section of the Danube River falls in its lower current and is characterized by numerous fish diversity (with over 60 fish species) (Polačik et al., 2008). Anthropogenic activity, including pollution of water by heavy metals/metalloids, has a negative influence on aquatic ecosystems, leading to the disappearance of habitats and species, changes in the variety of aquatic organisms and others (Schiemer et al., 2004). Parasites are a significant part of the biodiversity of aquatic ecosystems. The fish are characterized by a large number of fish parasites (Palm, 2011). *Abramis brama* from the Danube River has been investigated by a small number of authors for the content of heavy metals and a presence of parasites (Cojocar, 2003; Farkas et al., 2003; Đikanović et al., 2011; Đikanović et al., 2013; Jovanović et al., 2017). There are even fewer surveys on the freshwater bream from the Bulgarian section of the river, and they are mainly from the northeast section of the river on the territory

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of the country (Kirin et al., 2013; Kirin et al., 2014; Chunchukova et al., 2016; Chunchukova et al., 2017; Kirin & Chunchukova, 2017).

The study aims to provide information on the parasites and parasite communities of *A. brama*, as well as for the content of copper (Cu), cadmium (Cd) and arsenic (As) in liver, skin and muscles of freshwater bream, in water and sediments from the Danube River (Vidin region) in Bulgaria.

2. MATERIALS AND METHODS

In 2019, fish samples, fish parasites, water and sediments were collected between 805 and 810 kilometers markers of the Danube River, Vidin region, northwestern Bulgaria (Figure 1).

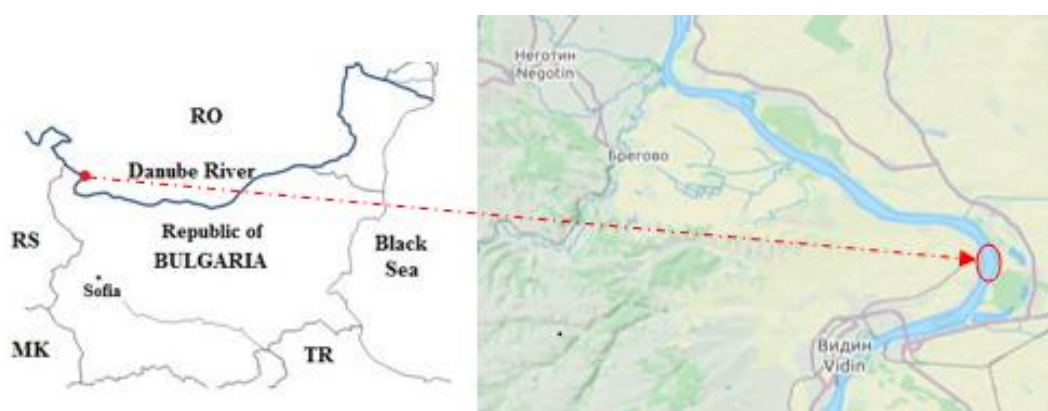


Figure 1. Danube River (805-810 river km), Vidin region [ViewRanger]

A total of 16 specimens of freshwater bream, *Abramis brama* (Linnaeus, 1758) and a total of 5 samples of water and sediment were collected. All caught specimens of freshwater bream were identified (Karapetkova & Jivkov, 2006; Kottelat & Freyhof, 2007); weight (g), maximum body length (L) and maximum body width (H) were recorded (Table 1).

Table 1. Length (in centimetres), width (in centimetres) and weight (in grams) of the collected *Abramis brama* specimens, Danube River, Vidin region

<i>Abramis brama</i>	L	H	g
Min - Max	13.7–25.5	4–8	28–186
Mean ± SD	20.36±3.51	6.04±1.30	97.44±49.99

All collected specimens of freshwater bream were examined for endoparasites (Petrochenko, 1956; Zashv & Margaritov, 1966; Kakacheva-Avramova, 1983; Bauer (Ed.), 1987; Moravec, 2013). The prevalence (P%), mean intensity (MI) and mean abundance (MA) were indicated in the study for each detected species of parasite. The structure of the component parasite communities was also determined (Kennedy, 1993; Bush et al., 1997). Infracommunities were examined on the base of the following indicators: total number of species, mean number of parasites and the Brillouin's diversity index (HB) (Magurran, 1988). Samples of tissues and organs of freshwater bream, together with samples of water and

sediment, were analyzed in an accredited laboratory (at the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences (BAS), Sofia) for copper, cadmium and arsenic content. In this study, the linear correlation coefficient of Spearman (r_s) and the bioconcentration factor (BCF) were calculated.

3. RESULTS

3.1. MODEL FISH SPECIES

The species *Abramis brama* (Linnaeus, 1758) (freshwater bream; Cyprinidae) is widespread in the Danube River and some of its tributaries, as well as in some lakes and dams on the territory of the country. The freshwater bream is an omnivorous species that inhabits the lower water layers. The specimens of this species can reach up to 80 cm in length and up to 6 kg weight and sometimes more (Karapetkova & Jivkov, 2006).

3.2. HELMINTH COMMUNITY STRUCTURE OF *ABRAMIS BRAMA*

In 11 specimens of a total of 16 studied specimens *A. brama* from the Danube River, five species of parasites were found: 3 trematodes (*Asymphylodora imitans* (Mühling, 1898); *Nicolla skrjabini* (Ivanitzky, 1928) and *Posthodiplostomum cuticola* (von Nordmann, 1832)); 1 cestode (*Caryophyllaeides fennica* (Schneider, 1902)) and 1 acanthocephalan (*Pomphorhynchus laevis* (Müller, 1776)).

3.3. COMPONENT COMMUNITY OF *ABRAMIS BRAMA*

In the component community of *A. brama* from the Danube River, Vidin region, the parasites of class Trematoda were presented by the largest number of species (3 species) and the highest number of specimens (>683). The parasites of class Cestoda and class Acanthocephala were presented by one species, with 1 and 2 specimens, respectively. In the study of the 16 *A. brama* specimens, it was found that *A. imitans* was a core species (P%=56.25) in the parasite community of freshwater bream from the Danube River and had the highest mean abundance (MA=33.00). *N. skrjabini* was a component species (P%=12.50). *P. cuticola*, *C. fennica* and *P. laevis* were accidental species (P%=6.25) in the parasite community of *A. brama*. The trematode *P. cuticola* had the highest mean intensity (MI=100.00) (Table 2).

Table 2. Biodiversity and ecological terms of the parasites and the parasite communities of *Abramis brama* from the Danube River (805-810 river km)

Parasite species	N = 16					
	n	p	MI	MA	P%	Range
<i>Asymphylodora imitans</i>	9	528	58.67	33.00	56.25	1-296
<i>Nicolla skrjabini</i>	2	52	26.00	3.25	12.50	9-43
<i>Posthodiplostomum cuticola</i>	1	>100	100.00	6.25	6.25	>100
<i>Caryophyllaeides fennica</i>	1	1	1.00	0.06	6.25	1
<i>Pomphorhynchus laevis</i>	1	2	2.00	0.13	6.25	2

N – number of studied fish hosts, n – number of infected fish hosts, p – number of fish parasites, MI – mean intensity, MA – mean abundance, P% – prevalence.

3.4. INFRACOMMUNITY OF *ABRAMIS BRAMA*

The study showed that 5 out of 16 specimens of *A. brama* were not infected, while 11 specimens were infected. Of them, 8 specimens were infected with only one parasite species, and 3 specimens were infected with two parasite species (Table 3).

Table 3. Infracommunity of *Abramis brama* from the Danube River (805-810 river km)

Number of specimens <i>Abramis brama</i>	Number of parasite species		
	0	1	2
	5	8	3
Total number of species (Mean number of species ± SD)	5 (0.87±0.72)		
Total number of specimens (Mean number of specimens ± SD)	> 683 (42.68±77.21)		
Brillouin's diversity index (HB)	0.34±0.02		

More than 683 parasite specimens of *A. brama* were studied. In the infracommunity of *A. brama* from the Danube River (805-810 river km), the number of parasite species varied from 1 to 296 in one fish specimen. The determined Brillouin's diversity index was low (HB=0.34), due to the abundant presence of one core species in the parasite communities (Table 3).

3.5. HEAVY METALS/METALLOIDS CONCENTRATIONS

In this study, the highest concentrations of copper (Cu), cadmium (Cd), and arsenic (As) were found in liver samples, followed by those in skin and muscle of *A. brama*. The concentrations of the examined metals in the liver samples decreased in the order: Cu>As>Cd (wet weight, respectively $C_{CuLiver}=11.43\pm5.92$ mg.kg⁻¹; $C_{AsLiver}=4.31\pm1.53$ mg.kg⁻¹ and $C_{CdLiver}=0.23\pm0.14$ mg.kg⁻¹). While the concentrations of the studied metals in skin and muscle samples of *A. brama* decreased in the order: As>Cu>Cd (wet weight, respectively $C_{AsSkin}=2.22\pm0.52$ mg.kg⁻¹, $C_{CuSkin}=1.55\pm0.96$ mg.kg⁻¹ and $C_{CdSkin}=0.06\pm0.06$ mg.kg⁻¹; and

$C_{AsMuscle}=0.46\pm0.14$ mg.kg⁻¹, $C_{CuMuscle}=0.37\pm0.15$ mg.kg⁻¹ and $C_{CdMuscle}=0.03\pm0.03$ mg.kg⁻¹). In water samples (mg.l⁻¹) from the Danube River the highest detected levels were of As ($C_{AsWater}=0.06\pm0.05$ mg.l⁻¹) and the lowest levels of Cd ($C_{CdWater}=0.002\pm0.001$ mg.l⁻¹). The sediment samples (mg.kg⁻¹ dry weight) had the highest levels of Cu ($C_{CuSediments}=228.58\pm189.39$ mg.kg⁻¹) and the lowest levels of Cd ($C_{CdSediments}=1.50\pm0.54$ mg.kg⁻¹) (Table 4-5).

Table 4. Cu, Cd and As (mg.kg⁻¹ wet weight) in liver, skin and muscle of *A. brama* and water (mg. l⁻¹) from the Danube River (805-810 river km)

<i>Abramis brama</i>	Cu	Cd	As
	Mean±SD	Mean±SD	Mean±SD
Liver	11.43±5.92	0.23±0.14	4.31±1.53
Skin	1.55±0.96	0.06±0.06	2.22±0.52
Muscle	0.37±0.15	0.03±0.03	0.46±0.14
Water	0.05±0.03	0.002±0.001	0.06±0.05

Table 5. Cu, Cd and As (mg.kg⁻¹ dry weight) in liver, skin and muscle of *A. brama* and sediments (mg.kg⁻¹ dry weight) from the Danube River (805-810 river km)

<i>Abramis brama</i>	Cu	Cd	As
	Mean±SD	Mean±SD	Mean±SD
Liver	45.74±28.05	0.87±0.71	13.49±3.74
Skin	4.37±3.25	0.22±0.26	7.17±0.78
Muscle	1.64±0.82	0.11±0.13	2.06±0.83
Sediments	228.58±189.39	1.50±0.54	22.71±14.58

3.6. HEAVY METALS/METALLOIDS EXCEEDANCES

The content of copper (Cu) in the liver, skin and muscles of *A. brama* was compared to the maximum permissible concentrations (MPC) specified in Ordinance No. 31 ($C_{Cu}=10$ mg/kg) of the Bulgarian legislation, as well as with the maximum values, shown by the World Health Organization (WHO) ($C_{Cu}=20$ mg/kg) and the Food and Agriculture Organization (FAO) ($C_{Cu}=30$ mg/kg). The content of cadmium (Cd) in tissues and organs of *A. brama* was compared to the MPC specified in Ordinance No. 31 ($C_{Cd}=0.05$ mg/kg) and with the maximum values pointed by FAO ($C_{Cd}=0.2$ mg/kg). While the content of arsenic (As) was compared only to the MPC specified in Ordinance No. 31 ($C_{As}=1$ mg/kg). Exceedances of Cu were recorded only in liver samples of *A. brama* – 1.14 times above the MPC in Ordinance No. 31. Exceedances of Cu were not observed relative to the values indicated by the WHO. Exceedances of Cd were found in liver and skin samples, 4.62 and 1.18 times above the norm in Ordinance No. 31, respectively. Exceedances of Cd above the values accepted by FAO were recorded only in liver samples of freshwater bream (1.16 times). Exceedances of As were found in liver and skin samples – 4.31 and 2.22 times above the MPC in Ordinance No. 31 (Figure 2).

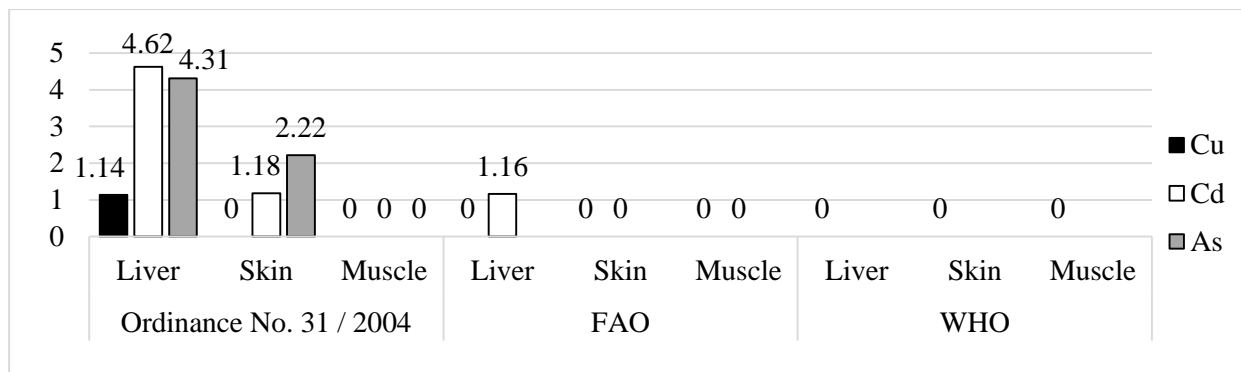


Figure 2. Exceedances of Cu, Cd and As in liver, skin and muscles of *Abramis brama* from the Danube River (805-810 river km)

The content of copper (Cu) in the water samples (Danube River) was compared to the norm in Ordinance No. 18 ($C_{Cu}=0.2 \text{ mg/dm}^3$). The content of cadmium (Cd) was compared to the norms specified in Ordinance No. 18 ($C_{Cd}=0.01 \text{ mg/dm}^3$) and in Ordinance on environmental quality standards for priority substances and certain other pollutants ($C_{Cd}=0.0009 \text{ mg/l}$). The content of arsenic (As) in water was compared to the norms shown in Ordinance No. 18 ($C_{As}=0.1 \text{ mg/dm}^3$) and in Ordinance H-4 ($C_{As}=0.025 \text{ mg/l}$). In the samples of water from the Danube River (805-810 river km), exceedances of As and Cd were found. Arsenic exceeded 2.4 times the MPC under Ordinance H-4, and cadmium exceeded 2.22 times the MPC under Ordinance on environmental quality standards (Figure 3).

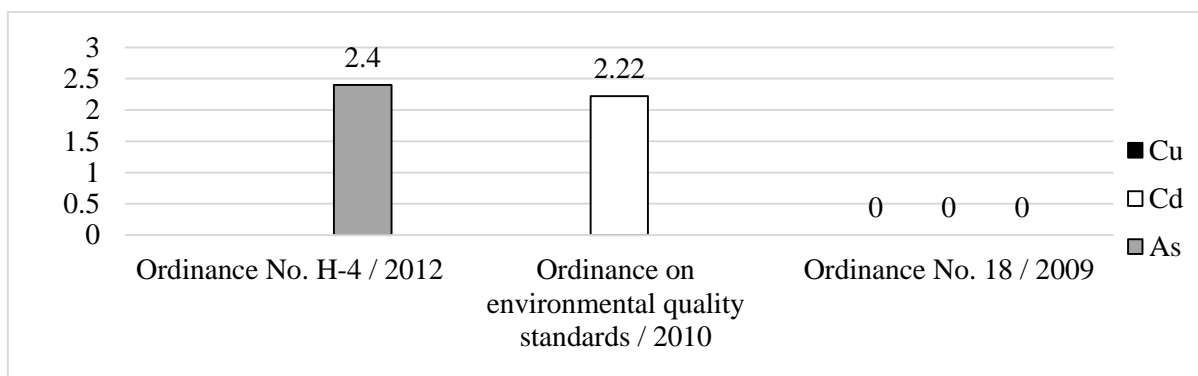


Figure 3. Exceedances of Cu, Cd and As in water from the Danube River

The content of copper (Cu), cadmium (Cd) and arsenic (As) in the sediment samples (Danube River) was compared to the MPC indicated in Ordinance No. 3 ($C_{Cu}=300 \text{ mg/kg}$ at $\text{pH}>7.4$; $C_{Cd}=3 \text{ mg/kg}$ at $\text{pH}>7.4$; $C_{As}=25 \text{ mg/kg}$) and to Dutch Target Values ($C_{Cu}=36 \text{ mg/kg}$; $C_{Cd}=0.8 \text{ mg/kg}$; $C_{As}=29 \text{ mg/kg}$). The study showed that the content of Cu and Cd in the sediment samples exceeded the Dutch target values 6.35 and 1.88 times, respectively. The obtained values for Cu, Cd and As in sediments did not exceed the MPC specified in Ordinance No. 3 (Figure 4).

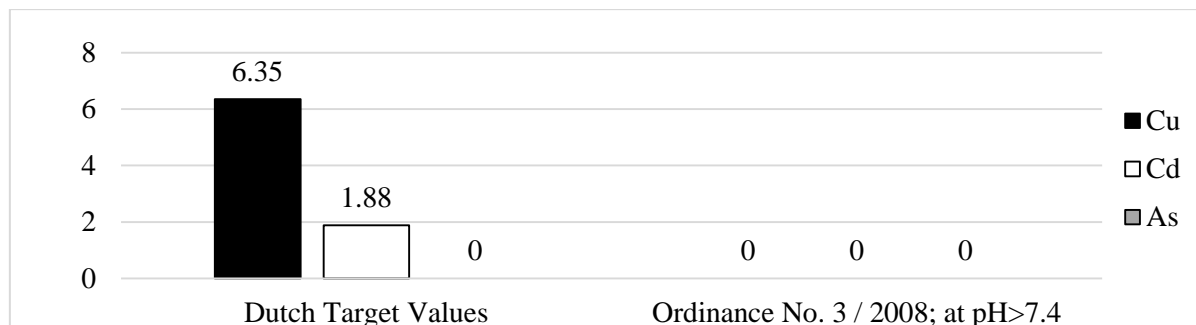


Figure 4. Exceedances of Cu, Cd and As in sediments from the Danube River

The highest bioconcentration from the water and sediments was found in the liver samples of freshwater bream for all three studied elements (copper, cadmium and arsenic), and the lowest was found in the muscle samples. The liver of the investigated freshwater bream specimens bioaccumulated 1.99 times more copper from the water compared to the accumulation of cadmium and 3.18 times more copper from the water compared to the accumulation of arsenic. The liver of *Abramis brama* accumulated 1.60 times more cadmium from the water compared to the accumulation of arsenic. The highest bioaccumulation of arsenic was found from sediments in the liver samples of freshwater bream (1.02 times more than cadmium accumulation and 2.95 times more than copper accumulation) (Table 6).

Table 6. Bioconcentration factor (BCF)

<i>Abramis brama</i> / Water	BCF _{Cu}	BCF _{Cd}	BCF _{As}
$C_{\text{Liver}}/C_{\text{Water}}$	228.60	115	71.83
$C_{\text{Skin}}/C_{\text{Water}}$	31	30	37
$C_{\text{Muscle}}/C_{\text{Water}}$	7.40	15	7.67
<i>Abramis brama</i> / Sediments	BCF _{Cu}	BCF _{Cd}	BCF _{As}
$C_{\text{Liver}}/C_{\text{Sediments}}$	0.20	0.58	0.59
$C_{\text{Skin}}/C_{\text{Sediments}}$	0.02	0.15	0.32
$C_{\text{Muscle}}/C_{\text{Sediments}}$	0.01	0.07	0.09

Positive linear correlations between Cu, Cd and As content in liver, skin and muscles samples of *A. brama* and those in water and sediments samples ($r_s=0.57-1.0$; $p<0.05$) were found.

4. CONCLUSIONS

As a result of the study of 16 specimens *Abramis brama* from the Danube River (805-810 river km), Vidin region, northwestern Bulgaria, five species of parasites were identified: *A. imitans*, *N. skrjabini*, *P. cuticola*, *C. fennica* and *P. laevis*. The investigated section of the river is a new habitat for *A. imitans*, *P. cuticola*, *C. fennica*. In the component community of freshwater bream from the study area, with the highest mean intensity (MI) was *P. cuticola* (MI=100.00), with the highest mean abundance (MA), was *A. imitans* (MA=33.00). The trematode *A. imitans* was a core species (P%=56.25) in the parasite community of *A. brama*. Brillouin's diversity index was low (HB=0.34), which could be explained by the presence of pollutants in the aquatic environment. The study provides new data on the levels of copper,

cadmium and arsenic in liver, skin and muscles of *A. brama* from the study section of the Danube River. The highest levels of the three elements were found in liver samples and the lowest levels – in the muscles samples. In the liver samples of *A. brama*, the concentrations of the examined elements decreased in the order: Cu>As>Cd, while in the skin and muscles samples they decreased in the order: As>Cu>Cd. In the liver of freshwater bream, exceedances for all three monitored elements were found, in the skin of freshwater bream, exceedances for two elements (cadmium and arsenic) were found in accordance with the norms specified in national legislation. Only the concentrations of cadmium in the liver of *A. brama* exceeded the maximum values defined by FAO.

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FORECASTING EMERGENCY SITUATIONS CONNECTED WITH REGIONAL FLOODING BY GROUNDWATER IN SOUTHERN UKRAINE

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Abstract: The current state of the problem of the Kherson region area regional flooding by the groundwater is analysed in the article. The factors and dynamics of the flooding process formation and its ecological and technogenic impact on the environment are identified. Quantitative characteristic of infiltration feeding value of the groundwater is given depending on natural-technogenic factors of its formation. The possible rise of the groundwater level in the region area is forecasted, and the risk of emergencies in the whole region industrial-agricultural potential functioning system is shown.

Keywords: flooding, emergencies, environmental protection, infiltration feeding, hydrogeological ameliorative conditions, drainage

1. INTRODUCTION

During the last decades, flooding processes in the Kherson region have covered a significant part of its area and form a significant environmental hazard nowadays. Among the regions of Ukraine, the Kherson region has the biggest index of the water ecological pressure, at which the water consumption amount exceeds surface and groundwater resources of the local formation up to 4 times (Scherbak, 2012). It's mostly conditioned by the creation of Kakhovka Reservoir with the regional backwater of the ground aquifer to 14m, irrigation systems network, trunk canals and unregulated water consumption, which have fundamentally changed hydrogeological conditions and slowed water exchange in the active zone of the sedimentary layers water-bearing rocks. (Baum et al., 2014; Telyma et al., 2020a; Trofymchuk et al., 2014).

As a result, a significant amount of the land appeared in the flooding and potentially water-logged areas (Anpilova et al., 2020; Korchenko et al., 2019; Lukianova et al., 2020; Telyma et al., 2020b; Trofymchuk et al., 2019; Trofymchuk et al., 2020). Thus as at 2012-2015, there was more than 70% of the territory and more than 260 cities and built-up areas with a total area of 1200 thousand ha flooded in the region, which is more than 20 times compared to 1982. As the region environmental state monitoring data show, an annual

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increase of the flooded territories makes 50 thousand ha (Ecological passport of Kherson region, 2012; Telyma, 2015; Oleinik, A. & Voloshkina, 1985). It is important to note that geological hydrogeological conditions on the territory of the Kherson region have a complex and diverse lithological composition, filtration parameters, hydrochemical indices, and have not been sufficiently studied in the process of Kakhovka Reservoir, North-Crimean Canal, current irrigation systems and water buildings engineering and development, which has conditioned the current dynamics of the area regional flooding. Combination of natural and technogenic factors, the major of which is a weak natural drainage, climate conditions changes, various water bodies creation, losses from utility networks, absence of effective drainage systems, numerous irrigation constructions and unordered irrigation conditions further flooding of the area nowadays. The complicated hydrogeological meliorative situation on the given territory requires carrying out forecasting estimates of the groundwater system change and development of the series of measures for protecting the land and built-up areas from this negative phenomenon.

2. PROBLEM STATEMENT

One of the further flooding forecast approaches is forecast based on the analysis of the groundwater level rise rates during the long-term monitoring period. At that, monitoring data from numerous original sources have been used. As far as irrigation bodies are mostly located on the terraces and alluvial and denudation plains, the average values of the groundwater level rise rates constitute approximately 0.25-0.3 m per year based on the data analysis on them. A more detailed analysis of the data concerning the groundwater level rise rates shows that within the boundaries of Krasnoznamenska irrigation system the groundwater level rise rates constitute 0.3 – 1.0 m per year, and 0.1 – 0.3 m per year at the surrounding areas at the average values of 0.65 and 0.2 m per year correspondingly. In the Kakhovka irrigation system, the groundwater level rise rates constitute approximately 0.8 m per year and 0.15 m per year on average within the surrounding territories. In the areas where groundwater lies in the Pliocene sand and limestone and Quaternary deposits are irrigated only in small areas, the average annual growth rate constitutes about 0.1-0.2 m per year. Thus, we can consider that according to the analysis long-term monitoring data, average annual groundwater level rise rates constitute from 0.1 to 0.5 m per year in the irrigated land and 0.1 to 0.3 m per year in the surrounding territories. Based on received data we can elaborate the long-term forecast using linear extrapolation of the irrigated areas and surrounding territories potential flooding becomes possible as at 2030 ($t = 10$ years). Thus, in Krasnoznamenska irrigation system, we can expect the level rise to 5.0 m and up to 2.0 m in the surrounding territories; up to 8.0 m in the irrigated areas of Kakhovka system and up to 1.5 m - in the surrounding territories.

3. MATERIALS AND RESULTS OF THE RESEARCH

At the groundwater level rise rates forecast tasks reasoning, the main criterion is the maximum groundwater level bedding depth specified, which depends on the potential flooding area exploitation character and natural and technogenic factors having an impact on this process. At that, there should be the following ratio:

$$[Z - (h + \Delta h)] < NCD \quad (1)$$

where Z is the land surface mark, m; h is the known value of the groundwater level at the beginning of the forecast, m; Δh is the forecasted rise of the groundwater level at the defined period, m; NCD is Normal Critical Depth of the groundwater level bedding, m (Baum et al., 2014; Telyma et al., 2020b; Trofymchuk et al., 2014). The NCD normative value on the Kherson region irrigated land depends on numerous factors. Thus, for the fresh groundwater, it constitutes 2.0 m and above with drainage systems; 2.5 m and above for low mineralized water; 3.0 m and above for the groundwater with increased mineralization (dry residue is more than 3.0 g/l); more than 3.0 m for the groundwater with various levels of mineralization and $\text{pH} > 8$, which conditions sodium carbonate salinization; in the rice systems NCD is 1.6-1.7 m.

The given forecast data based on the analysis of the annual groundwater level rise rates show that there is an arguable risk of the total flooding of the territories in those irrigated areas and surrounding territories, where the groundwater level is at a depth of 3.0-5.0 m from the land surface in current conditions. It is worth noting that the given forecast analysis is approximate based on the discourse that the impact of filtration from the trunk and distributing canals as an additional source of the groundwater infiltration feeding and the level rise acceleration has not been taken into consideration. However, the current state of these hydro-technical constructions makes filtration losses from them one of the major factors of the regional territory flooding. According to the balance estimates of the water exchange on the irrigated land, the level rise is formed over time taking into account correlation between infiltration feeding of the groundwater and coefficient of the water yield based on the transfer into Neogene complex.

As it is seen from the above-given data, an almost complete transformation of the aquifers system of the free and confined groundwater in the zone of active water exchange has occurred compared to natural conditions on the territory of the region. Schematizing of current hydrogeological conditions allows using a hydrodynamic scheme of three-layer formation with transfer in our case. The first layer is an aquifer of groundwater with free surface bedded in the irrigated layer of the Quaternary deposits; the second layer is a low permeable water-resistant layer of red-brown clay of low thickness; the third layer is an aquifer if Neogene deposits, which is the main aquifer, the water from which is used for the central water supply of the population within the region.

Thus, the water bearing rock, which lies above the regional water-resistant layer of the Sarmatian clay, can be presented as a three-layer in the cross-section filtration area with the boundary conditions of the third kind, which reflects interconnection between the groundwater and Kakhovka Reservoir and trunk canals. At that, the vertical water exchange is prevailing, and the horizontal component of the flow is a lot smaller compared to the vertical one. This difference is conditioned by the fact that aeolian-deluvial layer of Quaternary deposits is characterised by sudden filtration anisotropy with the prevailing vertical filtration coefficients index. Based on the above said, we can assume that the groundwater system in the studied territory has quasi-permanent character at the rise as well as at the recession of the groundwater level. That is why on the biggest part of the areas further groundwater level rise will be conditioned first of all by the size of the additional infiltration feeding of its surface taking into account interconnection with the aquifer in the Neogene deposits as a regional drainage.

With regard to the fact that the feeding character and intensity depend on the groundwater level position (aeration zone capacity), we consider two types of feeding: at a great depth of groundwater level bedding and at low depth after the development of drainage to keep the groundwater level at an appropriate safe depth from the land surface. Numerous in situ observations show that at the groundwater level table depth (more than 3-4 m), feeding of

the groundwater takes place throughout the whole year. At that, with increasing depth, this value becomes constant [5]. At a low depth of the groundwater level bedding, feeding takes place mostly in the irrigation period, although it partially comes after the irrigation is complete at the expense of the movement of water into the groundwater surface in the aeration zone. Based on the numerous data analysis, we can consider that infiltration feeding value beyond the irrigation massifs constitutes 3.4×10^{-4} m/day ($124 \text{ mm/year} = 3.9 \text{ l/sec} \cdot \text{km}^2$) in average at the expense of precipitations and losses from the water-pipe and sewerage networks as well as household plots irrigation. Regarding irrigation massifs, the infiltration value for the Kakhovka massif exceeds 1.7-4 times the infiltration feeding value on the unirrigated land; 2-3 times for the Sirohozy massif. In summary feeding (precipitations and irrigation) from 440 to 800-1200 mm/year the infiltration intensity value changes from 10-50 to 100-120 mm/year. Regional evaluation of infiltration feeding in the region shows that irrigation increases feeding 1.6-3 times and therefore conditions regional rise of the groundwater level to the critical depth.

In general, the given data about the state of the flooded region during the period from 1982 to 2012-2015 allow tracking dynamics of the development of the process during the mentioned 30 years based on the suggested scheme of the vertical water exchange in the saturated and unsaturated layer based on the above-defined additional infiltration feeding of the groundwater surface.

There is a schematic forecast map of the regional territory flooding dynamics during the period from 1982 to 2012-2015 shown in the Figure 1. Areas flooded under conditions of natural factors at the expense of the regional long-term groundwater level rise, precipitations, on the territories of weak natural drainage and head of reservoirs of the Dnieper Cascade are highlighted on the map.

Additionally, highlighted areas of the flooded land are mostly conditioned by technogenic factors: under conditions of irrigation, filtration from the trunk canals in the boundaries of urban-industrial agglomerations, under conditions of the backwater flow from Kakhovka Reservoir as well as the area of the flooded rural population centres.

Increase of flooded areas is shown in 2015 compared to 1982. Such areas are located in the boundaries of the Inhulets irrigation system and the south-east in Chaplinka and Henichesk districts. Essential impact of Kakhovka Reservoir constitutes 12-15 km on the Left Bank and 3-8 km on the Right Bank of the Dnieper River. Impact of the regional backwater of ground flow has expanded to the significant areas on the Left Bank from north rayons of the region to the Black Sea. At that, areas of the flooded land are mostly located in the zone of interaction of the major trunk canals. Similarly to 1982, areas have remained flooded in Bilozerka district and in other districts which belong to the seaside area of the region, where deceleration of the upward discharge of the groundwater regional flow occurs. Only areas on the east of the Left Bank and in the central part of the Right Bank remained almost unsubmerged. It is also worth noting that in the seaside area near Sivash as a regional drainage all localities are in the flooded state. Width of the flooded land strip constitutes 2-8 km in these areas. There has been formed an inland region, in the boundaries of which the current technogenic feeding of the groundwater has resulted in its intense rise. At this, the only major upward discharge item of the water balance is evaporation, which conditions regional salination of the soil (Scherbak, 2012).

Thus, further flooding of the territory of the region can be evaluated based on the groundwater level rise rates, which have been defined using analysis of flooding process development dynamics during the last 30 years.

The given estimates allowed to summarize groundwater level rise value and rates depending on the geological hydrogeological conditions of the flooded area location.

Additionally, the irrigated massifs data analysis shows that the groundwater level rise constituted 0.3-1.3 m/year in their boundaries and 0.1-0.3 m in the surrounding territories. In the Sivash zone where groundwater lies in the Quaternary loam, the average long-term rate of the level rise has reached almost 0.5 m.

In the Kakhovka irrigation system areas when land irrigating with the Fregat sprinkler the average annual increase of the groundwater constitutes 0.8 m/year, and 0.1- 0.3 m/year within water dividing territories.

To evaluate the impact of the level rise on the forecasted period in the irrigated areas the inverse tasks have been solved based on the model of the accelerated groundwater level rise in the systems. The maximum impact on the surrounding territories is calculated under the conditions when on a certain distance (L) the level rise approaches zero. This value has been chosen equal to 0.05 m for the calculations. Quantitative calculations have resulted in the following values of L: the minimum and maximum distance constitute approximately 972 and 1350 m respectively in the Kakhovka massif; 810 and 999 m respectively in the Sirohozy massif; 918 and 1242 m respectively in the Askaniya-Melitopol plain of the Kakhovka system; 875 and 1053 m respectively in the Sivash plain of the Kakhovka system; 875 and 972 m respectively in the Krasnoznamenska system; 945 m in the Kakhovka system according to the processing data of the system monitoring. Analyzing the given data we can conclude that in the forecasted period impact of the flooded land on the surrounding territories will expand in the distances from 800 to 1350 m, which is connected first of all with the low filtration capacities of the ground free surface aquifer in the horizontal direction (average coefficient index hydraulic diffusivity in the horizontal direction constitutes 20 m²/day). Given results of the forecasting modelling of the groundwater level rise for 10-15 years allow concluding the risk of potential flooding of irrigated areas and surrounding territories in the defined period: 43.25% of land can be potentially flooded in the Inhulets system; 72.83% in the Krasnoznamenska system; 7% in the Kakhovka system; 50.6% in the Kalanchak system; 12% of the land in the Right Bank system; 26% of the land in total from the overall area of the flooded land (111403 ha).

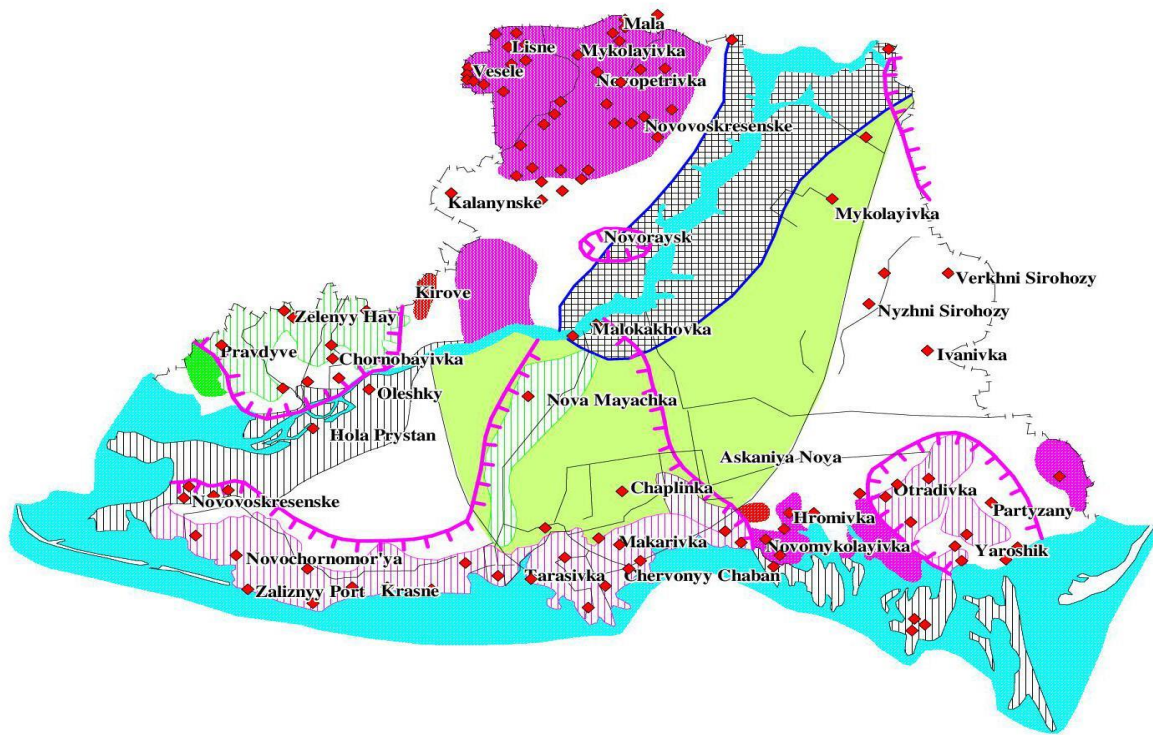


Figure 1. Forecast map of the territory flooding dynamics in the region from 1982 to 2012-2015

The Legend: - technogenic flooding; - through backwater of Kakhovka Reservoir; - flooding through natural and technogenic factors; - increase of the flooded areas compared to 1982 through irrigation; - increase of technogenic flooding compared to 1982; - flooding through irrigation (as at 2015); - increase of flooding of the areas as at 2015; - flooding on a set of factors; - forecasted zone of flooding as a result of irrigation; - flooded territories of the built-up areas



(Sources: <https://kherson.tv/>; <https://youtu.be/yMJa5Q91EGA>)

Figure 2. Catastrophic moisture in rural settlements of the Kherson region, April 2015

Thus, if the specified groundwater level rise rates remain constant for the next 15-20 years (Figure 2), the main massifs of the irrigated land with the bedding of the groundwater level depth less than 5.0 m from the land surface can become flooded. In the boundaries of the

irrigated land we can expect the groundwater level rise from 1.2 to 7.5 m approximately at the existing irrigation standards and filtration losses in the canal zones, and 1.2-3.6 in the rain-fed land. Comparison of the forecasted groundwater level rise rates for 2015 has shown a good convergence in the margin of error.

In general, the given data show that a quite critical ecological hydrogeological state can be formed on almost all territory of the region, which will lead to disruption of normal life in the region, the complication of the agro-industrial complex, built-up areas and other objects of different purposes exploitation. Additionally, due to the flooding, the strength of the basement rocks and seismic stability of the buildings are reduced, and their destructive deformation increases, drinking water supply sources protection deteriorates due to pollution, soil fertility is lost.

According to the official data, there are more than 200 potentially dangerous objects on the territory of the Kherson region, which under certain conditions can constitute a real threat of accidents and emergencies occurrence. On the territory of the region potentially hazardous objects are plants in the food, chemical, oil, light and mechanical engineering industries, areas of accumulation of housing waste, pesticides, fertilizers, oil and lubricants storages, filtration fields, garbage dumps, etc. At that, level rise also activates pollution and deterioration of the surface and groundwater quality (Building code, 1996; Ecological passport of Kherson region, 2012).

Regarding the above said, an issue of the mentioned objects protection through effective and reasonable activities to eliminate areas of their flooding arises.

The only effective activity to protect potentially dangerous objects is drainage. As the data show, horizontal, vertical and combined drainage is used in the flooded areas of the region, canal zones and built-up areas. Thus, in the boundaries of the Krasnoznamenka irrigation system area horizontal drainage in 7 sectors with a total area of 5032 ha is put into effect. Analysis of the given drainage work has shown that it is effective only when it lies at the depth of 2.5-3.0 m in the sand underlayed by the loess loam. Under other conditions, it is ineffective and does not ensure the required groundwater level decrease.

Based on hydrogeological conditions, on the territory of the region, vertical drainage is more effective. Vertical drainage is used to protect Skadovsk city and a range of the built-up areas of Hola Prystan, Skadovsk, Novotroitske and Henichesk Rayons, on the irrigated massifs, rice seed zones and adjacent canal zones.

Analysis of the vertical drainage exploitation data shows that its use together with the horizontal one and their stable work ensure the required groundwater level decrease. At that, the rate of decrease depends mostly on the water-bearing rocks lithological composition.

In general, the use of vertical and combined drainage is justified by the probable protection of potentially hazardous objects in the region. If the objects are located in the zone of the reservoir impact, building the sectionalized vertical drainage system will be effective and purposeful in our opinion, and building of the local sectionalized, random or trench vertical drainage will protect separate areas of these objects placement.

It is worth noting that the choice of the drainage type will depend on the protection of particular objects, their position and specific geological hydrogeological situation.

However, as the research and achieved results analysis shows, apart from using drainage measures to protect the specified objects, the point is to develop and implement a series of measures to improve the environmental situation in the region in total, which had to have large-scale and systemic manner, namely:

- Reconstruction of the trunk canals systems, including North-Crimean, Krasnoznamenka, Kakhovka, Chaplinka canals, which will ensure regulation of active aquifers on their separate areas and maximum decrease of filtration losses from these canals;

- Reconstruction of the distributing irrigation network to decrease filtration water losses from this distributing system;
- Optimization and control of irrigation standards to reduce irrigation water losses for the groundwater infiltration feeding;
- Reconstruction of currently inactive rice irrigation systems which harm the environmental state of the surrounding areas;
- Reconstruction of active rice seed systems based on water-conservation technologies;
- Development of built-up areas territories vertical planning projects and their implementation to regulate surface and household sewage withdrawal beyond the boundaries of built-up areas;
- Reconstruction and renewal of vertical drainage systems based on the water consumption conditions and technical state of irrigating systems to reduce technogenic feeding of the groundwater from below from the pressure aquifers and thus reduce groundwater level rise rates on the irrigated land as well as on the surrounding territories;
- Total reconstruction of the Inhulets irrigation system which is characterised by big filtration losses.

Suggested measures for the environmental safety of the flooded territories management allow to do a search of optimal management decisions on the municipal level for a range of activities of potentially hazardous objects in the region and prevent occurrence and development of emergencies when forming a stable environmental policy of the regions in Southern Ukraine.

4. CONCLUSION

To prevent emergencies during technogenic flooding of potentially hazardous objects in the Kherson region there arises necessity in forecasting and preventing the development of dangerous processes as a consequence of the damaging effects of the water and specified objects protection issues through organizing effective and reasonable measures for eliminating flooding of the areas they are located in. In terms of recommendations on the further research, there is a necessity in creating research areas to define movement of water in the aeration zones (unsaturated filtration) on the irrigated land under the current conditions; definition of filtration losses from the trunk canals end estimation of their impact on the surrounding territories based on a new vision of water exchange on the investigated territory and its connection with the groundwater flow; creation of local and regional permanent filtration models of the investigated territory.

To draw up strategic plans of stable development and preventing occurrence and growth of emergencies it is necessary to forecast the development of a strategic ecological evaluation of the regional territory development based on the ecological safety state of flooded territories.

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REQUIREMENTS FOR DRINKING WATER MANAGEMENT WITHIN THE TERRITORIES OF DONBAS MINING COMPLEXES

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Abstract: This paper addresses the issue of changes in the quality of surface water bodies of the Siverskyi Donets River basin, which serve as the main source of drinking water supply for the given region inhabitants. Comprehensive analysis of changes in the surface water bodies quality long-term hydrochemical indices monitoring data on the example of mineral composition indices suggests deterioration of the natural-technogenic balance in the river basins and loss of their resource capacities as well as assimilation potential. Indices of ecological-resource capacities excess for the Siverskyi Donets River main inflows of Samara and Kalmius are defined based on the previous evaluation of the growth of additional pollution impact on the surface sources, which are used for drinking water supply, caused by the mines flooding and uncontrolled leakage of mineralized and polluted water. Use of geostatistical methods of water bodies monitoring data interpolation in GIS and advanced method of surface water quality data processing in classes and categories is suggested. Given forecasting estimates of surface water quality both from central water supply sources and near the backup sources based on the GIS-technologies confirm the necessity of a gradual transition to the given region water supply from the underground protected aquifers beyond the mines flooding and polluted water transfer areas.

Keywords: GIS, surface water pollution, assessment, environmental protection, industrial water, drinking water

1. INTRODUCTION

Ecological equilibrium and safety of Donbas during its industrial history in XIX-XX centuries before the widespread flooding of mines (like in Ruhr - Germany, Wales - Great Britain) based on the regional decrease in the groundwater level in the process of its pumping out of the mines as the main factor of the coal mining ecological-technogenic security.

Nowadays the biggest ecological-technogenic, social and economical threats for the Donetsk-Prydniprovsk region population arise in the ecologically imbalanced shut-down of mining companies. It is connected to accelerated flooding of mine workings and groundwater level rise in the depression watering can periphery part beyond mining allotments on the adjacent territories, which are 3-5 times bigger (up to 200-300 km²) (Anpilova et al., 2020;

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Hunchenko et al., 2020; Telyma et al., 2020a; Telyma et al., 2020b; Trofymchuk et al., 2019; Trofymchuk et al., 2020; Yakovliev & Chumachenko, 2017). The environmental hazard of the region is conditioned by flooding areas development, additional surface subsidence, polluted mineralized water and explosive and toxic gas (methane, radon, hydrocarbon) migration increasing, as well as by depleting waterproof (low permeable) layers which have divided mineralized and fresh-water aquifers. At that, groundwater and ground pollution surface centres can get in the mainly freshwater zone of active water exchange and actively move to rivers, sources and water intakes spreading the environmental risk area. In practice, it can result in disabling surface and underground water supply systems. Uncontrolled development of these processes is mostly irreversible.

2. PROBLEM STATEMENT

Nowadays, surface water vulnerable to pollution is the major source for drinking water supply in the Donetsk-Prydniprovsk region. According to the report data from the Centre for Humanitarian Dialogue and a range of research institutions (2015), the surface hydraulic Donbas Water complex is (85-90%) based on the use of the Syverskyi Donets River surface flow with little involvement (10-15%) of groundwater (Report, 2019; Regional Reports, 2017).

Mine-water is characterised with high mineralization (3-4 g/l) and a large amount of organic-chemical pollution (heavy metals, oil products, etc.) which dangerously deteriorate surface water ecosystems quality as illustrated by persistent degradation of sanitary chemical indices of water samples. Long-term coliphages presence, the concentration of which was tens of times higher than acceptable level (episodic data provided by the Donetsk regional sanitary and epidemiological service during 2000-2013 years) was observed in the selected water samples during 2010-2012 years (before active flooding of mines - more than 50%) in cities and towns as well as in villages. In 2017 1,83% of 4968 studied samples from the central drinking water supply systems on microbiological indicators did not meet the requirements of the State Sanitary Rules and Regulations 2.2.4.171-10 “Hygienic requirements for drinking water intended for human consumption” and DSTU 7525:2014 “Drinking water. Quality control requirements and methods”. Compared to 2016, percentage of samples which did not meet the health and hygiene standards on microbiological indicators (common coliforms) reduced by 1,47% (in 2016 the percentage of non-standard samples was 3,3%). At that, the highest percentage of non-standard samples from plumbings on microbiological indicators is detected in Novoposkov (5,8%), Bilovodsk and Popasna (3,2% in each), Stanytsia-Luhanska (2,6%), Bilokurakyn (2,1%) rayons and in the city of Lysychansk (4,4%). The increasing number of cases of diarrhoeal diseases conditioned by consumption of low-quality drinking water, especially among children and young people during the last years demonstrate its significant deterioration (Yakovliev, 2015; Rudko & Bondar, 2016; Voloshkina et al., 2007; Lukianova et al., 2020; Anpilova et al., 2020; Trofymchuk et al., 2020; Yakovliev & Chumachenko, 2017).

According to the statewide monitoring network, lately, indices of the quality of surface water in the Syverskyi Donets River ecosystem rise significantly as a consequence of mine water flow, growth of irregular precipitations and deterioration of effluents cleansing. The average annual concentrations of major pollutants in the water of the Syverskyi Donets River and its inflows (in MAC units) reached critical proportion lately: nitrite nitrogen - <1-14, ammoniacal nitrogen - <1-12, hexavalent chromium - 1-10, manganese - 1-7, copper compounds - 1-5, zinc compounds - 1-2, phenols - 1-3 MAC.

Pumping reduction leads to the regional rise of the groundwater level to dangerous depths and pollution migration to local watercourses. Currently, there are more than 60 mines in the Donetsk-Prydniprovsk region which are put in the mode of practically uncontrolled (self-rehabilitation) flooding (so-called “wet conservation”) and hydraulically create a risk of urban agglomeration areas flooding, including the city-forming factor of most mines.

Analysis of the wastewater disposal into the rivers basins shows that its largest volume belongs to the surface water of the Samara River basin water bodies - 95%. The largest volume of the wastewater disposal is formed by the coal mining enterprises - 70% (35,8 mln m³). At the same time, papers from a large number of research studies show that highly mineralized water with unstable chemical composition hurts cardiovascular and gastrointestinal systems functioning, deteriorates water ecological parameters of the vital activities of the population.

Issues of the mines abandoning impact on the ecological situation of the region and its connection to the surface water quality deterioration near drinking water intakes are considered in the papers (Voloshkina et al., 2007; Anpilova et al., 2020; Trofymchuk et al., 2020; Yakovliev & Chumachenko, 2017). Currently, issues of the surface water quality worsening dynamics require additional research concerning the regional rise of groundwater level as a consequence of uncontrolled closure of Donbas coal mines for restructuring and further stable (ecologically balanced) development of the given region.

The objective of the paper is to research changes in the water resources quality near central and reserve water supply sources in the Donetsk-Prydniprovsk region based on the monitoring data and forecasting these changes as a result of the groundwater level rise in the process of unprofitable coal mines mass shut-down.

3. MATERIALS AND RESULTS OF THE RESEARCH

Given that the self-purification capacity index of the water body is an integral component of the separate ingredients concentration change and a tendency for changes in the surface water mineralization depends first of all on human pressure on the environment, water ecosystem anthropization increase was detected on the example of the Syverskyi Donets main flows (Samara and Kalmius Rivers) based on monitoring data long-term indices analysis.

Method of determining the level of technogenic disturbance of the surface water ecosystems natural balance, which is presented by the authors in the paper (Voloshkina et al., 2007; Anpilova et al., 2020; Trofymchuk et al., 2020; Yakovliev & Chumachenko, 2017), when evaluating the long-term technogenic impact on the ecosystem, takes into account a range of constituents namely:

- anthropization part (an additional increase of the hydrochemical index of the water quality index during active agricultural activity in the region);
- level of technogenic disturbance of the water ecosystem, which is the difference between the level of a separate given repeated stabilization index of the considered system and its initial index, while disregarding the maximum index of the index in the given trend;
- exceeding the ecosystem resource capacity, which can be considered by correlation of the maximum figure of a surface water quality separate index to the figure of the system technogenic disturbance level.

Increase of the average mineralization index starting from 1981 for the Samara River is shown in Figure 1.

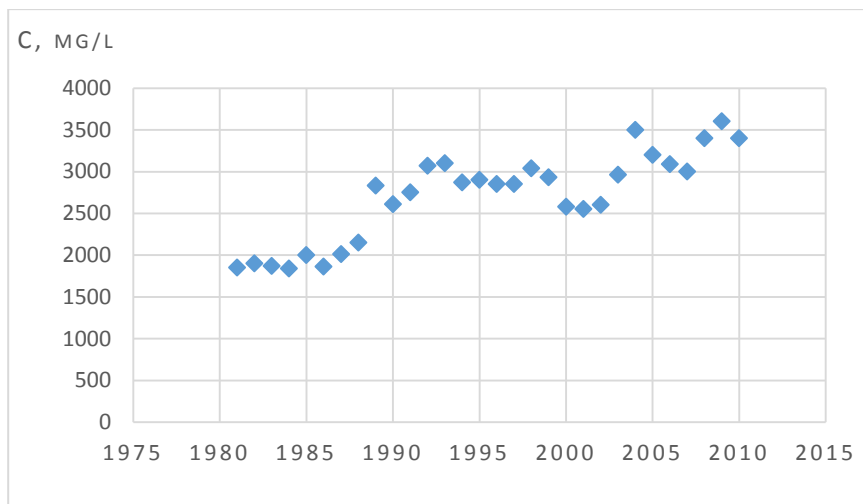


Figure 1. Dynamics of mineralization level increase and level of technogenic deformation of the Samara River system during 1981-2010 years

Thus, analysing the graph in Figure 1 we can state the following:

Up to and including 2002 taking into account the anthropization part for a single year t_i the general equation of the surface water mineralization increase of the Samara River is approximated by the dependency:

$$\frac{d_c}{d_t} = \frac{C_i (t_i + d)}{(t_0 + \gamma \cdot t_i)} \quad (1)$$

where C_i is average annual mineralization of surface water in the i -th year in the corresponding gateway, t_0 is the beginning of observation in the long-term observation cycle, d is the modal coordinate of the period between the maximum observed mineralization index and the distribution centre (the ordinate of the radius of the curve skewness), γ is the dimensionless coefficient which responds to the skewed curve of distribution.

Having integrated the equation (1), we bring the index of the mineralization level for the i -th point in the long-term trend of observations into the form:

$$C_i = C_d \cdot \exp^{-\frac{t_i}{d}} \left(1 + \frac{t_i}{t_0 - t_{max}} \right)^{\frac{t_0 - t_{max}}{d}} \quad (2)$$

where C_d is the mineralization level for the given point.

Taking into consideration the given method, we define that the surface water technogenic deformation level of the Samara River was 1375 mg/l during 1987-2012, the maximum mineralization index in this period was observed in 1993 - 3390 mg/l and the system resource capacity was exceeded in 4,25 times.

Starting with 2003 the mineralization level increases and reaches its previous maximum index in 2010. This fact signals that gradual stable rise of the groundwater level in the region starts in that period as a consequence of mines intensive shut-down and growth of the underground stream unloading into the river flow. Growth of the average mineralization index is approximated by the direct dependency with the approximation index $R^2 = 0,599$.

The analysis of the changes in the surface water quality dynamics on the mineralization index in the Samara River shows the growth of water-ecological hazard and the formation of the unstable hydrochemical system. Analysis by a similar method of monitoring data during the long-term observing period allowed to define the resource capacity exceedance on other hydrochemical indices.

According to the observation data, the Kalmius River water mineralization index in the middle course changed from 1600 mg/l to 2280 mg/l until the year 2013 and reached 7000 mg/l near the city of Mariupol.

In 2017 surface water of the basin gateway in the Kalmius River belonged to the quality class III of the 5th category (satisfactory, moderately polluted) in the mouths of the rivers Kalmius and Kalchik and class III of the 4th category (satisfactory, lightly polluted) based on the water quality composite measure (category). Content of the major mineralization indices, organic, biogenic and specific elements varies within the range of the average long-term indices. Excess of MAC limits is observed for: BOD5 1,5 - 1,8 MAC, ammoniacal nitrogen up to 4,5 MAC, common iron - 2,4 - 2,6 MAC, manganese - 9,6 - 11,2 MAC, copper - 4,6 - 7 MAC, petroleum products - 1,9 - 3,5 MAC, nickel – 3,4 MAC, nitrite up 16 MAC, chrome (VI) - 2,5-4,5 MAC, zinc - 3,7 - 3,9 MAC.

In the upstream of the Kalmius River 2km before the city of Donetsk the resource capacity for ammoniacal nitrogen was exceeded 3,1 times during 1981-2001 (with the general index 230 mg/l) but starting with 2002 this index increased according to polynomial dependency. The index weighted average growth dependency chart between the basic stations 2 km and 3,5 km before the city of Donetsk is shown in the Figure 2.

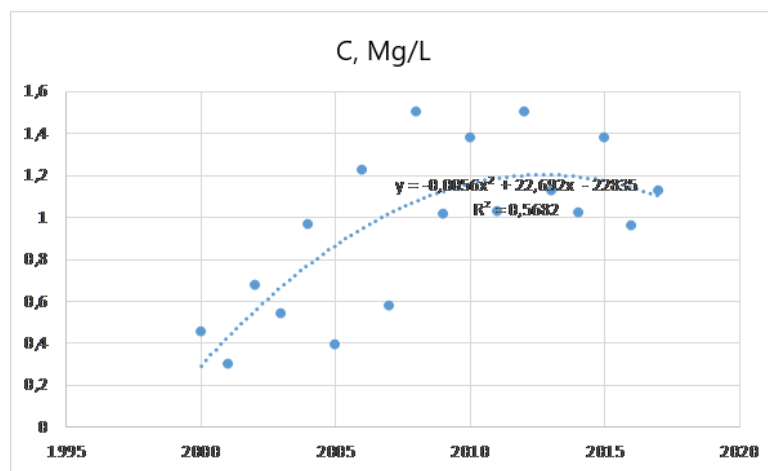


Figure 2. Ammoniacal nitrogen dynamics in the Kalmius River before the city of Donetsk during 2000-2018 years

Monitoring of the state of the drinking water intakes quality which takes place in two basic stations located in the Syverskyi Donets River, Bilohorivka village, 469 km, and the Syverskyi Donets River, Switlytschne village, 406 km has shown the mineralization index 1,2 MAC exceedance and ammoniacal nitrogen index exceedance by 0,25 and 0,36 mg/l accordingly (MAC is 0,5 mg/l).

In our opinion, the given indices of nitrate-ammonium pollution of the Syverskyi Donetsk River flow at selected sites can signal about the relative reduction of technogenic pressure in the river basin.

Thus, the analysis of long-term monitoring data of the surface water resources quality confirms a hypothesis of a great impact of subterranean nourishment on the technogenic deformation level of ecological hydrochemical indices of the river basins.

The chart in the Fig. 3. shows the data reflecting relation between the underground flow coefficient and relative level of technogenic disturbance of water ecosystems environmental balance C' :

$$C' = \frac{(C_r - C_i)}{C_i} \quad (3)$$

C_r is the prevailing level of mineralization, which has been occurring at least during the last several years in the given gateway over the initial C_i .

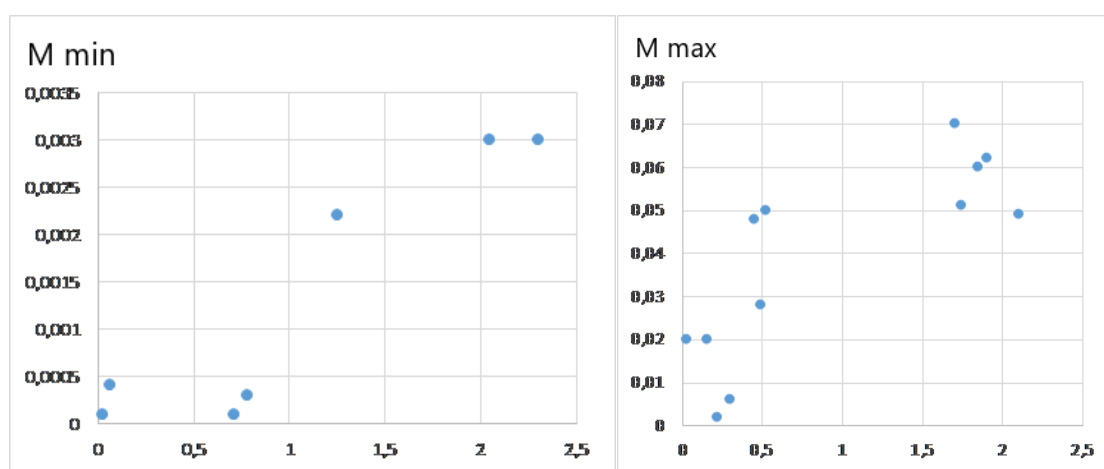


Figure 3. The relation between the relative technogenic disturbance (C') and underground flow coefficient:

left - minimal underground flow coefficient value in the baseflow (M_{min});
right - maximum underground flow values that characterise freshet (M_{max})

The studies only confirm the fact the negative impact from uncontrolled mines shut-down, which occurs nowadays, forms hydraulic-geofiltrational risks of local agglomerations areas flooding as well as leads to the steady tendency for surface water resources quality deterioration.

As far as the local population of the Donetsk and Luhansk regions actively use local dug wells, boreholes and reservoirs beyond the Donbas Water central water supply system, the urgent need in evaluating the environmental state of the backup sources of drinking and economic water supply arises taking into account the mines shut-down forecast (Anpilova et al., 2020; Yakovliev & Chumachenko, 2017).

Additionally, established by the KWR Water Research Institute, Netherlands fact of the coronavirus long-term viability in the wastewater (more than 5 days) is in our opinion additional evidence of the urgent need for surface and groundwater monitoring improvement, as well as the increase in the use of the latter resources, taking into consideration their increase security from the surface pollution.

Given above the factors of potential critical deterioration of the water-ecological state in the region beyond the Drinking Donbas Water power and lack of regular monitoring with

defining of additional monitoring research in the critical areas near the backup water supply resources, an urgent need in creating a forecast model based on cutting-edge information technologies has arisen.

To build pollution spatial distribution models and evaluate surface water quality the use of geostatistical methods, which had allowed to receive the interpolation values surface of the pollution level, was suggested by the authors. Relevant maps were built for the whole basin surface water quality changes probability.

At the present stage of critical changes in the Donbas natural-technogenic geosystem as a consequence of mining-geological conditions complication at the uncontrolled mines flooding a complex of the following hazardous processes is being developed:

- flooded areas increase with activation of hazardous landslide, subsidence and other processes;
- destructive surface subsidence, in the surrounding cities and villages boundaries in particular, and the rising threat of critical infrastructure objects and potentially hazardous objects destruction;
- activation of explosive gas migration (methane, radon, etc.);
- technogenic earthquakes occurrence risk due to the growth of flooded mines number;
- acceleration of the pollution migration to the underground and surface sources of drinking and economic water supply.

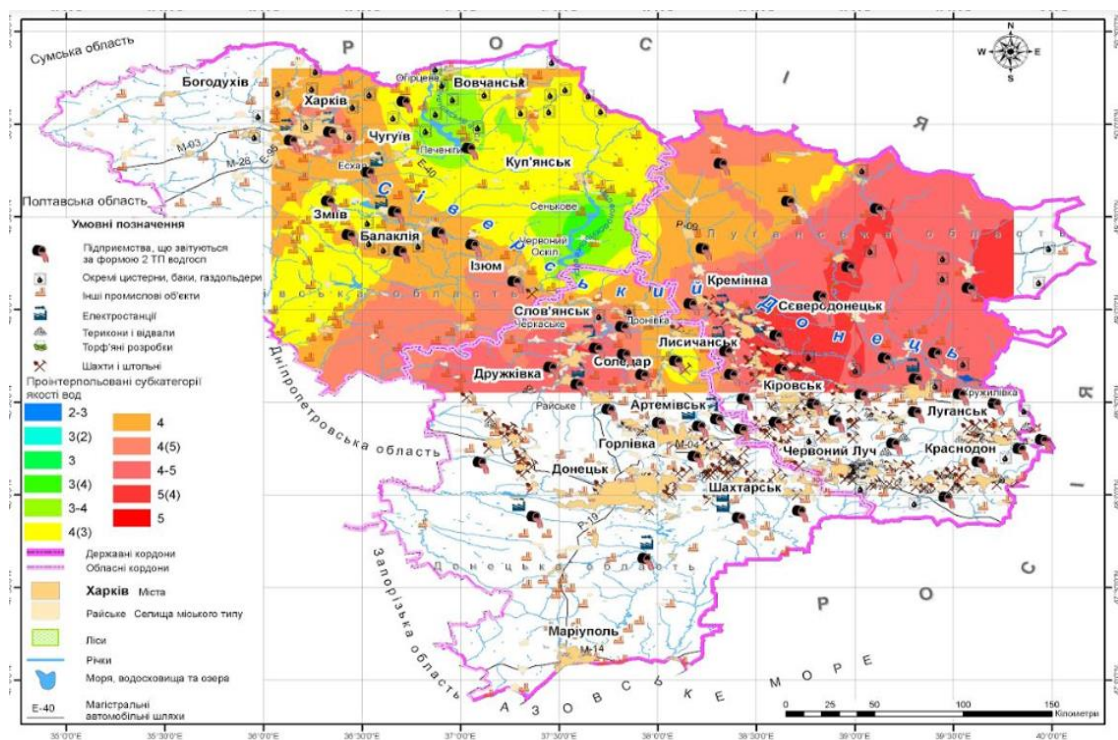


Figure 4. Map of the interpolated indices of the Syverskyi Donets River basin pollution level (as at 2013)

The elaborated GIS-model allows to:

- evaluate and forecast major water ecological threats in the Donetsk and Luhansk regions and set additional monitoring research in the critical areas;
- develop well-grounded overriding measures for the water ecological state stabilization and preventing emergencies;

- analyse current environmental monitoring for compliance with the current requirements and environmental state;
- substantiate gradual transition to the use of better-protected underground aquifers for the drinking water supply needs.

Thus, setting spatial-temporal factors of the mines flooding and uncontrolled mineralized and polluted water leakage from filter storages impact on additional pollution of both surface and underground sources, intended for drinking water supply, condition the needs in additional monitoring research aiming at the improvement of the water ecological situation improvement and its extraordinary deterioration preventing. In the Donbas region emergency probability of a water ecological origin increases in the central drinking water supply objects as a consequence of the formation of additional pollution impact of toxic leachate leakage from industrial and domestic waste polygons, waste pit areas (up to 1500 objects, more than 300 of which are in the combustion process).

4. CONCLUSION

As the research shows, modern control of drinking water quality is mostly connected to the Donbas Water local hydraulic system, while there is a great number of geographically dispersed dug wells, streams and local boreholes the quality of which is not systematically controlled. At the same time intensity of their use grows significantly when the central water supply objects are damaged.

Hydrochemical analysis of surface water monitoring data in the areas of mines flooding impact and reserve water supply sources given the flooding temporal dynamics shows stable growth of water resources pollution and their quality deterioration according to the standards for drinking water supply resources.

Analysis of the current environmental monitoring for compliance with the current requirements and environmental state of the water ecological threats at the water resources of the Donetsk and Luhansk regions shows the necessity of setting additional monitoring research in the critical areas of mines flooding groups taking into account additional mutual influence of surface and groundwater. Geospatial models of the surface and groundwater objects quality and the subsoil ecological-geological state with a predominance of their irreversible disturbance are basic for regulating water consumers' activities; providing reasonable natural resource utilization measures; informing relevant authorities and population about possible hazardous water ecological situations on the local level as well as on the state level.

Taking into consideration critical destruction of the integral system of monitoring of geological environment and surface water objects ecological state in the region, and in case of complications, while carrying out traditional land ecological monitoring (for example on the territories where the armed conflict takes place), Earth remote sensing technologies (interferometry, multispectral imaging, etc.) in our opinion are the only method of detecting dangerous changes in the ecological state of subsoil at the initial stages of the impact of mines flooding.

That is why it is necessary for the Donetsk-Prydniprovsk regions water management system to forecast improvement of the water ecological monitoring of drinking and economic water supply resources (terrestrial and remote methods, mathematical and full-scale modelling, etc.) as well as coordinated with the mines shut-down process transfer to the increasing water supply of the given region from the underground, better-protected aquifers.

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ECOLOGICAL ASSESSMENT OF THE CONDITION OF THE OGOSTA RIVER, DANUBE RIVER BASIN, BULGARIA

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Abstract: The Ogosta River is one of the biggest right tributaries of the Danube River Basin, Bulgaria. The lowest section of the river ecosystem is a part of protected area BG0000614 "River Ogosta" for the conservation of natural habitats. The ecological assessment is performed based on the main biological quality elements: macrozoobenthos, helminths and helminth communities of *Squalius cephalus* (Linnaeus, 1758). Bioindicator macrozoobenthos fauna (Biotic and Saprobic indices, EQR) indicated moderate ecological condition in a studied freshwater ecosystem. As a result of ecologohelminthological examinations of 11 specimens of chub, four species of helminths were found. They are reported for the first time of the freshwater ecosystem of the Ogosta River. *Allocreadium isoporum* (Looss, 1894) is a core species (P%=45.45%) and *Ligula intestinalis* (Linnaeus, 1758), *Rhabdochona denudata* (Dujardin, 1845), *Acanthocephalus lucii* (Müller, 1776) are component species for the helminth communities of the chub. The determined helminth species and the helminth communities indicated the biodiversity of the ecosystem, its nutrition relationships and ecological status. The results of the study are grounds for taking measures for the effective management of the freshwater ecosystem.

Key words: bioindication, macrozoobenthos, helminths, helminth communities, *Squalius cephalus*, Danube River Basin

1. INTRODUCTION

Ogosta River is one of the six largest right tributaries of the Danube River, North-western Bulgaria. The Ogosta river valley is characterized by great biological diversity. The lower sections of the river is a part of the Protected Zone BG0000614 "River Ogosta" for the conservation of natural habitats (Directive 92/43 / EEC). The river is subject to anthropogenic impacts - extraction of limestone and aggregates for construction needs. The waters of the river are used for irrigation and the development of an agriculture. The water resources of the river are used for the operation of four hydroelectric power plants. The river is an object of intensive tourism, an attractive place for fishing and water sports, etc. (Geography of Bulgaria, 2000; Penin, 2007).

The river ecosystem is the subject of research and inventory of biological diversity under the program NATURA 2000 (NATURA 2000). One of the main biological elements of the river is the ichthyofauna, represented by about 24 species of freshwater and passable fish

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(Trichkova et al., 2009). The Ogosta River is part of the environmental monitoring system in Bulgaria. There is research on the biological diversity of macrozoobenthos and ichthyofauna. They concern some of its elements and assessment of the ecological condition (Uzuniov & Kapustina, 1993; Trichkova et al., 2007; Trichkova et al., 2009; Zarev et al., 2013; Kenderov et al., 2014; Stoyanova & Traykov, 2014, Soufi et al., 2018, etc.), carried out in different sections of the river ecosystem.

Parasites and parasitic communities are important bioindicators because, as elements of biodiversity in the aquatic habitat, they are affected either directly by it or through their hosts. For the most part, fish parasites have complex life cycles and are thus closely linked to the biodiversity of the aquatic ecosystem, but are often overlooked as a biological element for ecological assessment. Some parasites accumulate pollutants and affect free-living bioindicators, the physiology and behavior of both their hosts and the ecological parameters of their populations and communities. The use of parasites and parasitic communities of fish increases the effectiveness of environmental monitoring programs (Kuperman, 1992; Sures, 2004; Nachev, 2010; Vidal-Martínez et al., 2010; Palm, 2011, etc.). Parasite communities have not been studied from freshwater fish from the Ogosta River, as well as as elements for bioindication.

The study presents the results of the ecomonitoring studies for the ecological assessment of the Ogosta River, downstream, based on the biological quality elements: macrozoobenthos, parasites and parasitic communities of *Squalius cephalus*.

2. MATERIAL AND METHODS

The Ogosta River begins with the Chiprovska River, which springs below Vrazha Glava Peak, Chiprovska Mountain as part of the Stara Planina mountain, at 1760 m above sea level. The river is 141.1 km long and the catchment area is 3157.1 km². It flows into the Danube River at the 685th km, at 27 m above sea level. The present study was carried out in the last sections of the lower reaches of the river, just before its confluence with the Danube River. The lower reaches of the Ogosta River belong to the river type R7: Large tributaries of the Danube (Belkinova et al., 2013).

A total number of taxa, abundance, species diversity index (H, Shannon-Weaver species diversity index), Rhithron Feeding Type Index (PETI index), Saprobic Index (SI), Biotic Index (BI) and Ecological Quality Assessment (EQR) are determined based on the biological element macrozoobenthos, according to the methods and international standards of sampling and examination (Belkinova et al., 2013; Peev & Gerassimov, 1999; Rusev, 1993).

The chub (*Squalius cephalus* (Linnaeus, 1758); Cyprinidae) was chosen as a model and bioindicator fish species to examine the intestinal parasite and parasite communities. Eleven specimens (N = 11) of *Sq. cephalus* were caught by angling from the Ogosta River and were object of the ecologoparasitological study. For species determination, permanent microscope slides were prepared from the representatives of classes Trematoda and Cestoda, using methods reported by Georgiev et al. (1986); Scholz & Hanzelova (1998) and temporary slides – from representatives of Acanthocephala and Nematoda using glycerol (Zashev & Margaritov, 1966; Moravec, 2013). The species determination is based on Petrochenko (1956); Zashev & Margaritov (1966); Scholz & Hanzelova (1998); Kakacheva-Avramova (1983); Bauer (Ed.) (1987); Moravec (2013). The number of infected fish specimens (n), the number of parasites (p), prevalence (P%), mean intensity (MI) are calculated for each species of intestinal parasites. The component communities are described on the base of prevalence (P% > 20 - core species; 10 < P% < 20 - component species; P% < 10 - accidental species;

Kennedy, 1997). Based on the criteria: total number of species, total number of parasites, Brillouin's diversity index (HB), infrastructure communities were analyzed (Magurran, 1988). The ecological and environmental terminology was used according to Bush et al. (1997); Rosenberg & Resh (1997); Maguran (1988); Margolis et al. (1982). The biodiversity measures are calculated using the software products Statistica 10 (Statsoft Inc., 2011) and MS Excel (Microsoft 2010).

3. RESULTS

3.1. BIOMONITORING BASED ON A BIOLOGICAL ELEMENT MACROZOOBENTHOS

According to the results of the committed hydrobiological monitoring, 14 bioindicator macrozoobenthos taxa were found. A total of 117 specimens were studied and determined (Table 1).

Table 1. Ecological characteristics of biological element macrozoobenthos from the Ogosta River

Taxa	Abundance	Group of sensitivity	Group of saprobity
OLIGOCHAETA <i>Tubifex tubifex</i> (Mueller, 1774)	3	E	p
CRUSTACEA <i>Dickergammarus villosus</i> (Sowinsky, 1894)	9	C	β - α
<i>Aselus aquaticus</i> (Linneus, 1758)	2	D	α
MOLLUSCA <i>Lynaea stagnalis</i> (Linnaeus, 1758)	5	D	β
<i>Physella acuta</i> (Draparnaud, 1805)	1	D	α
HIRUDINEA <i>Erpobdella octoculata</i> (Linnaeus, 1758)	3	D	α
<i>Glossiphonia complanata</i> (Linnaeus, 1758)	4	B	β - α
<i>Helobdella stagnalis</i> (Linnaeus, 1758)	4	C	β - α
ODONATA <i>Gomphus</i> sp.	9	D	β - α
TRICHOPTERA <i>Hydropsyche</i> sp.	12	B	β - α
<i>Leptocerus</i> sp.	7	B	β
<i>Hydroptilia</i> sp.	4	C	β
<i>Stenophylax</i> sp.	5	C	0- β
DIPTERA Chironomidae	49	D	P

The representatives of Chironomidae are established with the highest abundance (49 specimens), followed by those of *Hydropsyche* sp. (12 specimens). All other taxa are represented with less than ten specimens (Table 1).

The identified bioindicator taxa refer to five groups of saprobity: 0- β (5 specimens); β (16 specimens); β - α (38 specimens); α (6 specimens); p (51 specimens). The p and β - α groups of saprobity stand out with the largest number of specimens. The saprobity group 0- β was presented with the lowest number of specimens (Table 1).

The identified bioindicator taxa belong to 4 groups of sensitivity: Group B (less sensitive forms; 23 specimens); Group C (relatively tolerant forms; 22 specimens); Group D (tolerant forms; 69 specimens) and Group E (most tolerant forms; 3 specimens). The bioindicator macrozoobenthos taxa from sensitivity group D clearly dominated (Table 1).

The basic ecological characteristics of the determined macrozoobenthos taxa (Total No. of taxa = 14; H = 1.68; %EPT = 23.93; PETI = 0.58; BI(EQR) = 3.5(0.7); SI = 2.34) from the Ogosta River showed moderate ecological status according the rule “one out – all out”.

3.2. FISH COMMUNITIES

The chub (*Squalius cephalus* (Linnaeus, 1758); Cyprinidae) is one of the most abundant freshwater fish species in the downstream of the Ogosta River. The species inhabits the lower and middle reaches of the rivers and is widespread in Bulgaria. It prefers sections of rivers with gravel and sandy bottom. The chub is omnivorous, typically diurnal fish (Fröse & Pauly, 2019). *Sq. cephalus* is included in the list of IUCN as least concern species (LC=Least Concern; IUCN Red List Status, 2019). The chub is not a protected species in the country. All examined eleven fish specimens are infected with intestinal parasites.

3.3. BIODIVERSITY AND HELMINTH COMMUNITIES OF BLACK BARBEL (BARBUSPETENYIHECKEL, 1852) FROM OGOSTA RIVER

As a result of ecologohelminthological study of 11 specimens of chub from the Ogosta River, four species of helminths were found, belonging to four classes, orders, four families. A total of 13 helminth specimens were studied for its species determination (Table 2).

Table 2. Biodiversity and basic ecological indices on helminth communities of *Sq. cephalus* from Ogosta River

Ecological indices (N = 11) Species of helminths	N	P	P%	MI
Class Trematoda Order Fasciolida, Family Allocreadidae				
<i>Allocreadium isoporum</i> Ergens & Lom, 1970	5	38 1-13	45.45	7.6
Class Cestoda Order Pseudophyllidea, Family Ligulidae				
<i>Ligula intestinalis</i> (plerocercoid) (Linnaeus, 1758)	2	2	18.18	1
Class Acanthocephala Order Echinorhynchida, Family Echinorhynchidae				
<i>Acanthocephalus lucii</i> (Müller, 1776)	3	5 1-3	27.27	1.67
Class Nematoda Order Spirurida, Family Rhabdochonidae				
<i>Rhabdochona denudata</i> (Dujardin, 1845) Railliet, 1916	3	8 2-4	27.27	2.67

The developmental life cycles of the identified parasite species are presented (Kakacheva-Avramova (1983); Bauer (Ed.) (1987)); Moravec (2013). The following circulation of the parasitic flow was established:

A. Trematoda

1. Mollusca (*Sphaerium*) – Insecta, larvae (*Ephemera*, *Anabolia*, *Chaetopterix*) – Freshwater fish (Cyprinidae) – *Allocreadium isoporum*.

B. Cestoda

1. Crustacea (*Cyclops strenuus*, *Acanthocyclops bicuspidatus*, *Megacyclops viridis*, *Eucyclops serrulatus*, *Diaptomus gracilis*) – Freshwater fish (Cyprinidae) - Fish eating birds - *Ligula intestinalis*.

C. Acanthocephala

1. Crustacea (*Asellus aquaticus*) - Freshwater fish (Cyprinidae) - *Acanthocephalus lucii*.

D. Nematoda

1. Insecta, larvae (*Heptagenia*, *Ephemerella*, *Hydropsyche*) - Freshwater fish - *Rhabdochona denudata*.

The representatives of the genus *Ephemera*, the species *Eucyclops serrulatus* (Fischer, 1851) and *Megacyclops viridis* Jurine, 1820 are bioindicators for 0-β mesosaprobity. The representatives of the genera *Anabolia*, *Ephemerella* and *Hydropsyche* are bioindicators for 0-α mesosaprobity. The intermediate hosts of *Chaetopterix* and the species *Acanthocyclops bicuspidatus* (Claus, 1857) are bioindicators for 0-saprobity. Only the intermediate hosts from the species *Cyclops strenuus* Fischer, 1851 are bioindicators for β-α-mesosaprobity (Rosenberg & Resh, 1997).

The parasites of freshwater fish from the Ogosta River were studied by Kakacheva-Avramova (1969). Four species of parasites were also registered in this study: *Caryophyllaeus brachycollis* Janiszewska, 1951; *Caryophyllaeides fennica* (Schneider, 1902) Nybelin, 1922; *Pomphorhynchus laevis* (Müller, 1776) and *Rhabdochona denudata* (Dujardin, 1845) Railliet, 1916.

A common species of the parasite in the two study is only *Rh. denudata*. In this study, only *Rh. denudata* was found as endohelminth species in examined specimens of *Sq. cephalus* from the Ogosta River. This gives us reason to report helminth species *A. isoporum*, *L. intestinalis* and *A. lucii* as new to the helminth fauna of freshwater fish from the Ogosta River. *Sq. cephalus* was reported as a host for the helminth species *A. isoporum*, *L. intestinalis* and *A. lucii* from other freshwater ecosystems in Bulgaria.

3.4. COMPONENT COMMUNITIES

Al. isoporum, *Ac. lucii* and *Rh. denudata* are a core species of the helminth communities of the chub from the Ogosta River. *Al. isoporum* is distinguished with the highest prevalence ($P\% = 45.45$). The other two species have the same prevalence ($P\% = 27.27$). *L. intestinalis* is a component species of the helminth communities of the chub from the river. With the highest mean intensity is the populations of *Al. isoporum* ($MI = 7.6$), followed by this of *Rh. denudata* ($MI = 2.67$). With the lowest mean intensity was distinguished *L. intestinalis* ($MI = 1.0$) – two specimens of the plerocercoids in two fish specimens (Table 2).

Only for *L. intestinalis*, *Sq. cephalus* is an intermediate host. *L. intestinalis* is an allogenic species for the helminth communities of chub from the Ogosta River. All other helminth species are autogenic species and *Sq. cephalus* is a definitive host for them. All determined helminth species are generalists for the helminth communities of the chub from the lower reaches of the river.

3.5. INFRACOMMUNITIES

The infection was fixed for all examined fish specimens. One species of helminth was found in eight fish and two species – in three specimens of examined chubs. The Brillouin's diversity index is low ($HB = 0.432$) probably due to the poor species diversity (four helminth species) represented by the low mean intensity (from $MI_{L. intestinalis} = 1.0$ to $MI_{Al. isoporum} = 7.6$) (Table 3).

Table 3. Infracommunities of *Sq. cephalus* from Ogosta River

Total number of species	4	
Number of fish	8	3
Number of helminth species	1	2
Total number of specimens	13	
Mean \pm SD	4.82 \pm 4.28	
Rang	1 – 13	
HB (Brillouin's diversity index)	0.432	

No helminths or other pathogens have been identified to cause severe diseases in aquatic organisms or in humans, in contrast to serious diseases, identified by other authors (Pekova et al., 2017; Pekova et al., 2019; Mitev & Chakarova, 2020, etc.).

4. CONCLUSION

Ecological monitoring studies were committed for ecological assessment of the downstream of the Ogosta River based on the biological quality elements: macrozoobenthos, parasites and parasitic communities of the chub (*Sq. cephalus*). Fourteen macrozoobenthos taxa were identified, represented by 117 specimens. Based on the core ecological characteristics of the macrozoobenthos communities, a moderate ecological status of the river in the studied area was determined. Eleven specimens of chub were studied. Four species of parasites were found. *A. isoporum*, *L. intestinalis* and *A. lucii* are reported as a new species of the helminth fauna of freshwater fish from the Ogosta River. The pathways of circulation of the parasitic flow are outlined, reflecting the connection with the state of the free-living organisms in the studied part of the ecosystem. The main species of the helminth communities is *A. isoporum*, represented with the highest prevalence and mean intensity (P% = 45.45 and MI = 7.6, respectively). The dominance of *A. isoporum* closely correlated to the distribution and abundance on the representatives of Mollusca and Insecta, intermediate hosts for this helminth species.

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BIODIVERSITY AND ECOLOGICAL ASSESSMENT OF THE FRESHWATER ECOSYSTEM OF THE OSAM RIVER, BULGARIA

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Abstract: Biological monitoring of the Osam River, Danube Water Basin was carried out by analyzing the biological quality elements for environmental assessment: macrozoobenthos; parasites and parasite communities of the *Barbus petenyi*, Heckel, 1847. Fifteen bioindicator macrozoobenthos taxa with 108 specimens are found. The Shannon-Weaver diversity index, the total number of taxa, Biotic index, EQR and RETI indices showed a good ecological status in the studied biotope. As a result of ecoparasitological studies of 30 specimens of *B. petenyi*, five species of parasites was found. *B. petenyi* is reported as a new host record for *I. pileatus* in Bulgaria. The Osam River is a new habitat for the five helminth species of *B. petenyi*. *I. pileatus*, *P. laevis* and *R. hellichii* are core species for the helminth communities of *B. petenyi* from the Osam River. *I. pileatus* (53.18 specimens) followed by *Rh. hellichii* are with the highest mean intensity (7.45 specimens). A total of 14 specimens of *B. petenyi* are free of parasites (46.67%). The Brillouin's diversity Index is $HB = 0.683$. Pielou's evenness index is low due to the obvious dominance of one of the found parasite species (*I. pileatus*), both in prevalence and mean intensity.

Keywords: bioindication, Black barbell, Danube River Basin, helminth communities, macrozoobenthos

1. INTRODUCTION

Osam River refers to the river type R7: Large tributaries of the Danube River (Danube Water Basin, Northern Bulgaria). It is the longest Balkan Mountain's River (314 km). The river is formed north of the town of Troyan at 311 m above sea level and flowing as a right tributary into the Danube River (599th River km) at 22 m above sea level. The waters of the river are using for irrigation, as the main source for drinking, domestic and industrial water supply, electricity production and more. The river is influenced by anthropogenic impacts (industrial pollution, etc.) (Pandakov et al., 2017). At the same time, the freshwater ecosystem of the Osam River and its adjoining territories are distinguished by high biodiversity, in connection with which protected zones (BG0002102 "Devetashko Plato" and BG0002088 "Mikre" – Directive 79/409 EEC; BG0000615 "Devetashko Plato" and BG0000616 "Mikre" - Directive 92/43 EEC), as well as a number of protected territories (Biodiversity Act; Protected Areas Act; Natura 2000) are announced. Studies on biodiversity, and especially on the ecological status of the river ecosystem, are extremely limited. There are a few scientific

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examinations on the biodiversity of freshwater fish and the ecological status of ichthyocenoses, as well as on macrozoobenthos from the Osam River (Vassilev & Pehlivanov, 2005; Pehlivanov et al., 2012; Hubenov et al., 2013; Tyufekchieva et al., 2013; Zarev et al., 2013; Soufi et al., 2018, etc.). There are no reports of parasites and parasite communities of fish from the river.

The results of the researches on the ecological status of the Osam River (surroundings of the town of Lovech), performed based on the Biological Quality Elements: macrozoobenthos, parasites and parasite communities of the Balkan (Black) barbel are presented.

2. MATERIAL AND METHODS

Hydrobiological monitoring was carried out by analyzing the Biological Quality elements for environmental assessment: macrozoobenthos; parasites and parasite communities of the Balkan (Black) barbel (*Barbuspetenyi*, Heckel, 1847). The samples of macrozoobenthos and Balkan barbel are collected near to the town of Lovech (Central Northern Bulgaria; 43°07'42.59N; 24°43'17.27E).

For the ecological assessment based on the biological element macrozoobenthos, a total number of taxa; abundance of benthic macroinvertebrate fauna; species diversity index (H, Shannon-Weaver species diversity index); Rhithron Feeding Type Index (RETI index); Saprobic Index (SI); Biotic Index (BI); Ecological Quality Assessment (EQR) are determined. Sampling and processing of samples were carried out by the requirements of the approved international standards (Belkinova et al., 2013; Peev & Gerassimov, 1999; Rusev, 1993).

Thirty specimens (N = 30) of the Black barbel from the Osam River were examined for parasites by standard methods. Fish were caught by fishing rod in compliance with the Law on Fisheries and Aquaculture in the Republic of Bulgaria. From representatives of Trematoda and Cestoda, permanent microscope slides were prepared by methods, reported by Georgiev et al. (1986); Scholz & Hanzelova (1998). Nematodes and acanthocephalans were examined on temporary microscope slides after enlightening in glycerol (Petrochenko, 1956; Zashev & Margaritov, 1966). The parasitological examinations and species determination follows Petrochenko (1956); Zashev & Margaritov (1966); Scholz & Hanzelova (1998); Kakacheva-Avramova (1983); Bauer (Ed.) (1987); Moravec (2013). For each helminth species, the number of infected hosts (n), the number of parasites (p), prevalence (P%), mean abundance (MA) and mean intensity (MI) are calculated. The component community is also characterized by dividing the species into core (P% > 20), component (P% > 10) and accidental (P% < 10) (Kennedy, 1997). Infrastructure communities were analyzed based on the criteria: total number of species, total number of parasites, Brilloun's diversity Index (HB) and Pielou's evenness index (Magurran, 1988). The ecological and environmental terminology was used by Bush et al. (1997); Rosenberg & Resh (1997); Magurran (1988); Margolis et al. (1982); Marcogliese & Cone (1987), etc. Calculation of the diversity measures was performed by software products Statistica 10 (Statsoft Inc., 2011) and MS Excel (Microsoft 2010).

3. RESULTS

3.1. BIODIVERSITY AND BIOINDICATION BASED ON A BIOLOGICAL ELEMENT MACROZOOBENTHOS

For the studied biotope from the freshwater ecosystem of the Osam River (town of Lovech), 15 bioindicator macrozoobenthos taxa are determined. A total of 108 specimens bioindicator organisms are studied (Figure 1).

Gammarus pulex (Linnaeus, 1758) (Arthropoda; Malacostraca; Gammaridae) (41 specimens) is distinguished with the highest abundance, followed by *Serratella ignita* (Poda, 1761) (= *Ephemerella ignite* Poda, 1761; Arthropoda; Ephemeroptera; Ephemerellidae) (17 specimens). All other taxa are represented in lower than ten specimens (Figure 1).

The established taxa are divided into groups of saprobity. There are four saprobity groups. With the highest number of taxa and the number of specimens is distinguished the group of the β -mesosaprobity organisms - 11 taxa with 56 specimens, followed by the number of taxa for 0- β -mesosaprobity (2 taxa). The other two groups (0- α and χ -p) are distinguished by on one taxon, but the χ -p-saprobity organisms are represented by a higher number of specimens - 41 specimens (Table1).

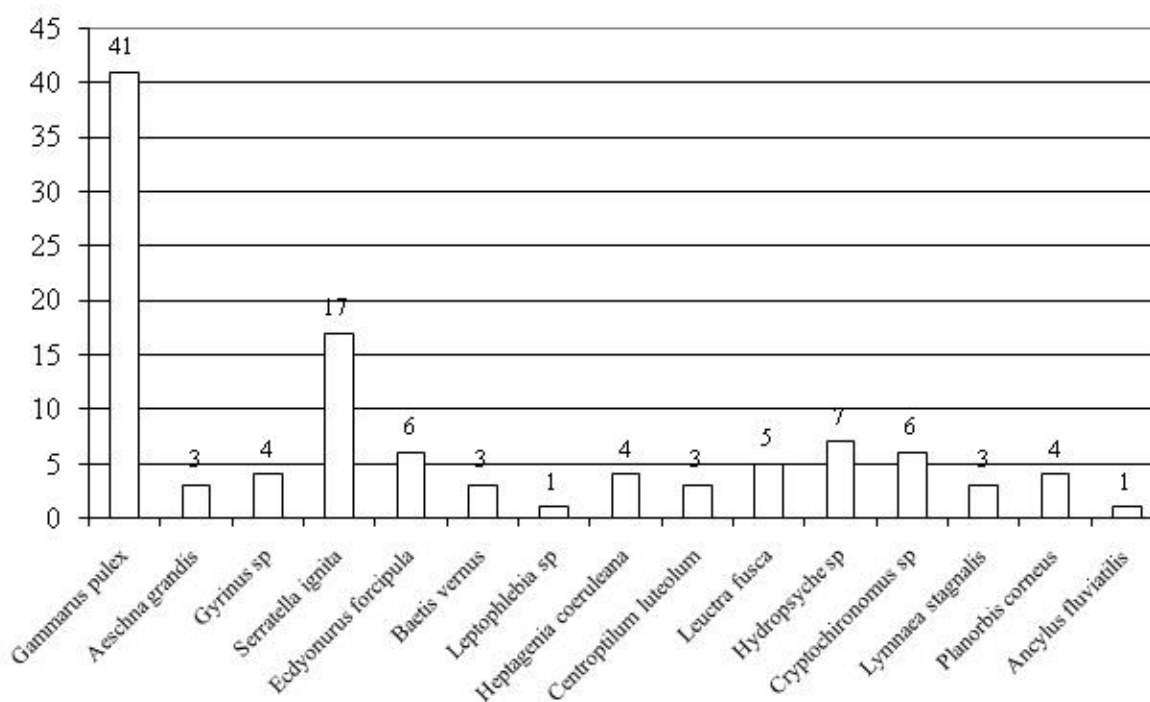


Figure 1. Abundance of macroinvertebrate bioindicator species

Table 1. Bioindicator taxa by saprobity groups

Number	Saprobitygroups			
	0 – β	0 – α	β	χ – p
Taxa (Specimens)	2(7)	1(4)	11(56)	1(41)
Total 15(108)				

The determined taxa are divided into groups of sensitivity. Taxa from 4 sensitivity groups are identified: Group A (Sensitive forms); Group B (Less sensitive forms); Group C (Relatively tolerant forms) and Group D (Tolerant forms). The highest number of taxa distinguishes Group B (7 taxa) and the highest number of specimens - Group C (51 specimens) (Table 2).

Table 2. Bioindicator taxa by sensitivity groups

Number	Group A Sensitive forms	Group B Less sensitive forms	Group C Relatively tolerant forms	Group D Tolerant forms
Taxa (Specimens) Total 15(108)	1(1)	7(43)	4(51)	3(13)

The Shannon-Weaver Diversity Index ($H = 2.15$) testifies to β -mesosaprobic conditions in the studied biotope of the freshwater ecosystem of the Osam River. The total number of taxa (TNT = 15), Biotic index (BI = 4), EQR index (EQR = 0.8) and RETI index (RETI = 0.79), determined based on the obtained results and the applied methodology for hydrobiological monitoring, shows a good ecological status of the Osam River in the studied biotope. Only the determined Saprobity index (SI = 1.41) shows a very good ecological status. According to the „one out - all out” rule, the total ecological status is good (Table 3).

Table 3. Basic ecological characteristics of bioindicator fauna

Ecological characteristics					
Total number of taxa	Total number of specimens	SI	BI (EQR)	H	RETI
15	108	1,41	4(0,8)	2,15	0,79

3.2. FISH COMMUNITIES

The Balkan (Black) barbel (*Barbus petenyi* Heckel, 1852; Cyprinidae) inhabit the upper and middle parts of the rivers. *B. petenyi* inhabits demersal layers of the aquatic ecosystems. In the spring it moves to deeper habitats and in summer - to higher and faster streams. The Balkan barbell is a passive type of fish. Usually, the passage involves fish of the same age group that is they were the same size when they caught. The colouring of the body is directly related to the environment. The species propagated between May and July. It feeds on larvae of Chironomidae, Trichoptera, Ephemeroptera, and plant substrates. It is growing slowly but is subject to sport fishing. The Black barbel is a typical fish species in the Danube Water Basin (Karapetkova & Zhivkov, 2006; Kottelat & Freyhof, 2007). *B. petenyi* is included in Annexes 2 (species whose habitats are to be protected) and 4 (species with limited use of natural habitats) of the Biodiversity Act. The Black barbel is included in the IUCN list as a least concern species (= LC = Least Concern; IUCN), as well as in the Bern Convention.

3.3. BIODIVERSITY AND HELMINTH COMMUNITIES OF BLACK BARBEL (*BARBUS PETENYI* IHECKEL, 1852) FROM OSAM RIVER

As a result of ecoparasitological studies of 30 specimens of *B. petenyi* from the Osam River, five species of parasites were found, belonging to 5 classes, five orders and five families. A total of 724 specimens of parasites were studied for their species determination (Table 4).

Definitive hosts of *Allocreadium isoporum* Ergens & Lom, 1970 are fish species from Cyprinidae (*Squalius cephalus* (= *Leuciscus cephalus*), *Leuciscus idus*, *Barbus barbus*, *Barbus m. petenyi*, *Abramis brama*, etc.) (Kakacheva-Avramova, 1983; Bauer, 1987). First intermediate hosts are snails and second intermediate hosts of *Ichtyocotylurus pileatus* (Rudolphi, 1802) Dubois, 1937, metacercaria, are fish species from Cyprinidae, Percidae, Cobitidae, Gobiidae, Esocidae, Siluridae, etc. Definitive hosts are species of Laridae (Kakacheva-Avramova, 1983; Sudarikov, 1984; Bauer, 1987). *Caryophyllaeus brachycollis* Janiszewska, 1951 develops with definitive hosts - different species of Cyprinidae. The intermediate hosts are *Limnodrilus hoffmeisteri* Claparède, 1862 and *Tubifex tubifex* (Müller, 1774) (Oligochaeta) (Kulakovskaya, 1961; Kakacheva-Avramova, 1983; Protasova et al., 1990). *L. hoffmeisteri* is a bioindicator for p- α -mesosaprobity and *Tubifex tubifex* - for p-saprobity (Rosenberg & Resh, 1997). The development cycle of *P. laevis* is performed with the participation of an intermediate host of Crustacea - the species *Gammarus pulex* (Linnaeus, 1758) (Amphipoda) (Kakacheva-Avramova, 1983; Bauer, 1987). *G. pulex* is a bioindicator for χ - β -mesosaprobity conditions in relevant habitats (Rosenberg & Resh, 1997). The development of the species also involves reservoir hosts - small fish of Cyprinidae. The definitive hosts for the adults of the species are freshwater fish from Cyprinidae, Salmonidae, Percidae, Siluridae, etc. The developmental cycle of *Rhabdochona hellichi* (Šramek, 1901) Chitwood, 1933, was not completely studied. Final hosts of *Rh. hellichi* are different fish species from Cyprinidae, Salmonidae, Acipenseridae, Siluridae, etc. (Bauer, 1987; Moravec, 2013). All identified endoparasites are intestinal parasites, without the larval forms of *I. pileatus* that are encysted under the serosa of the digestive system and the walls of the bladder of fish from Cyprinidae, Percidae, Cobitidae, Gobiidae, Esocidae, Siluridae, etc. *A. isoporum*, *C. brachycollis*, *P. laevis* and *Rh. hellichi* were reported for the Danube Water Basin (Kakacheva-Avramova, 1983).

Table 4. Biodiversity and basic ecological indices on helminth communities of *B. petenyi* from Osam River

<i>Ecological indices</i> (<i>N</i> = 30) <i>Species of helminths</i>	<i>N</i>	<i>P</i>	<i>P%</i>	MI
<i>Class Trematoda</i>				
<u>Order Fasciolida</u>				
<u>Family Allocreadidae</u>				
<i>Allocreadium isoporum</i> <i>Ergens & Lom, 1970</i>	5	29 1-14	16.67	5.8
<u>Order Strigeidida</u>				
<u>Family Strigeidae</u>				
<i>Ichtyocotylurus pileatus</i> (<i>Rudolphi, 1802</i>) <i>Dubois, 1937, metacercaria</i>	11	585 1-357	36.67	53.18
<i>Class Cestoda</i>				
<u>Order Caryophyllaeidea</u>				
<u>Family Caryophyllaeidae</u>				
<i>Caryophyllaeus brachycollis</i> <i>Janiszewska, 1951</i>	1	1	3.34	1
<i>Class Acanthocephala</i>				
<u>Order Palaeacanthocephala</u>				
<u>Family Pomphorhynchidae</u>				
<i>Pomphorhynchus laevis</i> (<i>Müller, 1776</i>)	6	42 1-26	20	7
<i>Class Nematoda</i>				
<u>Order Spirurida</u>				
<u>Family Rhabdochoniidae</u>				
<i>Rhabdochona hellichi</i> (<i>Šramek, 1901</i>) <i>Chitwood, 1933</i>	9	67 1-35	30	7.45

B. petenyi is reported as a new host record for *I. pileatus*. *I. pileatus* is reported for the first time as a parasite of *B. petenyi* in Bulgaria. The Osam River is a new habitat for *A. isoporum*, *I. pileatus*, *C. brachycollis*, *P. laevis* and *Ph. hellichi* as helminths of *B. petenyi* (Table 5).

The presented developmental cycles of the identified parasite species testify to the following pathways of parasite flow:

A. Trematoda

1. Mollusca (*Sphaerium*) – Insecta (*Ephemera*, *Anabolia*, *Chaetopterix*) - Fish (Cyprinidae) – *Allocreadium isoporum*
2. Mollusca (Valvata) - Fish – Birds - *Ichtyocotylurus pileatus*, metacercaria

B. Cestoda

1. Oligochaeta (*L. hoffmeisteri*; *T. tubifex*) – Fish (Cyprinidae) – *Caryophyllaeus brachycollis*

C. Acanthocephala

1. Amphipoda (*Gammarus pulex*) – Fish (Cyprinidae) – Fish (Cyprinidae, etc.) -

Pomphorhynchus laevis

D. Nematoda

1. Unclear life cycle - Fish (Cyprinidae, etc.) - *Rhabdochona hellichi*.

Only for *I. pileatus*, the Black barbel is an intermediate host. For the all other four parasites (*A. isoporum*, *C. brachycollis*, *P. laevis*, *Rh. hellichi*) *B. petenyi* is a definitive host.

Table 5. Helminths of *B. petenyi* from Osam River, reported by other authors

Species of Helminthes	Localization	Author
<i>Allocreadium isoporum</i> (Loos, 1894)	rivers Mesta and Struma	Kakacheva-Avramova, 1962
	rivers Sjujutljka and Asenitsa	Kakacheva-Avramova, 1965
	river Vycha	Margaritov, 1965
	rivers Vrabnishka, Nishava, Iskrecka and Buchinska	Kakacheva-Avramova, 1969
	Tundzha	Kakacheva-Avramova, 1972
	Rivers in Central and Eastern Balkan Mountain	Kakacheva-Avramova, 1973
	river Shiposhnitsa	Nedeva-Menkova, 1977
	rivers Gradevska and Blagoevgradska Bistritsa	Kakacheva-Avramova&Menkova, 1981
	river Mesta	Kirin, 2001
<i>Ichtyocotylurus pileatus</i> (Rudolphi, 1802) Dubois, 1937, metacercaria	-	-
<i>Caryophyllaeus brachicollis</i> Janiszewska, 1951	Struma, Strumeshnica, Mesta, rivers in Western Balkan Mountain	Kakacheva-Avramova,1962
	Mirkovska, Botunya, Ogosta, Malki Iskar rivers	Kakacheva-Avramova,1969
	Devinska, Syrneska	Kakacheva-Avramova & Menkova, 1978
	BlagoevgradskaBistritsa	Kakacheva-Avramova & Menkova, 1981
	river Mesta	Kirin, 2001
<i>Pomphorhynchus laevis</i> (Müller, 1776)	Mesta, Struma	Kakacheva-Avramova, 1962
<i>Rhabdochona hellichi</i> (Sramek, 1901)	river Iskar	Margaritov, 1959
	Struma, Strumeshnitsa, Mesta	Kakacheva-Avramova, 1962
	rivers in Western Balkan Mountain	Kakacheva-Avramova, 1969
	Rivers in Central and Eastern Balkan Mountain	Kakacheva-Avramova, 1973
	Rivers in Rhodopa Mountain	Kakacheva-Avramova & Menkova, 1978
	Blagoevgradska Bistritsa	Kakacheva-Avramova&Menkova, 1981
	river Mesta	Kirin, 2001

3.3.1. Component communities

I. pileatus, *P. laevis* and *R. Hellichi* are core species for the helminth communities of *B. petenyi* from the Osam River. With the highest prevalence is distinguished *I. pileatus* (P% = 36.67), followed by *Rh. hellichi* (P% = 30) and *P. laevis* (P% = 20). *A. isoporum* is a component species (P% = 16.67), and *C. Brachycollis* is an accidental parasite species (P% = 3.34) for the parasite communities of the Balkan barbel from the Osam River. *I. pileatus* (MI = 53.18) followed by *Rh.hellichi* (MI = 7.45) are with the highest mean intensity. *C. brachycollis* – one specimen in one of the fishes specimens, is with the lowest mean intensity (Table 4). *I. Pileatus* is allogenic species for the freshwater ecosystem of the river and all other helminth species are an autogenic species. All found helminth species are generalists for the helminth communities of the Black barbel.

3.3.2. Infracommunities

A total of 14 specimens of *B. petenyi* are free of parasites (46.67%). With one species are six hosts; with two species – five examined fish; with three species – four barbels and only in one fish are fixed four helminth species. The Brillouin diversity Index is $HB = 0.683$. Pielou's evenness index is low due to the obvious dominance of one of the found parasite species (*I. pileatus*), both in prevalence ($P\% = 36.67$) and mean intensity ($MI = 53.18$) (Table 6).

Table 6. Infracommunities of *B. petenyi* from Osam River

Total number of species	5				
Number of fish	0	1	2	3	4
Number of helminth species	14	6	5	4	1
Total number of specimens	724				
Mean \pm SD	45.25 \pm 89.66				
Rang	1 – 364				
HB (Brillouin's diversity index)	0.683				
E (Pielou's evenness index)	0.432				

Studies on the parasites and parasite communities of *B. petenyi* are very limited. Barus et al. (1997) reported for two species of Monogenea and one species of Nematoda (*Rh. hellichi*) as specific parasites of fish belonging to genus *Barbus*. As a result of 62 examined specimens of *B. m. petenyi* from Lake Ohrid, Stojanovski et al. (2004) reported for 12 species of parasites: *Ichthyophthyrus multifilis*; *Phyllodistomum* sp.; *Ligula intestinalis* (plercercoid); *Cystidicoloides tenuissima*; *Raphidascaris acus*; *Contraecum microcephalum*; *Paracanthocephalus tenuirostris*; *Metechinorhynchus truttae*; *Metechinorhynchus salmonis*; *Acanthocephalus anguillae*; *Pomphorhynchus laevis*; *Pomphorhynchus bosniacus*. The highest prevalence was found for *P. laevis* and the lowest - for *I. multifilis*; *L. intestinalis* and *C. microcephalum*. Moravec et al. (2005) found a new species of parasite - the nematode *Philometroides barbi* - under the serosus of the bladder, in the abdominal cavity and fins of *B. meridionalis* from France, Serbia and Slovakia. The authors indicate that this is the only representative of *Philometra* found in fish species of genus *Barbus*. Velkova-Jordanovska (2006) performs molecular-biological analysis of the parasite *Capillaria* sp. of the Liver of *B. meridionalis petenyi* from Ohrid Lake. Djikanovic et al. (2011) reported for *A. isoporum* and *C. brachycollis* as helminths of *B. petenyi* from the Serbian part of the Danube basin, etc. No parasites causing dangerous diseases to fish, humans or other hosts were identified, which cases and diseases (suspected pathogens) were reported to other parasites by other authors (Kakacheva-Avramova & Nedeva, 1979; Pekova et al., 2017a; Pekova et al., 2017b; Mitev et al., 2020).

3.4. CONCLUSION

The first results of the research on the biodiversity and ecological status of the freshwater ecosystem of the Osam River are presented, based on the biological quality elements: macrozoobenthos, parasites and parasitic communities of the Black barbel. Fifteen bioindicator macrozoobenthos taxa with 108 specimens are found. The determined taxa are divided into four saprobity groups and four sensitivity groups. The Shannon-Weaver diversity index testifies to β -mesosaprobity conditions. The total number of taxa, Biotic index, EQR

and RETI indices shows a good ecological status of the Osam River in the studied biotope. As a result of ecoparasitological studies of 30 specimens of *B. petenyi* from the Osam River, five species of parasites with 724 specimens were found. The development cycles of the helminths and the saprobic significance of their intermediate hosts are presented. The pathways for the circulation of the parasitic stream are described. *I. pileatus*, *P. laevis* and *R. hellichi* are core species for the helminth communities of *B. petenyi*. A total of 14 specimens of *B. petenyi* are free of parasites (46.67%). The Brillouin diversity Index is $HB = 0.683$. Pielou's evenness index is low due to the obvious dominance of one of the found parasite species (*I. pileatus*), both in prevalence ($P\% = 36.67$) and mean intensity ($MI = 53.18$). *I. pileatus* is allogenic species for the freshwater ecosystem of the river and all other helminth species are an autogenic species. All found helminth species are generalists for the helminth communities of the Black barbel. The identified helminth species, with their complex development cycles, indicate the status of the food chains, the biodiversity and the ecological status of the studied habitats.

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IN SEARCH OF COMPETITIVE ADVANTAGE: THE DIFFERENCES AND MUTUAL COMPLEMENTATION OF TWO APPROACHES

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Abstract: Achieving advantage in competition is a task constantly faced by managers and an object of ongoing research. Being aware of the sources of advantage is crucial along the way of creating it. The paper presents a review of two main approaches existing in literature to the sources of competitive advantage: the structure – conduct – performance paradigm and the resource- based view, and discusses the differences between the two as well as their codependence. Focusing on the arguments for their mutual complementation, we integrate them in a frame that explains the factors leading to competitive advantage. The mediating role of strategy choice as well as strategy implementation within this frame is thereby justified. The frame thus constructed can be useful for management practitioners in that it outlines the factors they should focus their attention on when creating their companies' competitive advantage. It can additionally be used as a tool for diagnosing the potential of an organization to maintain competitive advantage and above- average performance.

Keywords: competitive advantage, strategy, resource-based view, S-C-P model, organisational capabilities

1. INTRODUCTION

The term “competitive advantage” is a central one in strategic thinking. Authors' research regarding the sources of advantage and its sustainability exceeds the limits of strategic management theory, marketing studies, general theory of economics, resource theory and behavioural studies. Advantage is sought on regional, national, industry, organisational and product level.

The focus of the present paper is on advantage on the organisational level, mainly described as better financial performance on a given market (Besanko et al., 2000), sustained above-average return rate (Peteraf, 1993), out-performing the competitor by achieving the greatest gap between value and costs (Hoopes et al., 2003), greater economic value than that achieved by competitors. (Barney & Hesterly, 2006).

The central topic in authors' research in the field of competitive advantage are the sources of competitive advantage. Managers' awareness of them allows their systematic study (observation and analysis), where possible their modelling and thus taking conscious and purposeful steps towards achieving competitive advantage and success in competition. Depending on where scholars predominantly see sources of competitive advantage, two main approaches stand out in specialised literature: the environmental and the resource-based

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approach. The former gives a determining role to external conditions (industry structure) in achieving competitive advantage, while the latter recognises the differences in the organisation's resources as the main reason for differences in the organisations' performance, respectively in their achieving competitive advantage.

The present paper aims, by analysing the main views and the arguments of both approaches, to try to explicate

- Whether there is sufficient reason to prioritise one of the approaches and use it on its own, or the views of both approaches should be incorporated in a combined framework when analysing an organisation's capabilities for creating competitive advantage;
- In case the two approaches are to be used simultaneously, what should be the components and/or processes that bridge them in a combined framework;

2. VIEWS OF THE TWO APPROACHES – A SHORT OVERVIEW AND MAIN DIFFERENCES

The SCP (structure-conduct-performance) paradigm explains a company's performance through the parameters of the industry it operates in by assuming conduct on the market is determined by the structure of the market in question, and the performance, in turn, is determined by firm conduct (Bain, 1956). Some of the more important structure variables are the number and size distribution of buyers and sellers, product differentiation, barriers to entry and barriers to exit, vertical integration and diversification (Lipczynski et al., 2017).

In his model of the "five forces of competition," by including similar variables, Porter describes industry attractiveness and emphasises on the external conditions as a factor determining a company's success or failure. Within this approach a key role in determining competitive advantage is played precisely by the firm's positioning in the industry. The advantage is explained by the presence of a strong, defensible market position in an attractive industry. The marketplace is where the presence or absence of advantage is visible, and the advantage is manifested in differentiation or alternatively in lower costs (Porter, 1990).

Further developing his thesis on the role of external environment in achieving competitive advantage, Porter (1990) directs the attention to the role of national environment on the development of certain industries and on the participants operating within them, and emphasises that many aspects of a company's competitive advantage come from outside and are rooted in the location and industrial clusters. He summarises the factors of the national environment which play a determining role for local firms' competitive advantage in the so-called "national diamond". Factor conditions, demand conditions (the nature of home market), related and supporting industries and firm strategy, structure and rivalry are four attributes that individually and as a system constitute national advantage (Porter, 1990). Porter backs up the determining role of the above mentioned national variables with the pressure created by them to overcome inertia and support constant improvement and innovation. The pressure towards change comes more commonly from the external environment rather than internally – few companies undertake changes voluntarily, without pressure from outside, Porter declares.

Focusing on external conditions' role in forming a competitive position, the followers of the environmental approach underestimate the role the variable of the firm itself plays in constructing said position. They assume that firms in a particular industry (or a strategic group) are equal with regards to the resources strategic to the industry, and that even if a difference were achieved, it would be sustained for a short time only due to the resources' high mobility.

In contrast with the relative parity of firms in the same industry, Grant (1991) emphasises that most studies show much more substantial differences in the return rate of firms within the industry in comparison with the differences between industries. These facts direct the search for sources of competitive advantage inwards, towards the variables of the organisation itself. At the same time, in the early 90s, Rumelt (1991) presents the results of a study of his own which also question the consistency of the SCP model. His results show that only about 16% of the variations in firm performance is influenced by the industry's variables, while over 80% are influenced by in-firm variables. Similar results were reported in newer studies as well (McGrath, 2012), namely that “exogenous factors such as industry, geographical position, and age did not explain the outliers' growth rates.” These findings question the logic of the SCP-model and are in compliance with the views of the resource-based approach.

While the environmental approach neglects the possibility that the differences in a firm's resources and their lower mobility could be a source of competitive advantage, the resource-based approach supposes that firms differ in terms of the set of strategic resources which they control, as well as that those resources are not perfectly mobile. Such differences and the imperfect mobility of the resources condition a more long-term nature of differences in performance. A main view of the resource-based approach is that the presence of a unique resource can be a source of sustainable competitive advantage.

The term “resource” is used much more widely by RBV-researchers. In literature, different classifications are used to describe the set of resources used by the firm. They are usually separated into three sub-groups: tangible resources, intangible resources, and skills (also referred to as capabilities, competencies or core competencies). The tangible resources are characterised by being evident, visible, which makes them susceptible to copying by competitors and thus limits the possibility of their being a source of competitive advantage. Intangible resources, such as intellectual property, the name and reputation of a company, the established information base, established contacts, etc., are difficult to accumulate, cannot be easily transferred to another organisation (Itami & Roehl, 1987); they are relatively less susceptible to copying by competitors (Fahi, 2000) and do not decrease with use (Collis & Montgomery, 1995). Therefore, they are much more likely to produce competitive advantage than tangible resources, which is why intangible elements have strategic importance for the viability of the organisation (Carmeli & Tishler, 2004).

Researchers usually connect the terms “capabilities” and “competencies” with the combining and interaction of different resources and with the organisation's ability to combine the resources in a way that is useful for the goals it has set. According to Grant (1991) capabilities refer to “a firm's capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end. They are information-based, tangible or intangible processes that are firm-specific and are developed over time through complex interactions among the firm's resources”. Helfat and Peteraf (2003) define the firm's capabilities in a similar way, namely emphasising on their coordinating role regarding the rest of the organisation's resources. The authors define organisational capabilities as referring to “the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result” (Helfat & Peteraf, 2003).

Morgan and Hunt (1999) speak of competencies as higher-order resources formed by combining basic resources: “competitive advantage is realized only when the firm combines assortments of basic resources in such a way that they achieve a unique competency or capability that is valued in the marketplace”. And as “the source of a competency is always internal to the firm” (Reed & DeFillippi, 1990), the source of advantage stems from the internal environment of the organisation. Among higher-order resources, Morgan and Hunt

(1999) point out loyalty, trust, reputation – all examples of resources that cannot be transferred from one company to another, nor bought; i.e., they create a difference which can be an advantage or a source thereof. Bridoux (2004) also emphasises on the fact that “if there are strong relations of complementarity and co-specialisation among resources, it is the way resources are clustered and how they interplay that is important to the understanding of competitive advantage.”

We consider that it is the wide viewpoint of the RBV-researchers on the term “resources” (“capabilities” included) that is also an argument for the consistency of the main views of the approach, namely that the resources (what is more, the compound of resources) owned by different organisations can be heterogeneous, and that this heterogeneousness can be preserved for a longer time. Heterogeneousness is not in a single resource, but in its combination with the others and the formation of a company-specific set of resources.

3. A DISCUSSION ON THE SOURCES OF ADVANTAGE – MORE DIFFERENCES OR A NECESSITY OF A COMPLEMENTARY USE OF BOTH APPROACHES

Scholars’ research on the sources of competitive advantage are grounded in different starting assumptions, more or less supported by empirical evidence and theoretical arguments. The main differences in the two approaches’ views as presented in the paragraph above are summarised in table 1.

Table 1. Main differences in the views of the environmental approach and the resource-based approach to competitive advantage

Environmental approach	Resource-based approach
Focus on the role of <i>external conditions</i> in forming a competitive position (analysis on industry level)	Focus on the role of <i>firm resources</i> in forming competitive advantage (analysis on firm level)
The firms in an industry (or strategic group) are <i>equal</i> in regards to the resources strategic for the industry	The firms in an industry are <i>heterogeneous</i> in regards to the strategic resources they control
The resources owned by the firms are <i>highly mobile</i> and therefore any possible differences in performance would be short-lived	The resources are <i>not perfectly mobile</i> and therefore the heterogeneousness can be preserved for a longer time
Differences in performance stem from the received <i>monopoly-type rent</i> (a result of intentional restriction at exit)	Differences in performance are explained by differences in work efficiency and the received <i>Ricardian rent</i> (a result of inherent scarcity in resource supply)

Despite the differences and opposition in the two approaches, upon careful study and insight into their formulation, cross-areas and connecting elements can be found.

Porter’s Value Chain concept is in a sense a bridge between the environmental and the resource-based approach in search of competitive advantage. It places in managers’ attention the possibility of certain in-organisation variables being a source of competitive advantage and supports managers in finding potential advantages stemming precisely from the firm’s resources (in a wide sense). A firm’s competitive advantage stems from the way it organises and performs each activity, Porter postulates (1990). Activities generate costs, meaning that “cost advantage arises from performing particular activities more efficiently than competitors.

Similarly, differentiation arises from both the choice of activities and how they are performed” (Porter, 1996).

In different industries, however, activities are different in their importance regarding competitive advantage, Porter also emphasises. Thus, the analysis on the level of industry (or strategic group) is important for discovering activities with a determining influence on competitive advantage in the respective industry. Amit and Shoemaker (1993) demonstrate a similar logic by introducing the term “strategic industry factors”. The latter are to ground managers’ decision what strategic assets to develop – those precise industry-specific resources and capabilities which determine economic rent.

Though not quite evidently, representatives of the resource-based approach also give importance to the role of the external environment as determining for how valuable a resource is. Acknowledging that not every resource is a potential source of advantage, they name resource value as the first necessary condition for its being a source of advantage. Barney and Hesterly (2006) relate value with the answer to the question if a resource enables a firm to exploit external opportunities or defend against threats. The value of resources is determined by their interaction with marketplace forces, Collins and Montgomery (2008) emphasise. It cannot be observed in isolation from the conditions of the industry and time period in question. Evidently, the answer to this question requires familiarity with the external environment and all of its elements and participants; in other words – the resource value is directly dependent on the industry’s structure, the regulations existing within it, the characteristics of the national environment, etc.

Researchers also pay attention to the fact that, in the RBV definition for competitive advantage, terms such as “economic value”, “value perceived by customer”, “exchange value” and “profit realised” are determined by factors exogenous to the approach (Bridoux, 2004; Bowman & Ambrosini, 2000). Thus, the economic value is determined by the value perceived by the customer as well as the costs of resources. The first quantity depends on customer perception of the product’s usefulness, while the amount of costs depends on the bargaining power the suppliers of a certain resource have (Bridoux, 2004).

Similarly, the amount of profit realised “cannot be determined solely from an examination of processes within the firm [...] Profits will be determined through the exchanges the firm makes with [...] resource sellers (including sellers of labour) and customers. These exchanges are a function of the perceived bargaining relationships between buyers and sellers” (Bowman&Ambrosini, 2000). These considerations related to the quantity of profit ground the exogenous nature of the factors defining advantage, and are an argument for the standpoint that the two approaches are not to be used in isolation from one another.

Some authors attempt to nominate a “winner” in the competition between the two approaches, while others prefer looking at them as complementary. Among the first group of authors is Grant (1991), who gives arguments in favour of the resource-based approach. “A closer look at market power and the monopoly rent it offers, suggests that it too has its basis in the resources of the firms,” the author postulates. He supports this standpoint with the observation that “the fundamental prerequisite for market power is the presence of barrier to entry”, which in turn “are based upon scale economies, patents, experience advantages, brand reputation, or some other resources which incumbent firms possess but which entrants can acquire only slowly or at disproportionate expenses.” Grant adds further arguments for the leading role of resources in defining market power and bargaining power. His standpoint on the determining role of resource (as opposed to that of industry structure) in industry attractiveness, as well as in achieving competitive advantage (above-average performance) is demonstrated in figure 1.

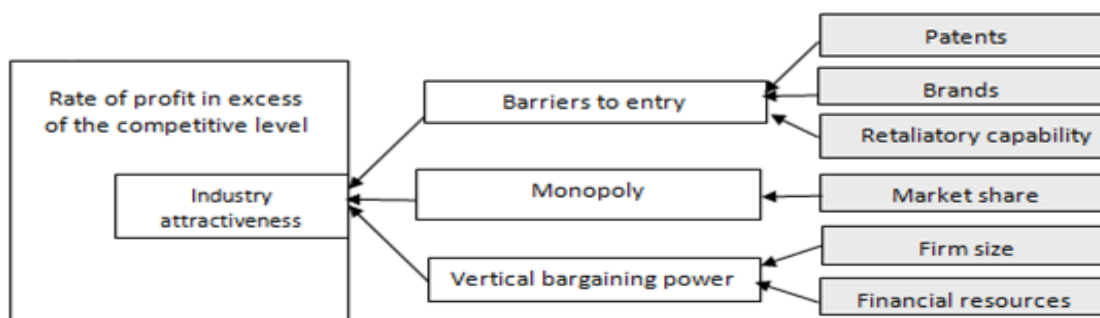


Figure 1. Resources as determinants of industry attractiveness and performance (adapted from Grant, 1991)

Comparing the two approaches, another group of researchers avoid ascribing a leading role to either of the approaches, instead looking at them as complementary. Amit & Schoemaker (1993) are among the most cited authors of this standpoint. In their article “Strategic assets and organisational rent”, the two researchers focus on connecting the model of the industry analysis framework with the resource-based approach as well as the behavioural decision theory. They include their understanding of strategy industry factors at the market level with the idea of strategic assets at the firm level in a common conceptual framework. “The challenge facing a firm’s managers is to identify, ex ante, a set of Strategic Assets as grounds for establishing the firm’s sustainable competitive advantage. [...] This requires managers to identify the present set of Strategic Industry Factors (SIF) as well as to assess the possible sets of SIF that may prevail in the future” (Amit & Schoemaker, 1993). Defining the latter requires an analysis on the industry level, while maintaining and developing strategic assets requires an analysis at the firm level. The two authors’ conclusion is about “the need for a multidimensional approach: one that includes internal and external elements, static and dynamic aspects, and rational as well as behavioural consideration”.

Other authors insisting on the necessity of complementing the resource-based approach with an environmental viewpoint are Priem & Butler (2001). “For the RBV to fulfil its potential in strategic management, its ideas must be integrated with an environmental demand model,” the authors state. They recommend that studies address essential connections between resource and environment because while resources express what can be done, the competitive environment determines what must be done in order for the organisation to compete effectively.

4. A FRAMEWORK INTEGRATING BOTH VIEWPOINTS. CONCEPTS BRIDGING THE TWO APPROACHES

As a summary of the discussion regarding sources of competitive advantage, we accept the considerations for the role of both industry structure and the firm’s resources in creating competitive advantage. This makes essential both industry analysis with the purpose of extracting the key success factors (in other words, what must be done) and the analysis of the firm’s resources for finding out whether the key success factors are present in the organisation (or whether they can be renewed and reconfigured). Sharing the view that the two approaches should be complementary, we consider it necessary to integrate them in a common conceptual framework.

Thus, the main components in this framework integrating both approaches are: (1) organisation resources (in a wide sense, including capabilities and core competencies), (2)

external environment elements with their influence, determining the key industry success factors, and (3) the firm's performance demonstrating presence or absence of competitive advantage.

When placing the two sources of advantage in a common framework, the question remains: what are the elements that, with a certain industry structure and combination of resources, would make certain firms have a better performance and others – worse? Understandably, the different resource base used by firms would create differences. What more is there? We can find arguments for what the bridging components in the framework are in two widespread concepts: the concept of fit and dynamic capabilities perspective.

4.1. THE CONCEPT OF FIT AND COMPETITIVE ADVANTAGE

The concept of fit is a key one in the field of strategic management as well as in theories examining the effectiveness of an organization, including the theory of organization design. Fit is examined in its many different faces and forms. Strategic management pays attention predominantly to ensuring the so called environmental fit – between the organization's components and processes, on the one hand, and the environment, on the other. When we have to select the appropriate strategy, the main purpose is to ensure the fit between internal strengths (resources, competencies) and external opportunities. Examining theoretical models of organizational diagnostics and design (Weisbord 6-box model, Galbraith's Star Model of organizational design, McKinsey 7-S framework, Nadler & Tushman model of congruence, Miles & Snow configurations, etc.), we can see that many of them connect different indicators of firm performance to the organization's components, their mutual interdependence and the level of alignment among them (internal fit) (Nadler & Tushman, 1980, Miles & Snow, 1994, Burton & Obel, 2004). Summarising the beliefs of researchers following the configurational approach, Charles Snow, Raymond Miles, and Grant Miles (2006) outline that the former perceive that “overall organizational performance is heavily dependent on the quality of the internal alignment of the organization's components as well as the external fit between the organization and its environment” (Snow et al., 2006). This belief is reflected in the framework bridging the two approaches and presented in figure 2.

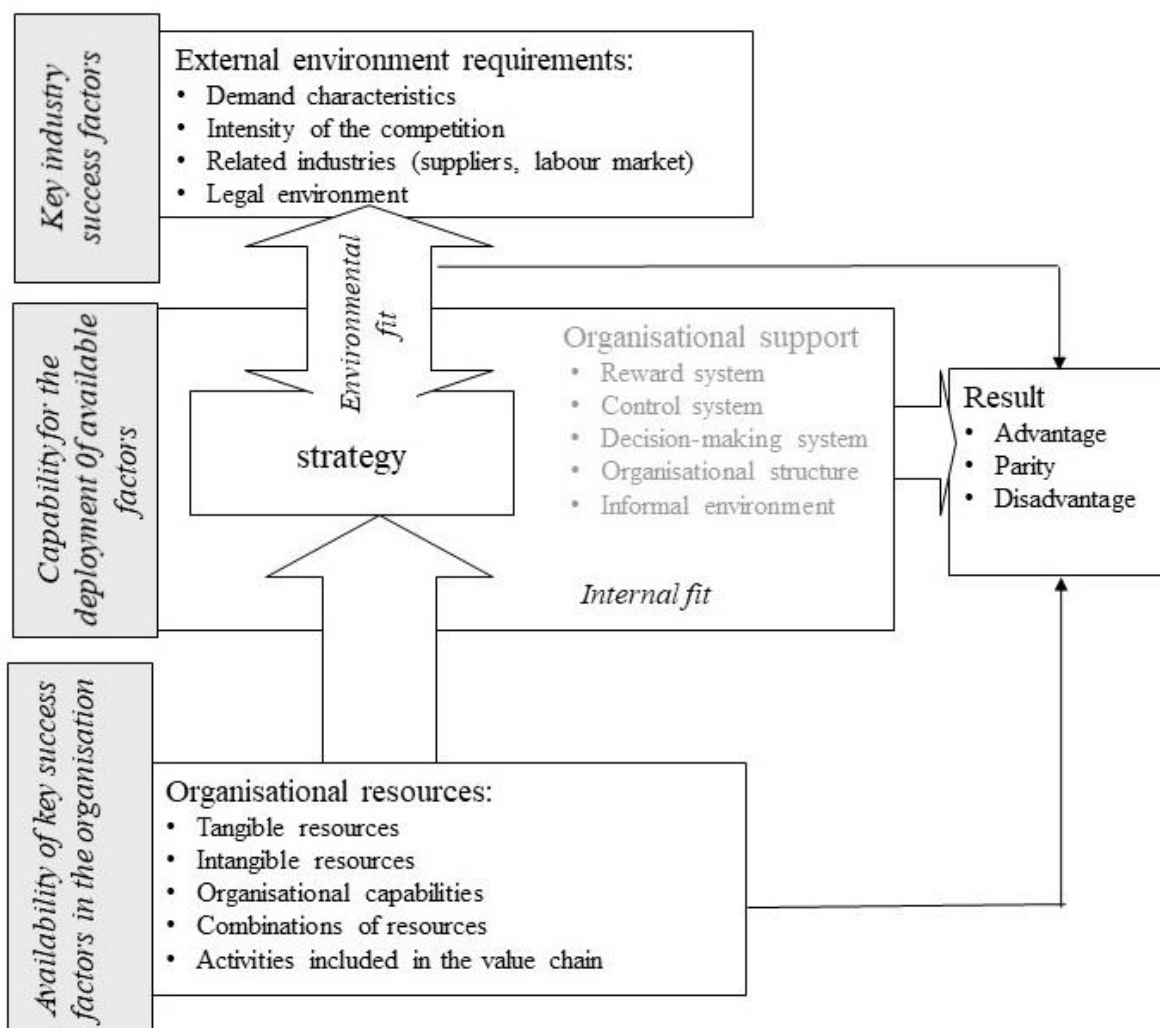


Figure 2. Conceptual framework of the sources of competitive advantage

Thus, reflecting the need of achieving both external and internal fit, we include in the framework the following:

- the strategy, viewing it as an instrument for ensuring external (environmental) fit; and
- the organisation's components as a means of implementing the selected strategy, with the requirement that they be in alignment with one another and the selected strategy in order to ensure internal fit.

4.2. DYNAMIC CAPABILITIES AND THEIR ROLE FOR ACHIEVING ADVANTAGE

The dynamic capabilities approach is formed as a continuation and upgrade of resource-based view. Teece, Pisano and Shuen (1997) define dynamic capabilities as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments”. The authors point out that “the term “capabilities” emphasises the key role of strategic management” in the above mentioned process of adaptation and reconfiguration of resources. Conceptual and empirical studies from the last decade also put

to the test and affirm the mediating role of dynamic capabilities between resources and performance (Schilke et al., 2018; Bittencourt et al., 2020). McGrath (2012), in the search of what sets apart “the growth outliers” from the rest of the companies, points out that they “rapidly adjust and readjust resources”, including human resources, and “are comfortable moving executives and other employees from one role to another”.

Thus, the framework’s “capability for the deployment of available factors” is expressed in both the choice of strategy (which might require a reconfiguration of resources) and the process of its implementation, when, through structure, control mechanisms, reward system, etc. the management should ensure organisational support for implementing the strategy. Resource reconfiguration is an iterative process because environmental changes are dynamic. Thus, the capability of the firm to continuously deploy, redeploy, and reconfigure resources is crucial for choosing the proper strategy and the proper organisational design to support its implementation.

4.3. STRATEGY CHOICE AND STRATEGY IMPLEMENTATION IN THE FRAMEWORK

As stated above, strategy choice and strategy implementation are determined by the organisational capability to deploy, redeploy, and reconfigure resources. Strategy, in turn, is to ensure the alignment between organisational resources and environment. Then, for its successful implementation, organisational support has to be done through designing an appropriate structure, reward system, control mechanism, decision-making procedures, etc.

4.3.1. Strategy choice and its mediating role in the framework

As far as companies choose what products to offer to what markets based on their choice of strategy, the latter is also a choice of environment which they are to operate in on the one hand, and gives the requirements for what resources are needed for this operating, on the other. As such, each strategy choice is preceded by an analysis of the external environment, of the opportunities and threats it offers, as well as an analysis of resources that are available in the organisation and that can and must be acquired. Thus, strategy choice is key for finding a fit between the organisation’s capacity, which it has through its resources, and the opportunities, which the environment offers (environmental fit). Bridoux (2004) points out precisely strategy as “a major channel of connections between the competitive environment and resources.” She pays attention also to the two-way influence of environment, resources and strategy, and declares her view on strategy “as an ongoing sequence of actions and reaction conditioned by the firm resources and competitive environment, which in turn become exogenous events in the environment of other firms.” This makes necessary the regular reconsideration of environmental conditions, as well as the reconfiguration and renewal of resources in order to find a new fit between the environment and the chosen strategy exploiting reconfigured resources.

4.3.2. Strategy implementation and the organizational components supporting it

Barney and Hesterly (2006) introduce their VRIO-framework for defining the results in competition; along with the conditions it gives regarding organisational resources (they

should be valuable, rare, and costly to imitate), they include a condition concerning the organisational elements. The latter “should employ and enable a firm’s efforts to fully exploit the valuable, rare, and costly-to-imitate resources and capabilities it controls”, the authors emphasise. The limitation they set with regards to the organisational elements is that “by themselves, they could not be a source of competitive advantage”. They call them “complementary resources” (Barney, J., W. Hesterly, 2006) because they cannot bring about advantage without the implementation of other resources. Thus, the authors perceive the presence of organisational support as a necessary (but not sufficient) condition for achieving and sustaining advantage. In terms of organisational elements supporting advantage, the authors point out formal reporting structure, explicit management control systems, and compensation policies.

Despite not including it in her framework, Bridoux also points out that “if the firm’s strategy does not set up the correct structure, control systems and reward systems to support the resource, it seems highly improbable that the resource will contribute to the firm’s competitive advantage”.

5. CONCLUSION

The constructed framework of sources of competitive advantage incorporating in itself both strategy choice and strategy implementation as mediating elements, outlines for managers the areas to analyse and the types of decisions to consider if they want to be successful in competition.

Reviewing the arguments of the SCP-paradigm and resource-based view regarding the sources of competitive advantage for the organisation, we conclude that the two approaches are rather complementary than opposed. A combining framework for their implementation is constructed, with the inclusion in it of strategy choice and strategy implementation being explained by the concept of fit (both external and internal), as well as the dynamic capabilities perspective.

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ORGANISATION DESIGN AND ENVIRONMENT DYNAMICS

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Abstract: In a dynamic environment, organisations are faced with the challenge of remaining stable while changing in response to dynamic external conditions. This complicates the process of designing an organisation in a way that enables its alignment with the environment. By reviewing the components of the organisational “hardware” and “software”, which are involved in different organisation design models, the paper is an attempt to outline which elements are the ones that ensure adaptability without harming stability. It goes over several forms of contemporary organisational structures. Additionally, it reports empirical evidence for the role of so-called relational resources, staff loyalty, the ability to innovate, the managers’ attitude towards the reasons for success/ failure, etc. in achieving better performance.

Keywords: organisation design, organisational hardware, organisational software, organisational agility

1. INTRODUCTION

Nowadays, the dynamism and uncertainty of the environment affect even those organisations that earlier perceived the industry they operate in as relatively stable, with established markets, rarely changing regulative environment that is comparatively protected from new entrants. The unpredictability of some events on a global or local level, however, faces every organisation with the necessity to revise their strategies as well as the way in which they would implement those strategies successfully. As Greenwood and Miller (2010) observe, “the most urgent and pervasive among these challenges can only be addressed by the continual and deliberate orchestration of organisation design on an ongoing basis.” They add that it is precisely organisation design that “drives the way strategies are formulated or formed, and determines whether and how they can be implemented.”

What elements make up the organisation design; which of them support adaptability to the changing environment; is it possible for the organisation to remain stable while it aligns with the different conditions of the external environment – these are the questions whose answer we are seeking in the present paper. Our view on these topics is formed by analysing theoretical models of organisation design briefly summarised in the paper and searching for empirical evidence for the correlation between certain organisational features and the continuously good performance of companies in the competition.

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2. ORGANISATIONAL HARDWARE AND ORGANISATIONAL SOFTWARE – THEIR MEANING FOR AN ORGANISATION’S AGILITY

Different organisation design models offer a combination of organisational components – the more stable ones such as structure, decision-making system, processes, reward system, control mechanisms (they are quite similar in different models), and the softer ones. The organisational hardware allows a formal description – its description is materialised in organisational charts, charts of interconnected processes, instructions for distributing powers and responsibilities in decision-making, information flow charts, systems of variables measuring performance, etc. Designing organisational hardware is expected to ensure a stable ground for a relatively long period of time. What drives the hardware are the people filling out the “boxes” in the organisational chart, analysing the incoming information and make decisions (good or bad), succeed or fail to use the physical and financial resources of the organisation effectively, comply with the rules or have an attitude that manipulates said rules. It is the people that form the so-called “organisational software”. It includes variables such as leadership and relationships (Weisbord’s 6-box model), shared values, skills, staff and style (McKinsey’s 7S-model), people, determining skill sets and mindsets of the organisation (Galbraith’s Star model), managerial philosophy (Miles & Snow configurations), informal organisation (Nadler-Tushman’s congruence model, organisational climate and culture and leadership style (Burton & Obel).

An organisation would perform better when there is internal (between the elements that makes up the organisational hardware and software) as well as environmental (between the organisation and the environment it operates in) fit – this is the proposition of the contingency approach in management. In other words, in order for an organisation to be designed properly, the design elements must be appropriate for the nature of the environment – whether it is mature and predictable or dynamic, complex and unpredictable. What is more – researching whether environmental or internal fit is of greater importance and has a greater impact on the firm’s performance, there have been reported theoretical and empirical considerations saying it is environmental fit that plays a key role in achieving results above normal, its impact on the performance has greater importance than that of internal fit (Maximova, 2017). These considerations are aligned with the notion of Klaas, Lauridsen & Hakonsson (2006) that external misfit is more detrimental to performance than internal misfit.

When the environment the company operates in is dynamic and unpredictable, achieving environmental fit is a challenge. The organisation needs to acquire flexibility in order to survive in a dynamic environment without losing its stability in the process. Constant design alterations would not lead to success – changes take time and if they are made often, it is highly probable that they end up struggling to catch up with the changes in the environment. A dynamic environment is not to be taken to mean constant alterations in the company design – more so choosing a design that is adaptive to the changing environment. Consultants from McKinsey & Company (Aghina et al., 2016) point out three core organisational areas “where balancing this tension between stability and flexibility is critical: organisational structure, which defines how resources are distributed; governance, which dictates how decisions are made; and processes, which determine how things get done, including the management of performance.” These components are perceived by McKinsey researchers as “a relatively unchanging set of core elements – a fixed backbone,” which is to support the organisation’s stability. These are the elements included as “organisational hardware” in the above mentioned models for organisational diagnostics and design as well. All models mentioned above observe the elements included in them in their correlation to the organisations’ strategy as well – all of them must support its implementation. Aghina, De

Smet, and Weerda (2016) insist that “at the same time organisations must also create looser, more dynamic elements that can be adapted quickly to new challenges and opportunities.”

What moves organisations from one opportunity to another and makes them respond quickly to environmental changes? McKinsey consultants emphasise that “agile companies have learnt that the stability of an organisational home (defined by the structure – author’s comment – V. M.) is critical because it helps companies to redeploy employees in less successful cells more easily and rapidly, with little of the disruption and fear over job losses that traditionally deter and hinder change” (Aghina et al., 2016). Searching for what differentiates “the growth outliers” from other companies, McGrath (2012) similarly concludes that they are both extremely stable, with certain organisational features that remained the same for a long time and “rapidly adjust and readjust resources and are comfortable moving executives and other employees from one role to another”. These frequently changing roles played by employees and executives, and rather with no resistance at that, form and develop people’s skill set and mindset, reinforce organisational relationships and the trust between employees, and intensify the flow of information and knowledge exchange. Being involved in new tasks and successfully dealing with them eases the tension about potential failure and enhances employees’ readiness to be responsive and accept upcoming tasks when the opportunity arises.

Which structure designs presuppose such human resource allocation, a more intensive knowledge exchange and acquisition and thus a more agile reaction to the environmental opportunities? There are several characteristics which, if owned by the designs, would facilitate a quicker reaction to an arisen opportunity:

- An increase in trust and authorisation of employees on lower hierarchical levels to make a wider range of decisions related to their day-to-day activities; a decrease in number of the hierarchical levels and transitioning to flat structures.
- Forming self-directed team structures for the execution of certain tasks; encouraging employees’ zeal; creating multifunctional teams united around a process or task;
- Developing horizontal communications and decreasing the level of formalisation of the decision-making process.

3. SEVERAL FORMS OF CONTEMPORARY ORGANISATIONAL STRUCTURES: ADVANTAGES IN THE PURSUIT OF AGILITY

Project structure and adhocracy have some of the above mentioned features and are meant precisely to facilitate a quicker response to the requirements of the changing environment. Meritocracy is in our focus when, along with the dynamic environment, high levels of technological progress are present. The ability of network design to adapt more successfully to market changes is also in our attention when we strive for agility.

In the so-called project structure, one or more units are formed that have a specific task, usually having to do with an emerged new opportunity. It is a temporary unit with a defined lifetime – the time it takes for the project to be realised. The project unit is made up of professionals from different functional departments of the company depending on the needs of dealing with the project task at hand. The team of professionals keep doing their tasks in their “organisational home” as well, which ensures their job stability while they are busy realising the project at the same time. The project team works autonomously, led by a project manager directly subordinated to the general manager. Different functional professionals can be brought into different project teams with different unit lifetimes according to the duration of the project in question. Thus, professionals can transfer from one team to another

depending on the needs of the projects and the tasks within them. This transfer of qualified professionals between different projects and the transfer of their knowledge from one task and team to another is at the basis of self-learning organisations. New qualities emerge in such organisations, which are in favour of their agility.

The adhocracy model of organization is seen as an antipode to bureaucracy as well as a means for a quicker response to the requirements of the changing environment by switching formal rules and procedures for an informal way of interaction within the organization. Birkinshaw and Ridderstråle (2015) redefine the concept in a way that further distinguishes adhocracy not only from bureaucracy but also from the meritocracy model of organisation. The three models are differentiated according to the conditions in which they are appropriate, which then presupposes and requires a difference in the way the activities are coordinated, in the way decisions are made and in the way people are being motivated. And while meritocracy is of great importance in high-technology activities and intensive technological changes, adhocracy is an appropriate model for an unpredictable environment with a high level of insecurity. Thus, adhocracy counts on experimenting – trying a course of action, receiving feedback, making changes, and reviewing progress. Employees are encouraged to initiate new projects and to choose which of them to work on. Self-selected teams emerge spontaneously, centred around the newly arisen opportunity. Unlike project structure units, which are created for a certain amount of time, in adhocracy, temporary units have an open-ended deployment that could last a few weeks or a few years, depending on market response. In adhocracies, motivation centres on giving people a challenge and providing the resources and freedom they need to surmount it. People's behaviour is also motivated by the recognition they would get for achieving goals. Once activities are complete, the disbanding of the project team is what follows. Here, an important role for a trouble-free involvement of employees in temporary teams and realising change is played by their belonging to a unit in the stable structure which is hardwired in the organisation chart. It also supports the ad hoc structure if the organisation management takes care that, after the disbandment of the temporary unit, the people formerly taking part in it be redirected and trained for newly-emerging opportunities. The appropriateness of adhocracy or alternative design models "varies by function, with compliance more likely to be a bureaucracy, R&D a meritocracy, and sales an adhocracy," Birkinshaw and Ridderstråle (2015) point out. The two authors also formulate a list of contingencies in whose presence the ad hoc structure is appropriate, namely:

- That the level of regulation and compliance imposed on a given function or business by external factors be low to medium;
- That the downside risks (safety and costs) if something goes wrong be low;
- That the rate of technological or scientific change (or both) in the business area be medium (in case of higher intensity of technological changes, meritocracy is to be preferred instead);
- That the level on which specialised training is required of people in the respective business in order for them to operate effectively be low to medium (if the requirement for such training is higher, meritocracy is appropriate);
- Volatility that exists on the demand side — for example, changing customer needs or emerging new segments is high
- That both the operating environment's level of ambiguity and the company's ability to influence and shape it in its favour (degree of malleability) be high.

When discussing design variants that make organisations more agile and adaptive to the environment by keeping risk on a moderate level, networks are also a matter of interest. They allow organisations to grow without this necessarily meaning a proportional growth of the

necessity for investments in physical assets, increasing exit barriers and decline or loss of agility. As a rule, as the organisation grows in size, it becomes clumsier, bureaucratisation often grows dangerously, control and coordination become harder, decision-making grows slower. Networks are an opportunity for the company to be “big and small at the same time” (Miles & Snow, 1994). Keeping only that part of the process and the general value chain in which the company owns signature competencies and can compete “on a world-class basis”, an organisation can become smaller while remaining big by delegating the rest of the chain activities to subcontractors, with whom it forms stable or dynamic networks. In addition to the enhanced agility, building a network organisation would allow for a more efficient consumption of resources, freeing the organisation from expenses in time and money for maintenance of the bureaucratic machine. The bureaucratic control system, based on following rules and procedures, which is dominant in larger companies, will yield to control through the market (Ouchi, 1980), where the prices suggested by subcontractors provide a “simple” measure of efficiency. Miles and Snow (1994) describe three types of networks – dynamic, stable, and internal. The first one of them, which presupposes possibly the greatest agility in company behaviour, is to be considered when response time is critical for success and investing in expensive and narrowly specialised assets is risky because of frequent and significant changes in technology and frequently changing customer preferences.

4. WHAT ELSE MATTERS? SOME DISTINCTIVE FEATURES OF SUCCESSFUL COMPANIES – EMPIRICAL EVIDENCES

Each one of the observed structures is more or less appropriate depending on the type of changes happening in the environment, the size of the company, the degree of required activity-specific knowledge or assets, etc. In other words, once chosen, even if it bears the characteristics of a more agile design, it might be necessary for some of its elements to be changed or redesigned. “Agile companies regularly rethink and, if necessary, redesign their structures, governance mechanisms, and processes to strike a balance between speed and stability”, emphasise also Aghina, De Smet, and Weerda (2016) from McKinsey and Company. In order for the company to go through the process of rethinking the design with fewer problems and less resistance, features such as organisational climate, leadership style, established interrelations between staff members, etc., matter. “One critical prerequisite for sustaining real change is putting in place the behavioural norms required for success”, Aghina, De Smet and Weerda (2016) warn and associate successful redesign with the degree to which organisation members accept behavioural norms: “the clearer and more widely adopted these kinds of behaviour become throughout all levels and units of a company, the easier it will be to change structures, governance, and processes in pursuit of agility.” In their theoretical framework of multiple-contingency organisational design, along with contingencies of size, technology, environment, and strategy, Burton and Obel (2004) also include leadership style and organisational climate and culture. Shared values are what the rest of the design elements centre around in McKinsey’s 7S-framework. Similarly, our assumption is that the soft characteristics of an organisation play an important role for achieving alignment between hard and soft elements of the whole design, and for realising the need for redesign as well.

We consider that owning the below mentioned features does prerequisite both the understanding of necessity and the realisation of organisation design and redesign in a way that makes them more flexible and adaptable to the challenges of the dynamic environment.

In this next part we turn our attention to several company features that, according to a study of ours, correlate with a company's success and the sustaining of said success. The research was executed among companies in the dairy sector in Bulgaria, which, during the period of the study, was characterised by many a challenge from the environment – problems in the supplier chain, a shortage of raw milk, high distribution costs and high bargaining power of retailers, changing legal requirements and shortage of control that prevents disloyal competition. Empirical evidence for the role of so-called relational resources, staff loyalty, the ability to innovate, the managers' attitude towards the reasons for success/failure, etc. are reported below. The results of the empirical study show that, for companies that outperform their rivals, the following is valid:

- Focus on the so-called “relational resources” – in an interview with each of the managers of the companies in the sample, they were asked: “If you had to change something in your work in order to sustain/ raise your success in competition, what would you prioritise on?” The answers about the resources and actions that managers put first in their list of priorities were then sorted into five groups: relational, organisational, technological, material and human resources. We studied the correlation between sustaining success in the companies and their attention to the different types of resources. All companies that prioritise the so-called relational resources such as relations with product retailers, relations with suppliers, consumer trust, consumer loyalty, and reputation, belong in the category of companies that have above-average sales revenue increase for the last six years prior to the study.
- Besides naming relational resources as a priority, their answers to other questions show that this mindset of theirs is reflected in real actions undertaken by the companies. For instance, they sustain stable interrelations with partners from the value chain – 65% of the firms in the sample whose performance is above the average for the industry, have well-sustained relationships with their partners on the supply chain: they either participate in common projects or financially support their partners by paying in advance in difficult times for them. This is a contribution to building stable networks with partners on the supply chain.
- Focus on innovation – an orientation towards constant improvement is characteristic for successful companies. 85% of companies with a high performance have made innovations in their products within the year preceding the study, where in half of them the innovation process is even more intensive (the last one has happened in the last three months before the study). The innovation and improvement of work organisation shows an even more definite correlation with high performance – all companies with above-average profitability have implemented organisational changes within the year preceding the study with 71% making changes in the last three months.
- Understanding the necessity of and realising the idea for the presence of an alignment between the strategic requirements and the reward system – in 53% of the companies that outperform their competition, the reward system is in accordance with the chosen strategy, in 37% it is neutral (neither gets in the way, nor supports the strategy), and only 10% achieve higher results despite the misfit between their reward system and their chosen competitive strategy. In 80% of companies with below-average performance, the reward system is not aligned with the chosen strategy. In those of them where there is misfit, a drop in sales revenue is to be observed.
- Focus on human resources and building staff loyalty – among those that focus on human resources, once again the majority have a sales revenue increase above the average for the industry (57% of the companies prioritising on human resources are companies with sales revenue increase above average). 82% of managers of

companies that outperform their competitors give a high score to their company's staff loyalty. In fact, in 76.5% of outperformers, trained professionals work long-term for the company (over 90% are in the company for more than three years). In contrast, only 20% of managers of companies with below-average performance score their staff loyalty highly and in fact less than half, namely 42.7% of those companies keep their key professionals for more than three years.

- Managers' attitude towards the reasons for success/ failure– the managers who participated in the study were asked where, in what areas, they would seek reasons for failure in case they undergo one. Emphatically, all managers of outperforming companies would search for a reason for potential failure in mistakes arising due to the organisation's operation (internal reasons), with 68% mentioning only factors from inside the firm as reasons for failure. The remaining 32% would seek the reasons for failure both within the company and in the external environment. In contrast, in low-performing firms, only 20% would seek reasons predominantly within the firm. The majority would "blame" their failure on the environment as well, while 10% of them attribute their failure only to reasons coming from outside the firm. We consider that analysing those reasons is in itself a favour to organisational learning. Looking for reasons inside the organisation means, on the one hand, that the processes inside it are to be analysed in detail, which supports the learning process, and on the other hand – indicates the organisation's striving for improvement by finding and correcting its mistakes.

We also consider that owning the above enumerated features is related to and does presuppose rethinking the necessity as well as actually realising a design and redesign of the organisations in such a way that makes them more agile and adaptable to the challenges of the dynamic environment. The focus on human resources, staff loyalty, and a reward system aligned with the strategy is in favour of motivation and is a condition for changes to happen with less resistance and more determination. The focus on innovation and the readiness for learning from failure transforms making changes into more of a routine activity, and the established relationships with partners allow more flexibility when modifying the processes.

5. CONCLUSION

Achieving environmental fit is of critical importance for the success of any organisation. Thus, the choice of organisational design that allows the organisation to respond quickly to the changes of the dynamic environment becomes an important task for the management. Both the elements of organisational hardware and the softer characteristics of the organisation such as shared behavioural norms, an atmosphere of trust and loyalty, management style and an approach to problem-solving are important in order for the design to facilitate responsiveness to market changes, timely utilisation of environmental opportunities and agility in problem-solving.

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IMPACT AND IMPORTANCE OF SUBSIDIES ON THE ECONOMIC EFFECTIVENESS OF ORGANIC FARMING

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Abstract: The characteristic features of organic farming, such as labour intensity, seasonality, higher production costs, lower incomes, more difficult production realization, etc., have a significant impact on the state and development of organic farms. The goal of the present scientific paper is to analyse and evaluate the impact and importance of subsidies on the economic effectiveness of organic farming. The study is based on directly collected empirical information from 73 organic farms operating on the territory of Plovdiv District in Bulgaria. Our research clearly shows that subsidies have a significant impact on organic production and the factors that determine it. However, given the many organizational and economic problems that accompany organic production, we believe that financial support research is essential to the future development of the sector.

Keywords: organic farming, subsidies, financial support research

1. INTRODUCTION

The development of organic farming was associated with an increasing demand for organic products and, thus, also with the development of processing industry and of the organic products. These changes could be observed in all European countries (Jansky & Zivelova, 2007). Worldwide, organic farming is a win-win proposition for environment, farmers and consumers. However, they are certain impeding factors like doubt in the professed quality of organic food, lack of awareness and price parity (Misra & Singh, 2016).

The agricultural sector, and in particular organic farming, is an important policy priority in a number of countries' economies around the world. The characteristic features of organic farming, such as labour intensity, seasonality, higher production costs, lower incomes, more difficult production realization, etc., have a huge impact on the state and development of organic farms. Despite the significant strides achieved in terms of spread, network and outreach of rural financial institutions, the quantum of flow of financial resources to agriculture continues to be inadequate (Mathur & Kalra, 2008).

We believe that an adequate and accurate farm management, and in addition with stable and fair financial support, is also a strong prerequisite of sustainable and prosperous organic farming. Of course, the quality of organic goods is of special importance for the realization of organic products and the increase of consumer interest. Here we must note that quality

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management is an important segment of modern farm management. Today, consumers require better quality, thus management has to be simply obsessed and persistent in attaining this goal as it is of essential importance for its success. The way to the desired results is a long process and it should include every part of enterprise, but the results are visible and long lasting (Boljevic, 2007).

In the majority of European countries, the system of subsidies for organic agriculture is relatively stable and no greater changes occurred in recent years. Support for organic farms is restricted through the implementation of maximum and minimum payment limits (with respect to the farm size or amount of financial support), payment digression and/or stocking rates. While most Member States have implemented minimum payment limits, maximum payment limits and payment digression are less frequently implemented (Johann Heinrich von Thunen-Institut, 2010). This agricultural system also entails costs for society which the farmer does not usually have to take account of. These not only include payments in the form of the subsidies which farmers receive. They also include the costs of putting right environmental problems caused by other farming practices (Lampkin, 1990).

Organic farming faces many challenges and an opportunity to change the face of the European agricultural landscape. However, while industrial agriculture, geared towards mass food production and maximising profits continues to dominate, organic farms are gaining increasing popularity among both farmers and consumers in the EU. Meanwhile, most of the CAP money is spent on direct payments to farmers under the first pillar and will remain so after 2020, which has been heavily criticised by the European Coordination Movement Via Campesina (ECVC). In addition, the second pillar of the CAP, which finances rural development and from which short chains could be supported, will face cuts, in line with the proposals of the European Commission. The European Commission argues that the new rules will allow member states greater flexibility in the use of the financial resources allocated to them, which will contribute to the development of tailor-made programs, such as the promotion of short supply chains. Therefore, although the new CAP can be seen as positive in the context of organic farming, and the changes are not progressing fast enough. Which clearly points out that organic farming still needs financial support and incentivises for the farmers (euractiv.com, 2019).

Nowadays, organic farming is being applied in over one hundred countries around the world, with significant potential for development in Bulgaria. The country is one of the richest in biodiversity countries. Over the last two decades, ways have been increasingly sought to make effective use of this enormous potential through organic farming methods. However, the dynamic changes occurring in organic production have a direct impact on the quality and the level of cost and cost of sales of organic production, labour productivity and profitability. This calls for increasing attention to its cost-effectiveness. Organic production refers to the number of intensive agricultural production. It requires the attraction of more labour and material resources on a small amount of land (Koprivlenski, 2003). Organic farms are typically small in size. The small-scale farms are the main group that has an important role for the development of the agricultural and rural area in Bulgaria (Dirimanova, 2018). According to MAFF (2013), organic farming is an important priority in the agricultural development policy in the Republic of Bulgaria and one of the highlights of the Common Agricultural Policy for 2014-2020. The effect of CAP subsidies is a constantly discussed issue among the public, politicians, academicians, practitioners, and others (Sarov & Kostenarov, 2019).

The assessment of the subsidies influencing the development of the organic sector in Bulgaria is of utmost importance. Growing export demand, especially from European consumer, subsidies for organic production and favourable government policy, and the

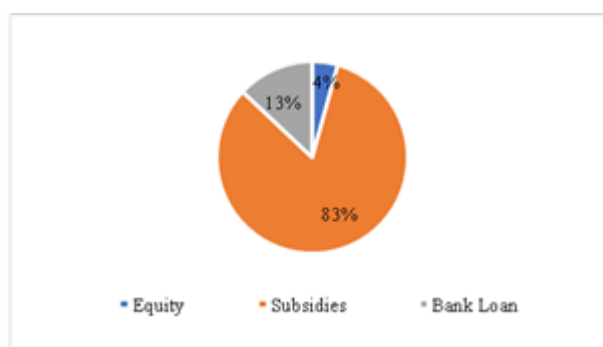
national legal framework have the greatest influences (Agapieva, 2015). Hence, the financial support is essential to the future development of the sector. Therefore, the goal of the present scientific paper is to analyse and evaluate the impact and importance of subsidies on the economic effectiveness of organic farming.

2. MATERIAL AND METHODS

The survey of 73 organic farms in Plovdiv District of Bulgaria covers the period 2014-2018 and was used to analyse and evaluate the impact and importance of the additional financial help to the organic farms. Based on this empirical information, we can conclude that there are financial resources to support organic farming in Bulgaria and that it is essential to develop more effective schemes for the distribution of European and national aid. Undoubtedly, the better organization and management of state subsidies for organic farming depends on strengthening and sustainability of production and increasing its economic efficiency.

3. RESULTS AND DISCUSSION

According to the research, 83% of organic producers benefit from subsidies, which shows that their corresponding share is really high. The financial support is used with the funds targeted and without exception, which has a positive impact on the direction of farm development. The state also responds to this form of financing as an economic lever in the restructuring of organic production, for the introduction of new equipment and technologies and other achievements of scientific and technical progress. Empirical data shows that farmers rely mainly on additional financial support – subsidies under European and national programs, and yet their organic production is difficult (Figure 1).

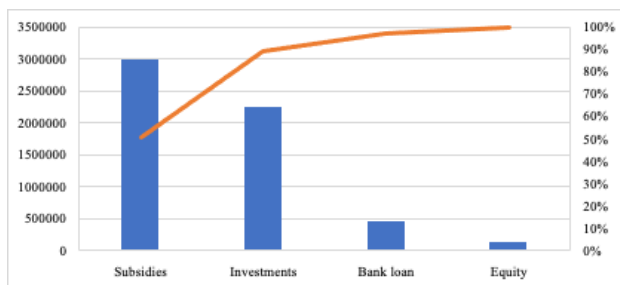


Source: Own calculations

Figure 1. Financing of the organic farms, (%)

The analysis of the organization and management of financial resources is based on the three main sources of financial resources (Agapieva-Aliosman, 2019). The figure clearly represents the share of subsidies in the total financial resources of the studied organic farms. In our view, the financial strategy is the first stage in the management of the money of each organic farm. Controlling the finances in the organic farms is a complex process. Given the specificities and characteristics of organic production, it requires a number of knowledge and skills related to the nature and scope of this type of agriculture. Depending on the fact that the

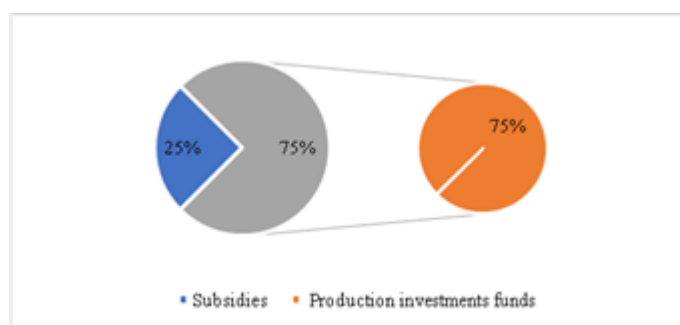
subsidies are part of the financial resources of most of the studied farms, we consider it important to analyse their connection with other types of financing and especially, the total production investments (Figure 2).



Source: Own calculations

Figure 2. Share of subsidies from the total financial structure of the organic farms, (BGN, %)

In view of the increasing findings, public interpretations and speculations about the misuse and/or unrealistic use of subsidies in recent years, the amount of investment funds compared to the amount of the obtained financing has been examined (Figure 3).



Source: Own calculations

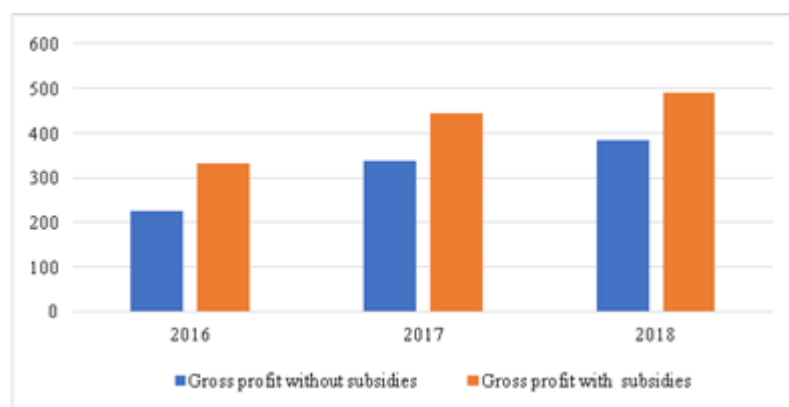
Figure 3. Share of investments from Total subsidies for organic farms, (%)

The established share of 75% shows that production investments are an important factor for the functioning and development of the activity of the sample of organic units and occupy a significant part of the subsidies received. We believe that an investment is a risky endeavour and the greater the risk, the greater its return. In addition, investments are essential for the formation of capitalization and therefore for increasing or decreasing the efficiency of bio-production. Our analysis shows that productive investments are one of the determining factors for the functioning and development of the farms being monitored. In this regard, the investment process in the organic farming of the Plovdiv District is fully consistent with the factors influencing the production development as well as with the current economic conditions.

Our study also estimates the difference in farm productivity, categorized by size as a significant factor in analysing the values and dynamics of this indicator and cost-effectiveness. This determines whether a given system of subsidies affects the productivity of

farm size groups. Subsidies have a significant impact on farm productivity as a whole. Therefore, organic farming in the study area and in Bulgaria is generally influenced by the EU's Common Agricultural Policy (CAP), the main instrument of which is subsidization. In our view, the sources of labour productivity growth are two: technical progress and an increase in the average capital-labour ratio. This is a serious challenge for the farms surveyed, given the real problems associated with the workforce and the predominantly small-scale organic farms. We agree with Newton (2004), that even a profitable farm can experience cash flow difficulties, which could lead to business failure.

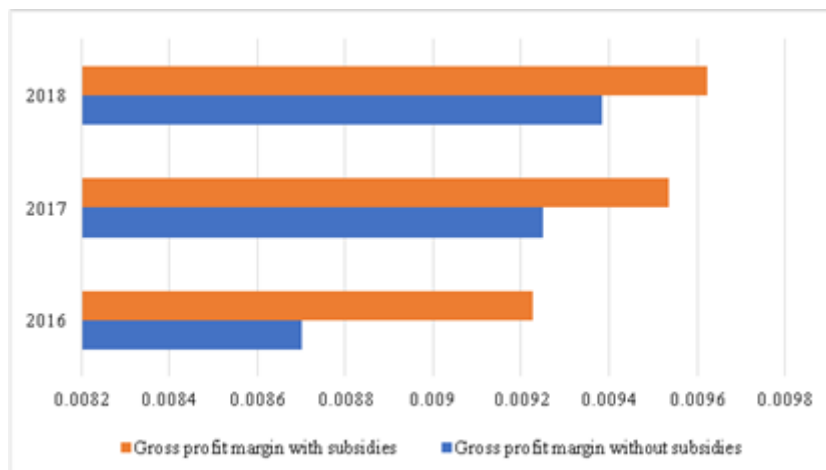
The study finds that in 95% of the organic farms surveyed, receiving subsidies is of enormous farming interest. The impact of the factor on the gross profit of 1 *da* land found for all organic production was calculated, since costs incurred, sales revenues received, and subsidies utilized were calculated as ancillary indicators earlier in the study (Figure 4).



Source: Own calculations

Figure 4. Gross profit margin per 1 *da* in the organic farms, (BGN)

Of interest is the dynamics of the level of gross profit in the observed farms benefiting from subsidies, and the graph shows that for the period its value is much higher than the profit obtained only from sales revenue. Gross profit margin was used to calculate the gross profit margin. Expressed as a percentage of revenue, this indicator is useful for comparing the productivity of organic farms over time. As gross profit may increase as gross profit margins decrease, for the sake of greater accuracy of the study, we consider it necessary to determine their size as well. The gross profit margin was used to calculate the gross profit margin. It is expressed as a percentage of revenue. The indicator is extremely useful for comparing the production efficiency of organic farms over time (Figure 5).



Source: Own calculations

Figure 5. Gross profit margin in the organic farms, (%)

The level of profitability was established overall for the organic production surveyed, as costs incurred, sales revenue received, and subsidies utilized were calculated as ancillary indicators. The increase in profitability is between 10% and 36% over the years, with no subsidies added. The impressive increase in the indicator of organic production with calculated subsidies is impressive, from 9% to 37% over the years. The difference without / with financial support in the indicator values for the period is significant – 91.49%. The analysis of the results shows that the increase (10%) of the rate of profitability in 2018, compared to the previous year, is accompanied by an increase in production costs by 80 thousand BGN (3%), which means that in the organic farms studied it is not achieved a significant increase in cost effectiveness. The significantly lower values of the unmanaged indicator indicate that subsidies play a significant role in shaping the economic performance of organic farms.

Depending on the ratio of the financial result to the resources spent on organic production, the amount of equity and attracted capital, the following additional types of profitability are calculated: Profitability of income, equity and debt-capital. Negative values of indicators without subsidies in the first year of the analysed period. Then the yields, equity and debt-capital and average selling prices are very low. The calculations are again based on unused subsidies, and the results openly show that the difference is in the positive aspect and the values of the indicators with subsidies are from 3 to 3.5 times larger.

4. CONCLUSIONS

The conducted research shows that subsidies are a cause for serious distortion of the measures applied for the development of organic production. There is a lack of effective, balanced and fair support for programs and measures in the sector in Bulgaria. Productive economic indicators, profitability and profit, are characterized by serious fluctuations. Without subsidies, both indicators tend to decline.

Subsidies support the activities of farmers, but do not stimulate an increase in the efficiency of organic production. The balance between the demand for and supply of organic products is disturbed.

This scientific work proves the huge impact and the decisive importance of subsidies in the organic farming. The paper suggests that the subsidy policy in the country and especially its distribution, need clear, transparent and fair future improvement.

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QUOTATION AS A MEASURE OF SCIENTIFIC CONTRIBUTION – THE POSITION OF THE WESTERN BALKAN COUNTRIES IN RELATION TO SOME EU COUNTRIES

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Abstract: In this paper, the ranking of scientific workers in the countries of the Western Balkan (WB) is performed according to the achieved result measured through the standardized Stanford University procedure for measuring the citation of scientific papers, using the so-called composite coefficient of citation (c). It was determined that only researchers from Serbia and Montenegro from the WB countries will be on this prestigious list, with modest results in relation to other comparable EU countries, as well as EU countries similar in terms of population. The obtained results indicate that the development of science in the WB countries is in an enviable lag behind the results of science in other EU countries, which will set great obstacles for further EU integration of these countries.

Keywords: Western Balkan countries, quotation, composite coefficient, EU countries

1. INTRODUCTION

It is the obligation of the academic staff employed at universities and scientific institutes to engage in scientific research and to publish their scientific results in scientific publications that are available to the widest possible public, so that they can be evaluated by other researchers and at the same time encourage new researches (Živković et al., 2017; Živković, 2019). The basic motive and driving force for this type of activity lies in the fact that it measures and evaluates the progress of researchers in teaching and scientific professions. Measuring and evaluating academic achievement is a "fact of scientific life" (Lane, 2010), and a widespread phrase: "Publish or perish" is the essence of engaging in scientific work. In the desire to publish as many papers as possible, there are many scientific scams: plagiarisms, autoplagiarisms, fake co-authorships (co-author in the paper who not deal with that issues), related (commissioned) quotes, predatory journals, fake sites and much more (Živković, 2019).

The quality of researchers is measured by the number of published scientific papers, the quality of the journal where the paper was published (the impact factor – IF), the number of citations, the number of citations per published paper and the size of the *h*-index. The SCOPUS database, which has been recording data since 1996, is most often used for rankings of this type, and as such it is a reliable source of information. Today, only two databases of

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this type are relevant in the world: Clarivate Analytics and Web of Science (WoS) with the categorization of SCI, SCIE (8,500 titles), SSCI (about 3,000 titles), and AHCI (about 1,700 titles) journals; Emerging Source Citation Index – ESCI (about 5,000 titles); Book Citation Index – BCI (about 60,000 titles – started in 2005); Conference Proceedings Citation Index – CPCI (about 160,000 conferences – started in 1990), as well as Scimago with about 31,000 journals classified as: Q₁, Q₂, Q₃ and Q₄, as well as papers presented at scientific conferences referred in SCOPUS.

In order to minimize fraud in scientific publications, extensive research has been conducted at Stanford University in the last few years to standardize the measurement of citations of scientific papers in 179 scientific fields (Hicks et al., 2015; Ioannidis et al., 2016; Ioannidis et al., 2019) in order to obtain an objective assessment of the quality of scientific work of individual researchers. Citation is the most important criterion for the quality of published papers, so that as a result of many years of effort, the so-called composite citation coefficient (c) has been defined (Ioannidis et al., 2019).

2. THEORETICAL FRAMEWORK OF THE RESEARCH

The issue of citation metrics methodology has recently received special attention, especially at Stanford University (Hutchins et al., 2016; Ioannidis et al., 2016; Ioannidis et al. 2019), which has led to the standardization of author citation measurements, on the basis of which a database has been created for individual scientific fields with the most cited researchers in the world for the period 1996–2017 and –2018. No large differences were observed in the results obtained.

For the purposes of ranking according to the standardized procedure proposed at Stanford University, which takes into account the position of the author in the paper (first, single or last), the calculation of the composite indicator (c) for each researcher was performed using the following formula (Ioannidis et al., 2019):

$$c = \frac{\ln(nc9617+1)}{\ln(nc9617_{max}+1)} + \frac{\ln(h17+1)}{\ln(h17_{max}+1)} + \frac{\ln(hm17+1)}{\ln(hm17_{max}+1)} + \frac{\ln(ncs+1)}{\ln(ncs_{max}+1)} + \frac{\ln(ncsf+1)}{\ln(ncsf_{max}+1)} + \frac{\ln(ncsfl+1)}{\ln(ncsfl_{max}+1)} \quad (1)$$

where is:

- nc9617 – the total number of citations,
- h17 – the h-index,
- hm17 – the Schreiber coauthorship-adjusted hm index,
- ncs – the number of citation to papers as single author,
- ncsf – the number of citation to papers as single of first author
- ncsfl – the number of citations to papers as single, first, or last author

The maximum values for these components of the composite indicator are $nc9617_{max} = 259,310$, $h17_{max} = 222$, $hm17_{max} = 103.9811$, $ncs_{max} = 135,334$, $ncsf_{max} = 149,125$, and $ncsfl_{max} = 163,476$. For the same percentages, total career citations and the composite indicator are divided into 176 sub-scientific fields.

The ranking takes into account that not all researchers publish papers in only one scientific sub-area, in conference proceedings or in journals that are not indexed in the SCOPUS database. The ranking includes all authors who have published the last five papers that are indexed in the SCOPUS database as articles, review papers or conference papers.

This paper analyzes the results achieved in scientific research in the Balkans and neighboring countries: Slovenia, Croatia, Hungary, Serbia, Bosnia and Herzegovina, Romania, Bulgaria, Montenegro, Northern Macedonia, Albania, Kosovo * and Greece, which are up to have recently been in transition, some are still, and some are EU members. A small part of the territory of Turkey and Italy belong to the Balkan Peninsula (3% and 0.1%, respectively), but due to the disproportionate size of these countries ($70 \cdot 10^6$ and $60 \cdot 10^6$ inhabitants, respectively), they are not considered in this analysis. At the same time, Hungary was considered, which does not belong to the Balkan Peninsula, but according to the number of inhabitants and connections with the Balkan countries, it was taken into consideration.

3. DISCUSSION

It is an indisputable fact that the basis of economic and overall development of a country is the development of scientific research, which is measured by the quality of published papers from that country, which depends on the size of the country (population) and the amount of government investment in scientific work and university education. Table 1 shows the results of the number of inhabitants in the studied countries with the achieved rank in the quality of scientific publications for the period 1996–2018, as well as data for several countries of approximate size by population, but with a far better position in the ranking of 216 countries in the world. Comparing the standard of living in these countries with the standard in the studied Balkan countries, in the best way confirms the above correlation between the development of scientific work and the overall development of the country (Živković & Panić, 2020a). In the ranking according to the results of scientific work, the following criteria were used: number of published papers, number of cited papers, total number of citations, number of citations per paper, number of self citations and h-index (data from SCOPUS database).

Table 1. Population in some WB countries with population growth rate to compare educational and scientific potential

Rank in the total scientific score in the world (1996–2018)	Number by population in WB countries	Country	Population in the country (2018)	Population growth (%)
52	1	Serbia	$8,7 \cdot 10^6$	- 0,50
94	2	Bosnia & Herzegovina	$3,3 \cdot 10^6$	- 0,30
95	4	Northern Macedonia	$2,1 \cdot 10^6$	+ 0,10
119	3	Albania	$2,8 \cdot 10^6$	- 0,10
-	5	Kosovo*	$1,8 \cdot 10^6$	+ 0,80
124	6	Montenegro	$0,63 \cdot 10^6$	+ 0,03
Comparison with countries similar in population:				
16	Switzerland		$8,4 \cdot 10^6$	+ 1,10
18	Sweden		$10,2 \cdot 10^6$	+ 0,65
23	Denmark		$5,6 \cdot 10^6$	+ 0,70
26	Finland		$6,1 \cdot 10^6$	+ 0,30
30	Norway**		$5,3 \cdot 10^6$	+ 0,90
Baltic countries and Luxembourg:				
60	Lithuania		$2,8 \cdot 10^6$	- 1,40
64	Estonia		$1,3 \cdot 10^6$	0,00
75	Latvia		$2 \cdot 10^6$	- 1,00
80	Luxembourg		$6 \cdot 10^5$	+ 3,00

* According to UN resolution 1244, the status has not been defined yet.

** Norway is not a member of the EU, but has been taken into account for comparison purposes due to population

The obtained results indicate that the WB countries achieved worse results compared to other EU countries of similar size, which indicates that science in the WB countries is less developed compared to developed EU countries.

Using the standardized methodology of Stanford University using WoS and SCOPUS database, 104,051 researchers for the period 1996–2017 and 105,000 researchers for the period 1996–2018 were ranked. The obtained results of the best ranked researchers in WB countries are shown in Table 2 and Table 3 (for the period 1996–2017 and 1996–2018, respectively).

Table 2. The best ranked researchers from WB countries for the period 1996–2017

No.	Researcher	Institution	Scientific field	Rank
<i>Serbia</i>				
1	Gutman Ivan	University of Kragujevac	General Chemistry	6,126
2	Kostić Vladimir	University of Belgrade	Neurology & Neurosurgery	73,319
3	Teodorović Dušan	University of Belgrade	Logistics & Transportation	77,129
4	Đorđević M.	University of Belgrade	Nuclear & Particle Physics	84,784
5	Čirić Ljubomir	University of Belgrade	General Mathematics	100,138
6	Konjević N.	University of Belgrade	Meteorology & Atmospheric Sciences	102,933
7	Atanacković Teodor	University of Novi Sad	Mechanical Engineering & Transports	103,168
8	Čirić-Marjanović Gordana	University of Belgrade	Energy	103,308
9	Cvetičanin L.	University of Novi Sad	Acoustics	103,569
<i>Montenegro</i>				
1	Stanković Ljubiša	University of Montenegro	Networking & Telecommunications	39,073

Table 3. The best ranked researchers from WB countries for the period 1996–2018

No.	Researcher	Institution	Scientific field	Rank
<i>Serbia</i>				
1	Gutman Ivan	University of Kragujevac	General Chemistry	4,438
2	Jeremić Branislav	BioIRC Centre for Biomedical Research	Oncology & Carcinogenesis	42,650
3	Čirić Ljubomir	University of Belgrade	General Mathematics	73,160
4	Đorđević Magdalena	University of Belgrade	Nuclear & Particles Physics	73,905
5	Teodorović Dušan	University of Belgrade	Logistics & Transportation	75,650
6	Kostić Vladimir	University of Belgrade	Neurology & Neurosurgery	78,559
7	Golić Jovan	Mathematical Institute SANU	Artificial Intelligence & Image Processing	93,579
8	Vukobratović Miomir	Mihajlo Pupin Institute	Industrial Engineering & Automation	97,561
9	Čirić-Marjanović Gordana	University of Belgrade	Energy	100,351
10	Atanacković Teodor	Mathematical Institute SANU	Mechanical Engineering & Transports	102,411
11	Konjević N.	University of Belgrade	Meteorology & Atmospheric Sciences	102,507
12	Cvetičanin Livija	University of Novi Sad	Acoustics	102,558
13	Petrović Zoran	University of Belgrade	Applied Physics	104,820
<i>Montenegro</i>				
1	Stanković Ljubiša	University of Montenegro	Electrical & Electronic Engineering	41,049
2	Đurović Igor	University of Montenegro	Artificial Intelligence & Image Processing	104,161

As can be seen from the previous tables, the remaining WB countries – B&H, Albania, N. Macedonia and Kosovo* do not have ranked researchers for both periods considered.

Table 4 shows the ranking of the best researchers from other Balkan countries, comparative EU countries, Baltic countries and Visegrad Group countries.

Table 4. Ranking of researchers from other EU countries similar in size for both periods, 1996–2017 and 1996–2018

Country*	Year	Total number of ranked researchers	Position of best ranked	Researcher	Institution	Scientific field
Other Balkan countries:						
Austria	2017	532	11	Kresse G.	University of Vienna	Chemical Physics
	2018	625	10	Kresse G.	University of Vienna	Mechanical Engineering & Transports
Greece	2017	250	169	Chrousos George	University of Athens	Endocrinology & Metabolism
	2018	300	213	Chrousos George	University of Athens	Pop Ioan Aurel
Romania	2017	62	16,736	Pop Ioan Aurel	Babes-Bolyai University	Mechanical Engineering & Transports
	2018	39	20,027	Pop Ioan Aurel	Romanian Academy	Mechanical Engineering & Transports
Slovenia	2017	52	1,991	Randić Milan	National Institute of Chemistry Ljubljana	Chemical Physics
	2018	55	1,917	Perc Matjaž	University of Maribor	Fluids & Plasmas
Bulgaria	2017	25	608	Maes Michael	Medical University of Plovdiv	Psychiatry
	2018	29	10,896	Atanassov Krasimir	Bulgarian Academy of Sciences	Artificial Intelligence & Image Processing
Croatia	2017	18	24,066	Reiner Željko	University of Zagreb	Cardiovascular System & Hematology
	2018	18	18,447	Reiner Željko	University of Zagreb	Cardiovascular System & Hematology
EU countries:						
Switzerland	2017	1,695	1	Grätzel Michael	Ecole Polytechnique Federale de Lausanne (EPFL)	General Chemistry
	2018	1,856	32	Reed John	F. Hoffman-La Roche AG	Biochemistry & Molecular Biology
Sweden	2017	1,659	212	Van Heijne Gunnar	Stockholm University	Biochemistry & Molecular Biology
	2018	1,706	295	Van Heijne Gunnar	Stockholm University	Biochemistry & Molecular Biology
Denmark	2017	998	323	Holst Jenst	University of Copenhagen	Edocrinology & Metabolism
	2018	1,023	123	Mann Matthias	University of Copenhagen	Biochemistry & Molecular Biology
Finland	2017	620	429	Laaksao Markku	University of Eastern Finland	Endocrinology & Metabolism

	2018	706	505	Laaksao Markku	University of Eastern Finland	Endocrinology & Metabolism
Norway	2017	441	1,057	Oxman Andrew	Norwegian Institute of Public Health	General & Internal Medicine
	2018	539	513	Lande Rusell	Norwegian Institute of Science and Technology	Evolutionary Biology
Visegrad Group countries:						
Poland	2017	243	1,936	Pawlak Zdzislaw	Warsaw University	Artificial Inteligence & Image Processing
	2018	334	1,918	Pawlak Zdzislaw	Warsaw University	Artificial Inteligence & Image Processing
Hungary	2017	150	1,761	Freund Tamás	Hungarian Academy of Science	Neurology & Neurosurgery
	2018	199	2,273	Freund Tamás	Hungarian Academy of Science	Neurology & Neurosurgery
Czech Republic	2017	153	1,122	Varma Rejender	Palacky University	Organic Chemistry
	2018	193	1,041	Varma Rejender	Palacky University	Organic Chemistry
Slovakia	2017	22	28,428	Biely Peter	Slovak Academy of Science	Biochemistry & Molecular Biology
	2018	30	3,679	Mészáros Peter	Comenius University	Astronomy & Astrophysics
Baltic countries and Luxembourg:						
Estonia	2017	13	511	Naatamen Risto	University of Tartu	Experimental Psychology
	2018	15	1,288	Naatamen Risto	University of Tartu	Experimental Psychology
Lithuania	2017	6	41,731	Kazimeras Z. E.	Vilinus Technical University	Civil Engineering
	2018	10	22,228	Kestutis P.	Center fof Physical Science	Fluids & Plasmas
Latvia	2017	2	30,822	Skuja Linards	University of Latvia	Applied Physics
	2018	4	30,691	Skuja Linards	University of Latvia	Applied Physics
Luxembourg	2017	8	13,408	Briand Lionel	University of Luxembourg	Software Engineering
	2018	15	14,023	Briand Lionel	University of Luxembourg	Software Engineering

*Countries are ranked according to the best ranked researchers

4. CONCLUSION

The citation of the researcher is the most reliable indicator of the quality of his work. If a published paper in a visible journal is not cited by other researchers (did not attract their attention) such work as if it had not been published. Also, it is not unimportant in which position the authors are signed at paper, what is the number of authors and in which areas does an author appear. The standardized Stanford procedure for measuring the citation of a

researcher in his entire opus and time of scientific activity through the so-called composite indicator (c) is the best indicator of true scientific value for any researcher.

The scientists who found themselves in the top 105,000 ranked people in the world represent the world's scientific elite, many of whom in their countries have not received adequate promotion as an incentive for young researchers to go their own way.

The obtained results for WB countries indicate that only scientists from Serbia and Montenegro are present in the world's scientific elite (approximate representation if we take the ratio of the size of these countries by population), and from other WB countries that prefer the path to the EU there is no researchers. This indicates that the level of science development in the WB countries is at a modest level, compared to the surrounding countries and other EU countries of similar size. Achieving EU standards in all areas is not possible without adequate development of science, which is the essential cause of all problems for WB countries in the EU integration process (Živković & Panić, 2020b).

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APPLICATION OF ADVANCED INDUSTRY 4.0 TECHNOLOGIES IN EUROPEAN AND SERBIAN ENTERPRISES

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Abstract: The fourth industrial revolution (Industry 4.0) is heavily influencing companies by transforming the contemporary economy and society. Industry 4.0 integrates the cyber and physical worlds by utilizing technology. Consequently, Industry 4.0 is a socio and technical related system to achieve industrial expansion with continuous digital transformation. The paper aims to investigate advanced technologies included in Industry 4.0 that have a high potential to significantly develop the digital economy in European countries and Serbia. For purposes of this paper the secondary source of data was gathered, such as Big data, 3D printings and robotics, Cloud computing services, and Horizontal and vertical integration systems. Analyzed data depicts that European countries and Serbia have made different progress in the employment of technology based on the fourth industrial revolution, where Serbian enterprises are making technological progress with a lot of delays, as well as in the other developing countries.

Keywords: Industry 4.0, Big data, 3D printings, Horizontal and vertical integration systems, Cloud computing services

1. INTRODUCTION

Industry 4.0 and advanced development of integrated technologies are anticipated to progress in terms of technical change and socio-economic influence. Hence, this transformation requires a holistic approach that includes not just technological solutions, but also innovative and sustainable systemic ones (Beirer, et al., 2020). The employ of Industry 4.0 technologies creates a proper environment for increased collaboration and communication on all system levels, by using a comprehensive cloud support system, based on a collaboration environment in combination with augmented reality technologies and mobile computing (Oesterreich & Teuteberg, 2016). Industry 4.0 is linked to “smart factory” which allows developing a virtual copy of the real world and decentralized decision making. Additionally, physical systems may mutually collaborate and communicate, and with people in real-time, all facilitated by the Internet of Things (IoT) and other similar services (Buhr, 2015).

Rapide technological development in Industry 4.0 disturbs predicting challenges and effects much more than the world has encountered in previous industrial revolutions (Morrar

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et al., 2017). The people in Industry 4.0, as well as smart systems, smart manufacturing, and people skills, have been recognized as top priorities. In the age of information technology and digital market operations, Industry 4.0 is revolutionary important for several considered reasons (Schmitt, 2017). First, Industry 4.0 reduces the pressure of the current challenges of flexibility and responsibility for the business trends that manufacturers face. These challenges include increased market instability, shorter product life cycles, greater product complexity, and global supply chains. Secondly, Industry 4.0 allows modern economies to become more innovative through transformation and thus improve productivity. Modern technology utilization, such as the industrial Internet, smart systems, and digital chains, is expected to accelerate innovation as new business models can be implemented more quickly.

Industry 4.0 is highly related to innovation. According to Geiger and Sá, (2013) innovation has built a perfect symbiosis, combining concepts such as social media, mobile, cloud, and big data, which jointly might build a new concept for the process of industrialization, a new era of marketing competition, and differentiation of products. Therefore, Industry 4.0 represents a breakthrough toward an economy based on the innovation of knowledge, Big data, and the IoT as crucial concepts (Morrar et al., 2017). Hence, the aim of this paper is to examine advanced technologies included in Industry 4.0 that have a high potential to significantly develop the digital economy in European countries and Serbia.

2. LITERATURE REVIEW

The extensive utilize telecommunications networks, especially the Internet, the beginning of a new revolution is considered. The introduction of advanced software applications such as the Internet of Things, the automation of machines and vehicles in production brought to the development of Industry 4.0 (Helbig et al., 2013). Numerous studies published on this topic examine the basic principles of design and technological trends in Industry 4.0. Considering that Industry 4.0 is conceived as the fourth deviation that has arisen in the manufacturing industry, it has evolved over the last few years into the digital transformation of the entire industrial and consumer market. In addition to focusing on digitalization, Industry 4.0 is also supported by technological innovations whose quantitative effects together create new entities and industry models that are fully oriented towards personalizing customer products and services (Riecken, 2000).

However, numerous studies reveal the consequences of these transformations, which disrupt almost every industry in every country. These changes are the heralds of the transformations of all systems of production, management, and government. A lot of people are connected by mobile networks, thus easy access to knowledge and their capabilities are diverse, which can be multiplied by technological innovations. Not only does Industry 4.0 refers to smart and connected machines and systems, but it has a much wider range and a more extended application. The areas on which the fourth industrial revolution is based are 3D printing, artificial intelligence (AI), robotics, Internet of Things (IoT), autonomous vehicles, biotechnology, nanotechnology, energy storage, materials science, and quantum computing (Klaus, 2016). These concepts are able to radically change the mode of production, mainly in developed economies (Helbig et al., 2013). Some of them are described in this paper, as well as in Table 1.

Table 1. Concepts of interest in the context of Industry 4.0 (Industry 4.0, 2015)

Field	Description
Big data and analytics	In order to support decision-making in real-time, the expected strong development a method for collecting and processing large amounts of data from large numbers sources, which will improve product quality, production economy process and utility value of the equipment.
Autonomous vehicles	An increase in the number of complex tasks that robots will be able to perform independently is expected perform, as well as their mutual cooperation.
Simulations	Provides for the possibility of virtual modeling of entire production processes.
Horizontal and vertical integration system	Individual business functions halt to be "silos", and through use of a single IT system, they can be permanently connected into one integrated and automated whole.
Industrial Internet of Things	It is envisaged to expand the use of machines and sensors in production that can exchange information via the Internet in real-time, accelerating and facilitating decision making.
Cyber-Physical Systems	With the increased dependence on the Internet connection come the risks of cyber attacks and this area requires special attention and large investments.
Cloud technology	There is the possibility of storing large amounts of data via cloud solutions, which could improve cooperation between companies in the industry.
Additive production (3-D the press)	3-D printing can be used to produce entire complex products at the customer's request, reducing the need to keep stock.
Augmented reality	Using augmented reality can facilitate the transmission of instructions workers and their training process.

2.1. BIG DATA

Big Data indicates to largeness and complexity of data that traditional processing software products are unable to download, manage, and process within a reasonable time frame (De Mauro et al. 2015). Its main purpose is transforming a large amount of raw data into useful information in real-time, that as a result has technical support automation (Lee, et al., 2014; Beirer, et al., 2020). These huge datasets can involve structured, unstructured, and partially structured data. Big data is caused by the continuous increasing production of data,

especially by the widespread deployment of digital platforms and applications in everyday life.

Big Data is a term that supports sustainability, which allows producing relevant statistics enabling better-informed decision making as much on economic as environmental or societal issues. Big data is often employed to explain sets of data characterized through high speed, high volume, and high variety, where advanced analytical tools to data processing are needed useful information by recognizing patterns, trends, and connections (Lycett 2013).

2.2. ARTIFICIAL INTELLIGENCE (AI)

Artificial intelligence can be defined as simulating the capacity for creative, abstract, deductive logic, and especially the capacity of learning by using the digital, binary logic of machines. Artificial intelligence can be also explained as an increasingly important means for computers to perform tasks that would demand human intelligence in regular circumstances (Sriram & Reddy, 2020). AI is playing a crucial role in the digitalization era, ie. Industry 4.0, whereby technologies and intelligent systems are employed to build a connection between the human (physical) and digital (virtual) worlds (Amos et al., 2020).

2.3. INTERNET OF THINGS (IOT)

Internet of Things (IoT) the digital world makes to the physical world employing advanced communication methods (Dhingra, et al., 2020). Internet of Things is the concept which the digital world transforms into the physical world employing advanced communication tools. The IoT connects devices to the Internet and applies to all devices, even those common devices, that can connect to the Internet. The IoT is a huge network of connected things and people, where everyone collects and shares information on how to utilize, and the environment in their environment vicinity (Lu, 2017). To put it simply, the IoT refers to the constant trend of connecting all types of physical objects to the Internet. Specifically, the IoT relates to any system of physical devices that receive and transmit data over wireless networks without human intervention. The IoT can also encourage companies to reassess the ways in which they approach business and give them the tools to improve business strategies.

2.4. CYBER-PHYSICAL SYSTEMS

The Cyber-physical system (CPS) is the integration of systems of a different character whose main purpose is to control the physical process and to adapt to new conditions in real-time through feedback. They are made at the intersection of physical processes, computing, and networking. The ‘physical’ term points to an object as seen by the human senses, whilst the ‘cyber’ term indicates a virtual image of the world to which a physical object belongs. The cyber-physical systems have the ability to observe from a physical and a virtual perspective, where supervision by people can evaluate operational conditions and support additional decision-making, and operational adaptation. A crucial component of cyber-physical systems is the presence of interrelated objects that produce and gain various data employing sensors, actuators, and network connections. CPSs are changing the way people communicate with engineering systems, just as the internet has changed the way people interact with

information. In the future, CPS will be present in all sectors of industry and within Industry 4.0.

It is considered as transformative technologies for controlling interrelated systems between computational capabilities and physical assets (Baheti, 2011). With recent advances in data collection systems and computer networks, the competitive industry requires companies to keep up with high-tech methodologies. In addition, by integrating CPS into manufacturing, logistics, and services into current industrial practice, it will transform today's factories into Industry 4.0's factory with significant economic potential (Lee & Lapira, 2013).

2.5. AUGMENTED REALITY – AR

The digital revolution continues to dominate and has created one more of the cutting-edge technologies such as augmented reality. Augmented reality extends the physical world, adding layers of digital information. AR does not build whole artificial environments to replace real virtual ones, in contrast to virtual reality. AR is shown in a direct perspective of the current environment and including videos, sounds, and graphics (Schuh et al., 2015). The term appeared in 1990, and the first commercial utilization was in the military and the media (Esquire, 2009; Cameron, 2010).

The majority of scientists in the previous period have visualized what augmented reality is and what it can be, but only recent technological advances have provided an opportunity for it to become a reality. Augmented reality is a technology that extends the existing boundaries of the real world. The augmented reality is different from virtual reality which replaces reality, while AR only expands, but does not replace it. The augmented reality can be defined as a depiction of the physical environment in the real world with overlaid images generated by computers that change the view of reality (Schuh et al., 2015). The progression of smart mobile devices and the constant improvement of their abilities augmented reality has infiltrated in various aspects of human life. Augmented reality is the process of merging interactive digital elements with real details of the environment.

2.6. 3D PRINTING AND ROBOTICS SYSTEM

3D printing is a technique that is based on manufacturing a product layer by layer. This technique contradicts traditional production techniques, such as welding, forging, and milling (Arbabilia & Wagner, 2020). According to Lynch, (2019), investing in 3D printing technology is recognized as the ability to produce products that will be closer to the ultimate customer.

Similar findings can be found at Gross, (2013), that the 3D printing has gained significant attention in supply chains, where many governments, as their authorities and policy creators aim to revolutionize production using 3D (Arbabilia & Wagner, 2020). Also, pre-eminent firms, such as Mercedes Benz and Disney have invested in 3D printing technology to develop their supply chains.

2.7. CLOUD TECHNOLOGY

Cloud computing is regarded as a very viable alternative to a corporate information technology infrastructure for internal information management and organization (Liu & Xu,

2017). Consequently, cloud technology has redefined the way that the data is stored and shared. It has become a modern alternative data storage settlement for organizations (Ho et al., 2017). Cloud services offer highly changed computing platforms that can be configured on the demand of users thereby, reducing the investment that needs to develop the desired application of analytics (Dhingra, et al., 2020; Rastogi, et al., 2018).

2.8. HORIZONTAL AND VERTICAL INTEGRATION SYSTEM

The terms such as horizontal and vertical integration are known from numerous contexts. The company which is a horizontally integrated focuses its actions throughout its core jurisdiction and establishes cooperation with the construction of the final supply chain. On the other hand, the company which is vertically integrated retains as much of its value chain as it can - from product development to production, marketing, sales, and distribution.

The horizontal integration can take place at several levels, one of them is the supply chain (Liu & Xu, 2017). In this context, Industry 4.0 provides the visibility of data and a high automated collaboration through the upstream supply chain and logistics that ensure the production processes as well as the downstream supply chain that the final products are delivered to the market.

The aim of vertical integration in Industry 4.0 is to relate all logical layers within the organization, as well as to share information among different functional areas from the field layer through research and development, product management, sales and marketing, quality assurance, IT, and etc. The information shares visibility these layers thus that both tactical and strategic decisions can be data-driven (Beier et al., 2020).

3. INDUSTRY 4.0 IN SERBIA

Serbia is in the middle on the technological map of Europe (Strategy of industrial policy of the Republic of Serbia from 2021 to 2030, 2020). Similarly, when looking at the digital economy and society index (DESI index) Serbia is not in a satisfactory position. Therefore, Serbia adopted its national Industry 4.0 Program on June 6, 2019, at the Fourth International Conference on Industry 4.0 - AMP I4.0 2019, entitled: Digital Platform for Industry 4.0 in Serbia. Prokopović et al. (2020) have also thought that in Serbia digital revolution is still silent and closely watching process. On the other hand, Marjanovic et al. (2017) stated that even in transitional economies such as Serbia, dominantly large firms are applying smart technology. It was concluded that in Serbia digital technology concept was mainly applied in food (Marjanovic et al., 2017), textile, and apparel industries (Lalic et al., 2019) industries. Both group of authors Marjanovic et al., (2017) and Lalic et al., (2019) highlighted “near real-time production control system” and “software for production planning and scheduling” as the frequently used concepts among Serbian producers. Additionally, Lalic et al. (2018, p. 144) found that even though Industry 4.0 technologies are leading in manufacturing enterprises in Serbia, “the assembly process and service offers improves their organizational performance”. Recently, Spasojevic Brkic et al. (2020) recognized the benefit of this emerging approach, in the sense that in Serbian manufacturing companies “upgrading of technological levels forces employment of proactive people with soft culture in industrial companies” (Spasojevic Brkic et al., 2020, p. 101). Finally, Čočkalović et al. (2019) noticed that young entrepreneurs are the future of Serbia and they must keep pace with the development of ICT, which is the basis of the Industry 4.0.

4. USE OF ADVANCED TECHNOLOGIES INCLUDED IN INDUSTRY 4.0 IN EUROPEAN AND SERBIAN ENTERPRISES

This paper employed the secondary data, that downloaded from the Eurostat database (www.ec.europa.eu). In order to gain insight into the importance of some of the researched areas on which the fourth industrial revolution has established, it was investigated the data on the rate of use of Industry 4.0 technologies in European countries and Serbia. Therefore, Table 2 summarised the data on the rate of use of cloud computing services in companies in European countries and Serbia.

Table 2. Cloud computing services in enterprises in European countries and Serbia in 2018

Country	CC S used over the internet	CC S used over the e-mail	CCS used over the office software	CCS used over the hosting for the enterprise's database	CCS used over the storage of files	CCS used for finance or accounting software applications	CCS used over the Customer Relationship Management software	CCS used computing power to run the enterprise's own software	high CC services
Belgium	40	29	24	22	29	16	16	13	25
Bulgaria	8	6	5	5	5	2	2	2	4
Czechia	26	21	15	9	17	9	5	5	13
Denmark	56	41	32	30	39	29	23	21	38
Germany	22	11	8	8	14	6	4	4	10
Estonia	34	23	14	9	16	22	7	3	24
Ireland	45	35	28	24	35	20	16	10	28
Greece	13	9	6	5	8	3	3	3	5
Spain	22	16	11	14	16	7	7	6	11
France	19	13	9	12	15	6	7	4	11
Croatia	31	25	17	14	20	14	5	7	17
Italy	23	19	11	10	13	8	6	3	11

Cyprus	27	22	16	8	18	8	7	5	12
Latvia	15	9	6	7	6	7	3	1	8
Lithuania	23	16	9	12	14	9	6	8	14
Luxembourg	25	16	14	13	18	7	7	6	12
Hungary	18	13	10	7	11	6	5	6	10
Malta	37	29	23	15	27	10	9	8	17
Netherlands	48	32	27	34	35	28	22	12	33
Austria	23	13	9	7	16	4	5	5	9
Poland	11	8	6	4	6	3	3	2	5
Portugal	25	20	13	10	16	8	6	8	13
Romania	10	8	5	5	6	5	0	3	6
Slovenia	26	19	15	10	15	9	5	7	15
Slovakia	21	18	13	8	13	9	6	5	13
Finland	65	52	43	34	45	36	24	12	44
Sweden	57	41	30	30	42	29	18	15	37
UK	42	30	31	20	32	19	14	12	26
Norway	51	39	31	33	39	31	20	16	37
Montenegro	18	12	8	9	9	7	2	5	8
Serbia	15	/	/	/	/	/	/	/	6
Turkey	10	8	6	6	7	7	4	5	8
B&H	8	6	4	5	5	5	2	3	6

Source: Eurostat [isoc_cicce_use] - data extracted in 16.06.2020

The data in Table 2 represents the use of cloud computing services that companies use through: the internet, e-mail, office software, hosting for the enterprise's database, storage of files, finance or accounting software applications, customer relationship management software, computing power to run the enterprise's own software, and high cloud computing services. Unlike European companies, especially Belgian companies, which are in the leading position in the application of cloud computing services in all the described categories, Serbia is at a very low level of application of cloud computing services.

Furthermore, the use of 3D printing and robotics in small, medium, and large enterprises in Europe and Serbia was analyzed. Table 3 depicts the percentage of enterprises by size that use 3D printing for different purposes, such as 3D printing for prototypes or models for sale, 3D printing for prototypes or models for internal use, 3D printing for goods for sale, 3D printing for goods to be used in the enterprise's production process.

Table 3. Employing of the 3D printing and robotics in 2018

Percentage of enterprises with 3D printing												
Country	Small enterprises (10-49 persons employed)				Medium enterprises (50-249 persons employed)				Large enterprises (250 persons employed or more)			
	Use 3D printing for prototypes	Use 3D printing for models for sale	Use 3D printing for internal use	Use 3D printing for goods for sale	Use 3D printing for prototypes or models for sale	Use 3D printing for prototypes or models for internal use	Use 3D printing for goods for sale	Use 3D printing for goods to be used in the enterprise's production process	Use 3D printing for prototypes or models for sale	Use 3D printing for prototypes or models for internal use	Use 3D printing for goods for sale	Use 3D printing for goods to be used in the enterprise's production process
Belgium	38	41	14	30	33	68	14	29	23	74	12	35
Bulgaria	30	44	23	29	38	61	26	42	26	81	:	41
Czechia	31	70	17	47	30	73	14	57	16	86	12	61
Denmark	51	75	31	47	42	73	28	52	32	89	18	59
Germany	/	/	/	/	/	/	16	/	/	/	9	/
Estonia	69	70	24	32	42	84	28	66	18	100	9	45
Ireland	38	57	37	33	29	75	16	36	23	78	6	42

Greece	36	52	51	23	30	39	20	18	22	69	6	25
Spain	44	70	30	34	37	83	19	34	31	85	14	39
France	41	64	18	29	34	82	8	28	30	88	9	32
Croatia	26	41	14	15	32	50	26	31	20	92	22	/
Italy	33	63	17	33	36	87	12	31	30	86	10	31
Cyprus	42	88	17	55	27	64	27	36	0	50	0	50
Latvia	32	55	23	26	20	68	0	32	30	50	0	40
Lithuania	20	44	23	27	27	53	17	34	13	75	6	44
Luxembourg	24	45	14	21	21	45	6	6	33	75	8	25
Hungary	53	61	40	48	39	70	19	38	31	81	11	61
Malta	24	57	29	37	32	65	23	54	10	100	10	47
Netherlands	66	62	41	40	52	78	29	32	39	77	24	42
Austria	49	79	22	46	43	81	12	29	27	84	9	39
Poland	51	72	23	28	47	81	12	30	29	89	13	41
Portugal	69	54	38	36	52	80	10	40	38	90	10	34
Romania	26	49	41	30	29	48	18	25	32	56	16	39
Slovenia	44	76	23	31	39	74	18	51	30	89	22	43
Slovakia	42	58	6	14	31	50	17	45	13	82	8	27
Finland	33	81	27	42	30	81	13	31	23	90	/	29
Sweden	42	62	11	18	50	90	13	23	36	89	13	27
UK	2	6	3	5	8	16	1	4	8	22	5	12
Norway	45	76	13	21	38	86	16	32	27	90	8	27
Serbia	48	48	44	48	33	48	21	48	21	58	13	58
B&H	66	46	31	28	61	42	22	28	33	32	52	43

Source: Eurostat [isoc_eb_p3d] - data extracted in 16.06.2020

The data from Table 3 show that Serbia is at a satisfactory level in the use of 3D printing and robotics, given that it ranks among the leading European countries in the use of 3D printing for various purposes.

Furthermore, enterprises that have an ERP software package to share information between different functional areas were analyzed. The data available on the Eurostat website are shown graphically in Chart 1 and indicate the percentage of companies in 2019 that had an ERP software package in their business.

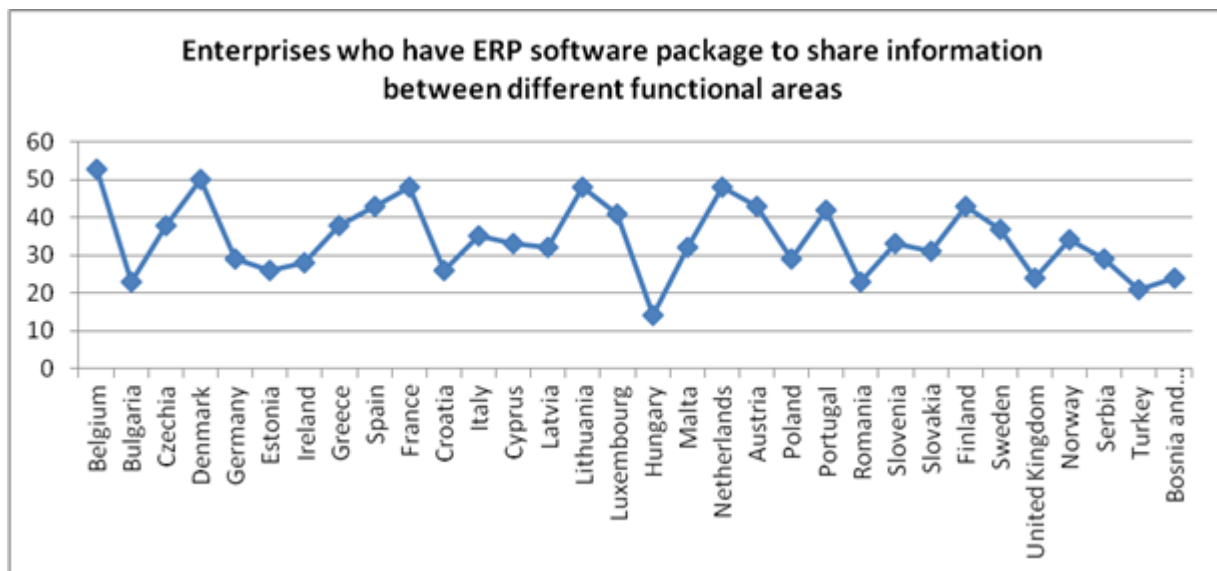


Chart 1. Vertical integration system in 2019 (Source: Eurostat [isoc_eb_iip] - data extracted in 16.06.2020)

Enterprises who have had the ERP software package to share information between different functional areas aims to relate together all logical layers within the organization. Chart 1 depicts that Belgian companies are the leaders in the application of ERP software package of 53%. In opposite, Turkish companies have the least share in utilizing the ERP software package (21%), while Serbian companies apply the vertical integration system by using ERP software package use to share information between different functional areas of 29%.

In the next, Chart 2 shows integration with customers/suppliers and supply chain management. It could be spotted that Finnish companies lead in the application of horizontal system integration with 79%, then Latvian companies engage with the lowest percentage of construction of the final supply chain of 7%, while the horizontal integration system in Serbian enterprises is with 18%.



Chart 2. Horizontal integration system in 2018 (Source: Eurostat [isoc_eb_ics] - data extracted in 16.06.2020)

According to Eurostat data from 2018, the use of Big Data by European companies without the financial sector, who have 10 persons employed or more was analyzed. The data of enterprises that analyzing big data from any data source are depicted, where Malta has the highest percentage of companies that use big data (24%). The lowest percentage of companies is observed in Cyprus with 5%. The data for using Big data in Serbian enterprises do not exist in evidence (www.ec.europa.eu), which indicates that Serbia is still not keeping pace with modern technological trends, which is an important breakthrough in the application of Industry 4.0 (Spasojevic-Brkic et al., 2020).

Further, Slovenia is a country with the highest percent of enterprises who analyzed their big data from smart devices or sensors with 65%, while Greece is the country with the smallest percentage share with 15%. Percentage of enterprises analyzing big data from geolocation of portable devices shown that Romanian enterprises the mostly used employed big data from geolocation of portable devices by 69%, and Estonia is the country with the smallest analyzing big data (25%). The highest percentage of enterprises analyzing big data generated from social media have Ireland companies (66%), while the lowest percentage is observed in Bulgarian companies (29%). Percentage of enterprises analyzing big data from the other sources is the highest in Sweden (47%), and the lowest in Luxembourg (10%). The percentage of enterprises big data analysis is done by employees, and results show the highest percentage of enterprises that use big data analysis is done by employees in Slovenia (91%), while Norway shows the lowest level of application (59%). Big data analysis for the enterprise is done by an external service provider in Austria (60%), while in Bulgaria and Slovenia it is least used with 24%.

5. CONCLUSION

Industry 4.0, which based on Big data and analytics, autonomous vehicles, simulations, horizontal and vertical integration systems, industrial Internet of Things, cyber-physical

systems, cloud technology, 3D printing and robotics, augmented reality are becoming means of radically changing the mode of production, not only in developed economies but in developing economies.

The aim of this paper is to examine the advanced technologies included in Industry 4.0 which represents a breakthrough towards an economy based on technological innovations, and which significantly affects the development of the digital economy in European countries and Serbia. According to Eurostat data (www.ec.europa.eu), an analysis of the application of Industry 4.0 concepts in European and Serbian companies was performed. The main contribution of this study is covering the gap in the literature about the application of advanced technologies included in Industry 4.0 in Serbian companies. It also provides a detailed overview of how far this concept is important for the development of the digital economy in European and Serbian companies.

Having in mind that considered European countries and Serbia have made divergent progress in the application of technology based on the fourth industrial revolution, it could be concluded that Serbian enterprises are keeping pace with technological progress with a lot of delays. According to Spasojevic-Brkic et al. (2020), Serbia is not an industrially advanced country. Additionally, the domestic enterprises have the most problem with data analysis, utilization of cloud technology, artificial intelligence, as well as with a lack of programmers, which is an important driver for the development of Industry 4.0. (Savic et al., 2019).

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CYBERSECURITY STRATEGY AND LEADERSHIP MANAGEMENT ISSUES

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Abstract: Cyberspace has become a defining dimension of our everyday lives. It affects every segment of our lives, be it the economy, politics, culture or even certain elements of our private lives. However, the services that make up cyberspace and the tools that enable them are increasingly dependent on us. The failure of these systems and services not only causes serious disruptions in everyday life, but now, in addition to material damage, they also pose a serious danger and risk to people's lives. Cyberspace and the security it provides are a fundamental interest for all countries. However, this has only been recognized in the last decade and a half. Since the mid-2000s, the number of countries capable of handling this at the state level has been gradually increasing. The study reviews the cyber defense capabilities that Europe and within it, Hungary needs, how to create them, and the role of the participants in all of this.

Keywords: cybersecurity strategy, leadership, management, risks, security, education

1. INTRODUCTION

The importance of cyberspace today can no longer be questioned or avoided. Accordingly, challenges, threats and risks in cyberspace need to be addressed at a strategic level. This is best reflected in countries' strategic visions of national cybersecurity, as in addition to the global powers, smaller countries are also seeking solutions to cybersecurity issues at the national level. These solutions seem to be different in each country, but they are united by one thing: security. About 20 percent of small and medium-sized enterprises operating in the European Union have some kind of information security strategy; in Hungary this proportion is similar, 17–18 percent. According to experts, the European Union is also in a bad position in terms of responses to possible data loss, while these SMEs are mostly online companies. Larger companies are already in a better position in this area: in Hungary, more than half of them have some kind of information security system, so they are able to apply the necessary procedures even in the event of an attack or data loss.

The biggest problem in the protection of IT systems is the human factor, i.e. the attacks can still be successful mainly due to the carelessness, irresponsibility and possibly lack of preparation of employees. Developing an information security strategy, understanding the relationship between business objectives, functions, and information security is a core interest

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of countries, organizations, and leaders. The preparation of strategic plans, the necessary strategic cost planning and reporting procedures, and the ways in which the costs of security investments are passed on to management must become an integral part of organizations. A key player in information security management is the head of the information security organization, which is responsible for organizing and maintaining data and information protection, providing awareness training, and selecting and implementing key metrics (KPIs) for control.

2. CLARIFYING THE CONCEPTS

Since the basis of scientific thinking and research is always a review of the system of concepts and terminology of the given area, it is worth examining the concept of cybersecurity without delving deeper into the topic. „It may seem evident, that for the benefit of mutual understanding the terminology and notions of policies and strategies created on the same field should have the same meaning for all parties involved. Generally, this is not the case, therefore the states often use differing notions in their documents (legislation, strategies, recommendations, guidelines etc.), which could lead to interpretation problems on both national and international levels.” (Berzsenyi, 2014).

Most cyber security related documents use different terminology, therefore the clarification of conceptual framework is often one of the most difficult tasks for the strategists working in the field of cyber security. This explains the opinion of experts who states that it is better to put aside questions of terminology and concentrate on other areas that can produce faster and more spectacular results. At the same time, if we want to comply with international recommendations and requirements, it is important to know the different aspects of the definition of cybersecurity, because, as we will show later, the use of well-defined terminology and its consequent application will play a more and more important role.

The term of cyber security has been formed to determine the correlation between cyber space and security. This term is now widely used by consultants, analysts, lobbyists and politicians. At this point, numerous questions could be raised regarding the meaning and usage of the term or even regarding the processes, tools and users. The establishment of the conceptual framework of cyber security is also facing difficulties by the increasing popularity of the term in the media, where the term is used in a general, simplified form for every event concerning the malicious use of computers. The United States Department of Homeland Security has two definitions of cybersecurity on its website for handling government IT events. The shorter definition states: Cybersecurity: The activity or process, ability or capability, or state whereby information and communications systems and the information contained therein are protected from and/or defended against damage, unauthorized use or modification, or exploitation (NICCS, 2020).

However, there is also a longer, more comprehensive definition on the next to this one, and many government documents and directives are given as source. This indicates that cybersecurity is difficult to define even for the US government. It does not get easier either, if we try to define cybersecurity from the viewpoint of a given sector, such as the operation of critical infrastructure or the military.

From a military standpoint, cybersecurity is a broader concept and usually includes a strategic element and is closely related to cyberdefense and cyberwar. According to the military dictionary of the United States Department of Defense, cybersecurity is “Prevention of damage to, protection of, and restoration of computers, electronic communications systems, electronic communications services, wire communication, and electronic communication,

including information contained therein, to ensure its availability, integrity, authentication, confidentiality, and nonrepudiation.” (Dtic.mil, 2020).

Considering the above, when defining cybersecurity, we should also consider the five main areas that cybersecurity covers, according to the European Union Agency for Cybersecurity (ENISA) (Brookson, 2015):

1. Communications security: Protection against a threat to the technical infrastructure of a cyber system which may lead to an alteration of its characteristics in order to carry out activities which were not intended by its owners, designers or users.
2. Operations security: Protection against the intended corruption of procedures or workflows which will have results that were unintended by its owners, designers or users.
3. Information security: Protection against. The threat of theft, deletion or alteration of stored or transmitted data within a cyber system.
4. Physical security: Protection against physical threats that can influence or affect the well-being of a cyber system. Examples could be physical access to servers, insertion of malicious hardware into a network, or coercion of users or their families.
5. Public / National security: Protection against a threat whose origin is from within cyberspace, but may threaten either physical or cyber assets in a way which will have a political, military or strategic gain for the attacker. Examples could be ‘Stuxnet’ or wide-scale DOS attacks on utility-ties, communications financial system or other critical public or industrial infrastructures.

The intersection of international law and cyber security is a novel and excessively complex issue not just for Hungary but for all other developed countries. In general, there is an ongoing professional discussion regarding the applicability of international law and international recommendations to cyber space, especially in the case of cyber warfare. In the past decades the Hungarian governments did not explicitly stated that Hungary recognizes the applicability of international law to cyber space, moreover the interpretation indicates that Hungary maintains the applicability of domestic law to the Hungarian cyber space.

However, in some particular issues Hungary is looking forward and contributing to different initiatives in relation with international law and cyber issues. [6]. Therefore in the following section we will consider recommendations from ENISA, the International Telecommunications Union (ITU), and NATO, however in this study there is no place to outline the deconstructed cybersecurity model used by these institutions in detail.

3. THE INTERNATIONAL FRAMEWORK OF CREATING A CYBERSECURITY STRATEGY

In order to analyse a cybersecurity strategy and define its role in the hierarchy of strategic documents, it is necessary to briefly address the concept of strategy-making after the clarification of the used terms. From a public policy point of view, strategy is a long-term, structured plan of actions, which are implemented to achieve a specific goal or state (Steiner, 1979).

In order to efficiently implement the strategic steps, the strategy document defines those responsible to each action and assigns resources to them. Strategic planning involves the detailed and methodologically consistent definition of each action, including the evaluation and the strategy’s fine-tuning process (Csiki, 2014).

3.1. THE RECOMMENDATIONS OF THE INTERNATIONAL TELECOMMUNICATIONS UNION (ITU)

The ITU has been operating since 1947 as a specialized organization of UN, and has nearly 700 industry and associate members in the 193 Member States. Its primary goal is to achieve international cooperation in standardizing infocommunication so that networks can be connected without problems, with special attention to the global distribution of radio frequencies and satellite orbit positions. The organization formulates recommendations for uniform methodology and planning system through its world meetings research groups and workshops. Its recommendations are not mandatory but contain scientifically sound results and good practices.

The ITU council decided on the organization of the World Meeting of the Information Society in 2001 with the approval of the UN General Assembly. The first phase of the meeting took place in Geneva in 2003, while its second phase in Tunisia in 2005. After the summit ended, ITU had an important new function: building trust between ICT users, and strengthening the security of infocommunication and telecommunications systems (UN, 2001). In 2007, the organization created the Global Cybersecurity Agenda (Global, 2017) which is an international framework to fight cybersecurity challenges. To promote the creation and development of national cybersecurity strategies, the organization issued a manual in 2011, which is still considered a basis when strategies involving cyberspace are evaluated (Wamala, 2012).

3.2. THE RECOMMENDATIONS OF THE EUROPEAN UNION AGENCY FOR CYBERSECURITY (ENISA)

ENISA was founded based on a decision of the EU and started its operation in Crete, in September 2005. ENISA strengthens the network and information security of EU Member States and the business community, and helps them address their problems, and also performs scientific activity. The Agency collects information for risk analysis, works out methods to prevent security problems, increases awareness, helps create security standards, creates its own guidelines and also advises the European Committee.

ENISA has published numerous guidelines, recommendations, and manuals, of which the practical guide on the development and execution of national cybersecurity strategies, written in 2012 (Liveri and Sarri, 2012) is of paramount importance when the international embedment of national cybersecurity strategies are examined. The organization issued another practical guide for the analysis, supervision and development of national cybersecurity strategies (Liveri and Sarri, 2012). It helps designers find shortcomings of the cybersecurity strategy, and find indicators necessary for monitoring the execution of the strategy. In the past few years, there have been many legal and public policy changes in the whole of the EU, as a result of which the agency published a new, good practice guide (ENISA, 2016), to help member states create their national cybersecurity strategy. The guide analyzes in detail the recommended elements of cybersecurity strategies, the method of creating and developing them, their main phases, and good practices, recommendations and policies for each step.

Since 2004, Hungary is a Member State (MS) in the EU, therefore international cooperation is crucial. Owing to the adoption of the NIS Directive, in 2016 an EU-level Cooperation Group was settled up with the aim to improving cross-border exchange of information and trust building.

Hungary also participates in the National Liaison Officers Network a statutory board of ENISA composed of representatives of all MSs. The Network facilitates the exchange of information between ENISA and the MSs, and supports ENISA in disseminating its activities, findings and recommendations to the relevant stakeholders across the Union.

3.3. NATO RECOMMENDATIONS

The NATO Cooperative Cyber Defence Centre of Excellence (NATO CCDCOE) was founded and accredited by NATO in 2008. The Centre is one of the most important organizations in tackling cybersecurity challenges. It performs cybersecurity training, research and development and offers consultations. They have created many online and printed publications on ethical and legal questions of cyber conflicts and cyber warfare, and on creating proper cybersecurity. They also publish in areas of technology, and on the creation and development of cybersecurity strategies.

The National Cyber Security Framework Manual was published in 2012 (Kliburg, 2012). It presents a cybersecurity framework and provides detailed background information and a theoretical framework to help the reader understand the different aspects of national cybersecurity. Similarly to the guides of ITU and ENISA, it provides guidance for the creation of a national cyberstrategy, outlining the area of application, determining the dimensions of cooperation, and identifying the critical issues that need regulation.

4. CREATING A CYBERSECURITY STRATEGY

Some experts say that a national cybersecurity strategy should be planned for 10 years, but international practice may be different from this (Table 1). The operational principle of strategic planning is cyclicity, which means a development process that returns to itself, and allows feedback and evaluation during and after execution. Although the time necessary for creating a strategy largely depends on the size, extent and environment of the given area of professional policy, the relevant regulations and international recommendations, generally, it can be stated that the strategic plan document can be optimally created in in 4–6 months. After this, it can be put up for professional and social discussion.

Cybersecurity strategies change in shorter periods due fast changes is cybersecurity and the fact that it is now approached as a strategic issue. For the first 5 years, it is worth elaborating the activities, actions and the resources assigned to them, and from the sixth year, it is worth working it out more generally based on national opinions. Based on this, a cybersecurity strategy would belong to medium-term strategies. The decree about strategic leadership puts three document types into the group of medium-term strategies: national medium-term strategy, professional policy strategy and white paper. Since of the three types, only the national medium-term strategy has to be prepared and accepted, where preliminary evaluation is mandatory, and also a follow-up evaluation has to be done in a year, a new national cybersecurity strategy would have to be a medium-term strategy to serve the goals adequately and fit into the hierarchy of strategic documents properly.

To protect its cyberspace, Hungary has to have the minimum capabilities that can ensure the proper level of protection and enable Hungary to take part in international cooperation with good results. The highest level of tasks that have to be fulfilled nationally is the National Cybersecurity Strategy (NCSS). “The first national cyber security strategy (Government Decision No. 1139/2013 (21 March); NCSS) was published in 2013, after the new decree on

the strategic management system came into force, however it does not conform to the rules of the decree, and the NCSS is not listed in the decree as a strategic document. The strategy does not correspond with the national criteria and seems incomplete and outdated compared to its international counterparts. Despite its shortcomings, both from the professional and the public perspectives NCSS reflects to the importance of cyber security. In 2014 the draft version of the National Cyber Security Action Plan (NCSAP) was finalized by a dedicated working group and the document covered several important issues like the coordination of activities at the operational level, handling international cyber cooperation, management of research and development and details on cyber education improvements, however the NCSAP has not yet been officially adopted by the government and its content is not publicly available.

By the end of 2016, the unclear vision of the NCSS, the missing action plan and other shortcomings together with the new directive on network and information systems of the European Union (NIS Directive) led to the idea of a new cyber security strategy that was articulated amongst the cyber security and policy professionals. In the beginning of 2017 a working group called the Information Security Strategic Committee was set up with the goal to lay down the basis of a new cyber security strategy. The main goal of the strategy planners was to correct the mistakes of the NCSS and bring the new strategy closer to the international requirements. The new strategy would have focused on the: creation of a free, secure and innovative cyber space; improvement of Hungary's cyber competitiveness; adaption of new technologies securely in the public and private sector; raising awareness.

However, for unclear reasons, by the end of the 2018 year the legislators chose to keep the 2013 NCSS in force, and a new sectoral strategy has been adopted on network and infrastructure protection (Government Decree No. 838/2018. (XII. 28.)), which details the strategic steps Hungary intends to take in order to implement the NIS Directive and the European Cyber Security Strategy. According to the plans NIPS will be in force until 2022 and a detailed Action Plan will include the timespan of the actions, the necessary resources and the stakeholders responsible for the different elements of the implementation” (Anamaeria et.al., 2020).

In contrary with the Hungarian model nowadays several countries adopt so-called “second-generation” (2.0) cybersecurity strategy documents, which differ from their first-generation counterparts in crucial areas. Moreover the “cyber-leader” countries develop “third-generation” (3.0) strategies and action plans.

In most countries, first-generation (1.0) cybersecurity strategies focused on identifying and presenting cyberspace as an important area of national security, identifying the important government players and who is responsible for what, and creating and developing the governmental organizations and concepts which are indispensable for handling challenges and threats from cyberspace at a national level. In many cases, governments had to create the processes described in first-generation strategies from scratch, therefore they can be considered foundation documents concerning a national need and responsibility for the security of cyberspace. On the other hand, next-generation cybersecurity strategic documents attempt to respond to an environment where basic cybersecurity coordination is present thanks to government strategies and organizations that were created, and no one questions the importance of cybersecurity in national security. As a result, next generation cybersecurity documents present a clearer picture of the challenges and threats in cybersecurity; they have clear, well-defined goals and put great emphasis on creating and developing concrete cyber capabilities and have many guidelines and documents which help interpretation and accountability (Balaz and Berzsényi, 2017).

Table 1. National cybersecurity strategies (NCS) and its timespan of selected European countries (edited by the authors)

Country	NCS 1.0	In effect	NCS 2.0	In effect	NCS 3.0	In effect
Czech Republic	Cyber Security Strategy of the Czech Republic for the 2011 - 2015 Period	2011–2015	National Cyber Security Strategy of The Czech Republic for the Period from 2015 to 2020	2015–2020		
United Kingdom	The UK cyber Security Strategy: Protecting and promoting the UK in a digital world	2011–2016	National Cyber Security Strategy 2016-2021	2016–2021		
Estonia	Cyber Security Strategy. Tallinn.	2008–2013	Cyber Security Strategy 2014-2017	2014–2017	Cybersecurity strategy Republic of Estonia	2019-2022
France	Information Systems Defence and Security: France's Strategy	2011–2015	French National Digital Security Strategy	2015–		
Netherlands	The National Cyber Security Strategy (NCSS): Success through cooperation	2011–2013	National Cyber Security Strategy 2: From Awareness to Capability	2014–2016	National Cyber Security Agenda	2018-in force
Hungary	Magyarország Nemzeti Kiberbiztonsági Stratégiájáról	2013–in force				
Germany	Cyber Security Strategy for Germany	2011–2016	Cyber-Sicherheitsstrategie für Deutschland	2016–in force		
Slovakia	National Strategy for Information Security in the Slovak Republic	2008–2015	Cyber Security Concept of the Slovak Republic for 2015-2020	2015–2020		

5. EVALUATION OF A CYBERSECURITY STRATEGY

A cybersecurity strategy works well if it can perform its contents well and reaches the security goals within it. However, there are possible “traps” of cybersecurity strategies, which may render implementation unsuccessful. Such pitfalls of implementing the strategy can be (CISM, 2020): overconfidence, optimism, “anchoring”, bias, following others, mistaken agreement, focusing on individual goals, improper indicators. There are two main methods of checking the implementation of the strategy and the efficient operation of the information

security control system: monitoring, reports made after checking, and auditing, supervision reports. The basis of checking is that there is a predefined factor or value that the measured values can be compared to. This is the purpose of indicators, where a measurable property has to be defined, which can indicate the efficiency or proper operation of a factor. Typical indicators in information security can be: the number of revealed vulnerabilities, the time required to restore the system to normal operation, or the estimation of the cost of damage. There can be several types of indicators (CISM,2020).

- Indicators of the efficiency of an information security control system: for the elements of the information security program, the most suitable are the Critical Success Factors (CSF), Key Goal Indicator (KGI) and Key Performance Indicator (KPI) indicators. These provide the most accurate and usable information to track processes and services, and the achievement of the predefined milestones.
- Indicators of implementing the strategy: The information security strategy contains its measurement methods and indicators, which show how much and how well the goals set in the strategy have been reached.
- Risk management indicators: Information security measures should be proportional to the risk, which is based on risk analysis. Risk management can only be successful if requirements and goals are well defined.
- Value creation indicators: Value is created if information security investments can efficiently help the company reach its business goals. Investments into information security are optimal when the goals defined in the information security strategy are achieved, and the level of acceptable risks can be minimized.
- Resource management indicators: Based on the above, information security requires resources, which can be: human resources, technological solutions, IT tools, infrastructural and other resources, and the processes connected to these. Designing, implementing, efficient operation and management of these have to be monitored similarly to other organizational resources. Indicators can be created for these too.
- Measurement of performance: To see if information security in the organization (as laid down in the information security strategy) reaches organizational goals, we have to measure and monitor the performance of information security processes and create various reports. It is very important that the indicators are tailored to the target group: the management needs a different report than operators and other players.

When the strategy is implemented, the operation of the information security management system and the attainment of goals has to be continuously monitored with the help of predefined indicators tailored to the organization (or to the country). Results have to be recorded in the form of reports, which have to be sent to the persons who evaluate the results, compare them to planned goals and intervene into the processes if necessary, to ensure that the goals are fulfilled. The stakeholders responsible for making the report has to be defined, as well as the people who provide the data for the report, and also from where, which systems the data comes from. Measurement results can only be considered original and authentic if they come from the predefined source, from the person or organization responsible for data provision. In making the report, it is very important to know who will use the report and how, and what the purpose of the report is. For this, the individual target groups and the information they need have to be defined.

For example, the full details of unforeseen system shutdowns probably only provide usable and important information for the information security manager, and the management is mostly interested in the cost and data affecting business processes. The persons responsible

for making the reports for the individual target groups have to be appointed in the interest of efficiency and appropriacy. In the previous example, the information security manager can compile an appropriate report for the top management from all the detailed data he/she received. Process managers and resource managers (operators) can get specialized, information security-related reports with the content they require from their colleagues. The decisions of the top management and the goals are communicated to them by the information security manager. The goal of measurement and checking is to provide information about how much and how well the contents of the strategy has been implemented. Based on the reports, and internal and external audits, it can be decided whether the goals in the strategy and the measured results are the same, and if there is a discrepancy, what should be changed or developed and in what direction. These data constitute the input data of strategic reviews. Of course, measurement and monitoring are only effective if their results are properly used, and this way they contribute to the proper operation of the information security system and the efficient implementation of the strategy.

6. TEACHING CYBERSECURITY STRATEGY

Events in cyberspace definitely affect the physical world; the events in 2017 taught this even to people who want to shut the digital world out of their life as much as possible. Just think of the fact that in January 2017, the first American president was inaugurated whose election was largely influenced by social media, through an external player, or the fact that the Hungarian media was full of a cyberattack and its aftermath for almost a month in August. But we can mention the two global malware campaigns (Wannacry, NotPetya), which caused considerable damage in many countries and sectors in May and June, demonstrating the possible effects of cyber warfare. They are all events that organizations taking part in defending the country have to respond to. The question is: where will public service experts be found who can tackle the challenges which are often not of a technological nature?

The United Kingdom has one of the most developed cybersecurity training systems in the world. Based on the 2017 survey of the ITU Global Cybersecurity Index (GCI), it is the best in the EU, it provides cybersecurity knowledge even for children in primary school (IT union, 2020). As Dóra Molnár puts it (Malnar, 2017): „The teaching of cyber knowledge started in primary school: in 800 primary schools, about 23 000 pupils have acquired basic knowledge since 2012. In tertiary education, all bachelor’s courses include a cybersecurity module subject, and in master’s training, there are 12 accredited cyber master courses, according to the standard issued by GCHQ. Currently, three research institutes have a cybersecurity profile, there are 13 centers of excellence, and the goal is for the two cybersecurity doctoral schools already in operation to have 100 doctoral students by 2019” (Malnar, 2017). The main question is what cyber defence capabilities are needed in general, with special attention to Hungary, how these can be created, and what role the University of Public Service takes in all this.

In Hungary, Public Service training is rather centralized, most of it is taken care of by the National University of Public Service, whose “education and training activity is directed to the state, its basic phenomena, services and functions, and its courses prepare the students to understand, practise and ensure these.

The course Cybersecurity strategy and management prepares the students to develop a cybersecurity strategy, and to understand the relationship between business goals, functions and information security. The students acquire the strategic cost planning and report procedures necessary for making strategic plans, and ways to have cybersecurity investments

be approved by the management. The students learn about the tasks of the cybersecurity manager, and doing these tasks through practical examples. For monitoring and checking, they learn about procedures to select and implement key performance indicators (KPI) and methods to monitor and check indicators.

7. CONCLUSION

Nowadays we handle far more and far more types of information than earlier, and information is stored in very high concentration. Anybody who can access these possesses a huge resource. The purpose of use has not changed basically but more and more information is stolen and used illegally. It is problematic that almost everyone has access to the right information on the Internet, and players of the economy, and a growing part of society uses the acquired data. Thus, information handlers have a huge responsibility, especially in state organizations, where a very large amount of information is present about both citizens, players of the economy and state organizations.

European countries try to handle the challenges of an ever-growing cyberspace and its importance. An analysis of the cybersecurity strategies of European countries shows that some countries approach the issue from the information society and its security aspects, while others from critical information infrastructure and related security aspects.

This is why making, teaching and enforcing the rules of security-aware behavior is of paramount importance from the lowest to the highest levels of the organization. Information security professionals have to show how much damage the improper protection of data can cause, what is the responsibility of the individual participants, and how they can comply with security requirements.

Therefore, handling threats from cyberspace is no longer a technological problem only. Many of the threats directly or indirectly threaten the security of the country, and a negative perception of security is starting to form that the state must respond to. It is not possible without well-trained and experienced professionals. In Hungary, it is the task and responsibility of the National University of Public Service to train public service professionals, so the proper cybersecurity teaching and research background has to be established in this university, too. International examples provide a good basis to determine the directions of teaching but there is no universal recipe that could be fully adapted. On the one hand, because in most places it is still information security that is taught, in other words, the technological approach, and on the other hand because there are few institutes of tertiary education that cover the whole of public service, similarly to the National University of Public Service. And without the proper abilities, a secure Hungarian, European and global cyberspace is not possible.

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ARE TODAY'S INNOVATORS / EXPORTERS FUTURE EXPORTERS / INNOVATORS? A COUNTERFACTUAL ANALYSIS IN SLOVAKIA

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Abstract: This paper focuses on the empirical research of the relationship between innovation and export in Slovakia. Both activities are important for increasing competitiveness and subsequent economic growth, while their interconnection stimulates the effects even more. We explore the two-way relations in the local business environment analysing the causal effects via propensity score matching and probit models. The data selection is based on an anonymous e-survey on the overview of pro-export and pro-innovation behaviour conducted from 11th February to 25th March 2019. The analysis using several matching techniques pointed to the existence of positive links. Firstly, there is on average by about 49 per cent higher likelihood of the interest in export with innovative firms than with those that do not innovate. Changing the forms of innovation and matching technologies the results oscillated between 43.6 per cent and 69.3 per cent. In the opposite direction, we found an average percentage of 28.1 per cent and oscillation between 15.7 and 44.5 per cent. Based on the results we recommend the national decision-making entities to focus external economic policy support towards SMEs' with innovative outputs and support activities of large manufacturing companies with low value-added towards the outside world.

Keywords: innovation, export, two-way causal effects, propensity score matching

1. INTRODUCTION

Economic theory categorises innovation and export into the group of so-called growth pullers. Both can be examined for their overall growth impact as well as for existing interrelation. Already Posner (1961) initiated the trend of international trade views where innovation leads to intra-industry trade flows. Other predictions on the existence of mutual causation come from the theories of product life cycle (Vernon, 1966), trade (Krugman, 1979) and growth (Grossman and Helpman, 1990). Latest theoretical and empirical studies (Damijan *et al.*, 2010; Palangkaraya, 2012; Becker and Egger, 2013; Tuhin, 2016) consider innovation and export to be strongly interconnected processes leading to a significant level of productivity and competitiveness of companies, and also countries in which they operate. Hence, the essence of the paper is a knowledge of a two-way causal link between innovation and export within the Slovak environment. Does innovation affect the exporting interest of companies operating in Slovakia in the future? Or is there any effect of their export on

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gaining knowledge that leads to the innovation hereafter? The likelihood that the company becomes an exporter/innovator after innovation/exporting we examine applying counterfactual analysis on the data from an anonymous survey. The results pointed to the existence of the two-way positive relationship. In the beginning, we present a brief overview of previous theoretical and empirical studies on the relationship. The third part explains the essence of the research, including the specification of hypotheses and applied models. The fourth part is dedicated to the specification and collection of the data. The fifth, main part presents the results. In the end, we summarize the analysis and discuss the results with similar papers.

2. THEORETICAL BACKGROUND

In general, countries with innovation or export activities generate much more wealth than non-innovative or non-exporting ones. Both activities accelerate competitiveness and form a better market position of companies doing business there. Today's accelerated technological progress has confirmed the statement while has been shifting the focus of competitive advantages from static to dynamic. According to Hečková (2007, p. 5), 'scientific and technological progress affects not only the structure of the domestic economy but also the nature of competitive advantages in foreign markets'. Innovation improves products, production processes and organisation of production and sales. Export, defined in the macroeconomic sense as 'the ability of the economy to enforce domestic products in foreign markets' (Csabay, 2007, p. 793) expand the sales market. Such activities make it possible to sell goods at different prices and under different conditions. They also lead to the acquisition of new knowledge through the process of learning (Karasek, 2012). Its basic form is *learning-by-doing* (Arrow, 1962). At present, the theoretical concepts have worked with the premise that innovation and export are interrelated and mutually pulled processes (Tuhin 2016). Hence, researchers should examine both acts individually and as well as their mutual causality, the mechanism of which is based on productivity growth. Higher levels of productivity allow companies to enter foreign markets more easily (Cassiman and Golovko, 2007). Griliches (1998), as one of the first economists who explored the link between innovation and business-level productivity, was followed by Mansury and Love (2008), Hall *et al.* (2009), Halpern and Muraközy (2009) and Carayannis and Grigoroudis (2014). Another essential factor is the high level of competitiveness below which Melišek (2012, p. 441) understands 'the ability to export goods and services to ensure external economic equilibrium with effective use of national economic growth factors, the ability of the innovation system to generate and use new knowledge, achieving continuous GDP per capita growth and implementing social and environmental goals'.

There are two basic hypotheses on the relationship between innovation and export. At first, a *hypothesis of self-selection* claims that the company wants to export if it is sufficiently competitive on the foreign market. This mainly covers product innovation while 'only through the constant introduction of new products firms can remain competitive on international markets, where rents stemming from the introduction of such new products are quickly eroded by the fast imitation of foreign competitors' (Castellani and Fassio, 2019, p. 1). In these terms, 'the decision to start exporting is determined by factors that affect the productivity of firms before they start exporting' (Damijan *et al.*, 2010, p. 2). Exporting companies tend to be larger, more productive, more capital and technologically demanding and tend to pay higher wages (Bernard and Jensen, 1999). Other studies on the hypothesis are Melitz (2003) and Wagner (2007). An adaptation of basic *learning-by-doing*, *learning-by-*

exporting, forms the second hypothesis. This can be interpreted as learning new processes through export activities, therefore, new knowledge mainly leads to process innovation. While Aw *et al.* (2005) identified an increased interest of companies with previous export experience or higher productivity in further export, Alegre *et al.* (2012) recall that companies which learn from exporting achieve better positions in the competition, maintain customers and revenue growth. From empirical studies, Delgado *et al.* (2001) recorded a stronger impact of *self-selection* and a weaker impact of *learning-by-exporting*. Ebling and Janz (1999) and Roper and Love (2002) confirmed the positive impact of innovation on exports in the German service sector and the British and German production sectors, respectively. Cassiman and Golovko (2007) used a survey in Spain to highlight the variability of the relationship between export and productivity depending on the company's innovation strategy. Damijan *et al.* (2010) specified the positive effect of innovation on the Slovenian companies' probability of becoming exporters. A two-way relationship for process innovation and service sector was confirmed by Palangkaraya (2012). Becker and Egger (2013) discovered a significant bias in the impact of product and process innovation in Germany. Tuhin (2016) found the highest impact of product innovation/export on export/product innovation in small and medium-sized enterprises (SMEs) in Australia. The topic is followed by new motives: the impact of entering the export market on citations and patents (Aghion *et al.*, 2018; Aghion *et al.*, 2019), the impact of inputs' import on product innovation in developing countries (Bos and Vannoorenberghe, 2019), the propensity to export after importing inputs (Castellani and Fassio, 2019), the impact of innovation on continued export activities (Dai *et al.*, 2019) and the impact of internal and external R&D on export (Zhang and Xie, 2019).

3. RESEARCH HYPOTHESES & EMPIRICAL DESIGN

The theoretical background outlines the essence of the research – the impact of innovation/exporting in one period on exporting/innovation in another period. We justify the need for the research by two factors. Firstly, there is a lack of clarity in the conclusions and diverse assumptions in previous studies examining this two-way relationship. Secondly, we did not find a similar study in the local environment. Some aspects of innovation, export and competitiveness in Slovakia are discussed in Lábaj (2017), Gonos *et al.* (2019) and Ďurčová and Bartóková (2019) and in Czechia Fojtíková and Staníčková (2017) and Coufalová *et al.* (2019).

The research sought to confirm or refute two basic hypotheses as follows:

- 1) Product, process or organisation innovation in the first period has a positive impact on the interest in the export of products or services in the second period.
- 2) The export of products or services in the first period has a positive impact on the interest in product, process or organisation innovation in the second period.

Answers to the hypotheses we try to find applying the counterfactual analysis to the collected data. The default method is propensity score matching (PSM) of Rosenbaum and Rubin (1983), a statistical matching technique often used to identify the robust causal effect of an intervention on a unit. It matches units affected by a particular intervention (treatment units) with units without intervention (control units) according to the propensity score of each unit (Randolph *et al.*, 2014). Matching enhances effects by adjusting distortion during the selection of the statistical sample. In past, Damijan *et al.* (2010), Palangkaraya (2012) and Becker and Egger (2013) availed this method. Our methodology involves the calculation of

the effects of two interventions – innovation on export and export on innovation, while the measurement covers company k at time t and $t+1$. Firstly, there are probit models used to estimate the propensity to innovate/export at time t . Treatment variables are dummy according to the survey assumptions. The propensity scores express the functions of the characteristics (criteria). We define the functions as follows: $\text{Propensity}(\text{Innovation}_{kt} = 1) = f(\text{Icharacter}_{kt}) + \varepsilon_{kt}$ & $\text{Propensity}(\text{Exporting}_{kt} = 1) = f(\text{Echaracter}_{kt}) + \varepsilon_{kt}$.

The estimated criteria coefficients do not reflect the scores, however, must be calculated in the next step. The matching is based on four PSM sub-methods – *nearest neighbour matching* (one or more intervention units are matched with one or more control units according to proximity in the propensity score); *optimal matching* (targets a minimum average absolute distance across all matched pairs); *full matching* (matching of all units and their division into groups containing either one treatment unit and several control units or one control unit and several treatment units); *genetic matching* (the specific intensive algorithm used to match all units). Concerning time lags, Palangkaraya (2012) works with one year period and Damijan *et al.* (2010) with two periods. Our approach prefers the former mainly due to the dominance of smaller companies that need only one year to customise their activities in the collected data. We estimate the intervention effects by comparing the likelihood that innovators/exporters will become exporters/innovators in the period following the intervention. Each innovative/exporting company is matched with one or more non-innovative/non-exporting companies. The output is a new dataset with matched treatment and control units. The subsequent analysis uses probit models due to the dummy form of the dependent variable. The likelihood of the interventions we calculate as marginal effects of the criteria. In our case, we are only interested in a simple relationship between two activities. The marginal effect or the average treatment effect on the treated (ATT) is a per cent likelihood that the unit performs a certain action after the intervention.

4. DATA AND DESCRIPTIVE STATISTICS

The dataset for the analysis consisted of the data collected through an anonymous e-survey with a total of 185 respondents who filled the questionnaire during the period from 11 February to 25 March 2019. The survey focused on a comprehensive overview of pro-export and pro-innovation behaviour in Slovakia. We adjusted the initial sample to the full sample of 128 observations to make it consistent with the methodological needs. The questions were specified for the 2015-2018 period. Hypotheses testing required only two periods, thus we divided the sample into the t period (2015 to 2017) and the $t+1$ period (2016 to 2018). The lagging allowed to work with combined cross-sectional data with a total of 384 observations. Table 1 and 2 show descriptive statistics for the data. In the first direction of the relationship, up to 44 per cent of all companies were engaged in the export of products and 47 per cent in the provision of services abroad in the $t+1$ period. In the case of innovation in the t period, we recorded smaller numbers (21 per cent of companies devoted to product, 14 per cent to process and 10 per cent to organisation innovation). There were rather smaller companies (average at size = 2.06, while 1 means micro, 2 small, 3 medium and 4 large) owned by Slovaks (average at head = 0.23, while 0 means Slovak owner and 1 foreign owner) in the sample. Approximately 40 per cent of companies imported products or services to Slovakia in the t period. At first glance, low average amounts of innovation spending indicated a general lack of interest in investing. These variables were significantly dependent on interest in innovation. The largest spending went to product innovation (average at in_prod_exp_t0 =

1.02). However, we measured a relatively high standard deviation (1.98) indicating a significant broad spectrum of survey responses.

Table 1. Descriptive statistics – innovation on export (N = 384). Source: the results from R

Variable	Description	Mean	Std. Dev.	Median
<i>exp_t1_p</i>	Export of products in t1 (dummy)	0.44	0.5	0
<i>exp_t1_s</i>	Export of services in t1 (dummy)	0.47	0.5	0
<i>in_prod_t0</i>	Product innovation in t0 (dummy)	0.21	0.41	0
<i>in_proc_t0</i>	Process innovation in t0 (dummy)	0.14	0.35	0
<i>in_org_t0</i>	Organisation innovation in t0 (dummy)	0.1	0.31	0
<i>exp_t0_p</i>	Export of products in t0 (dummy)	0.42	0.49	0
<i>exp_t0_s</i>	Export of services in t0 (dummy)	0.43	0.5	0
<i>size</i>	Company size (1-micro, 2-small, 3-medium, 4-large)	2.06	1.22	1.5
<i>head</i>	Mother company from abroad (dummy)	0.23	0.42	0
<i>imp_t0</i>	Import of products or services in t0 (dummy)	0.4	0.49	0
<i>in_prod_exp_t0</i>	Total expenditure on product innovation in t0 (1-€0-999; 2-€1,000-4,999; 3-€5,000-9,999; 4-€10,000-49,999; 5-€50,000-99,999; 6-€100,000-499,999; 7-€500,000-more)	1.02	1.98	0
<i>in_proc_exp_t0</i>	Total expenditure on product innovation in t0 (1-€0-999; 2-€1,000-4,999; 3-€5,000-9,999; 4-€10,000-49,999; 5-€50,000-99,999; 6-€100,000-499,999; 7-€500,000-more)	0.68	1.55	0
<i>in_org_exp_t0</i>	Total expenditure on product innovation in t0 (1-€0-999; 2-€1,000-4,999; 3-€5,000-9,999; 4-€10,000-49,999; 5-€50,000-99,999; 6-€100,000-499,999; 7-€500,000-more)	0.41	1.11	0
<i>in_prod_emp_t0</i>	% of employees involved in product innovation in t0	7.91	21.19	0
<i>in_proc_emp_t0</i>	% of employees involved in process innovation in t0	4.02	13.66	0
<i>in_proc_coop_1_t0</i>	Collaboration with companies in process innovation in t0 (dummy)	0.17	0.38	0
<i>in_org_coop_1_t0</i>	Collaboration with companies in organisation innovation in t0 (dummy)	0.12	0.32	0
<i>in_prod_coop_2_t0</i>	Collaboration with universities or research institutes in product innovation in t0 (dummy)	0.19	0.39	0
<i>in_proc_coop_2_t0</i>	Collaboration with universities or research institutes in process innovation in t0 (dummy)	0.08	0.27	0
<i>in_org_coop_2_t0</i>	Collaboration with universities or research institutes in organisation innovation in t0 (dummy)	0.07	0.26	0
<i>in_prod_coop_3_t0</i>	Collaboration with public administration in product innovation in t0 (dummy)	0.06	0.24	0
<i>in_proc_coop_3_t0</i>	Collaboration with public administration in process innovation in t0 (dummy)	0.04	0.19	0
<i>in_org_coop_3_t0</i>	Collaboration with public administration in organisation innovation in t0 (dummy)	0.02	0.12	0
<i>in_prod_cons_t0</i>	Product innovation within R&D consortium in t0 (dummy)	0.07	0.26	0
<i>in_proc_cons_t0</i>	Process innovation within R&D consortium in t0 (dummy)	0.04	0.21	0
<i>in_org_cons_t0</i>	Organisation innovation within R&D consortium in t0 (dummy)	0.03	0.17	0
<i>product</i>	Manufacturing of products (dummy)	0.56	0.5	1
<i>service</i>	Provision of services (dummy)	0.83	0.38	1

In the opposite direction of the relationship, the greatest interest we saw in organisation innovation (41 per cent of the sample), while 26 per cent applied product innovation and only 18 per cent process innovation in the t+1 period. There was smaller interest in export activities in *t* than in *t+1* (42 per cent for products and 43 per cent for services). The average

share of export sales in t was 18.52 per cent and of high-tech export in t was 9.91 per cent. The last two variables we could not divide by export form due to limiting assumptions set at the beginning. Moreover, most of the surveyed companies more likely deal with the provision of services than manufacturing products, while respondents could indicate that they do both activities at the same time.

Table 2. Descriptive statistics – export on innovation (N = 384). Source: the results from R

Variable	Description	Mean	Std. Dev.	Median
<i>in_prod_t1</i>	Product innovation in t1 (dummy)	0.26	0.44	0
<i>in_proc_t1</i>	Process innovation in t1 (dummy)	0.18	0.39	0
<i>in_org_t1</i>	Organisation innovation in t1 (dummy)	0.41	0.49	0
<i>exp_t0_p</i>	Export of products in t0 (dummy)	0.42	0.49	0
<i>exp_t0_s</i>	Export of services in t0 (dummy)	0.43	0.5	0
<i>in_prod_t0</i>	Product innovation in t0 (dummy)	0.21	0.41	0
<i>in_proc_t0</i>	Process innovation in t0 (dummy)	0.14	0.35	0
<i>in_org_t0</i>	Organisation innovation in t0 (dummy)	0.1	0.31	0
<i>size</i>	Company size (1-micro, 2-small, 3-medium, 4-large)	2.06	1.22	1.5
<i>head</i>	Mother company from abroad (dummy)	0.23	0.42	0
<i>imp_t0</i>	Import of products or services in t0 (dummy)	0.4	0.49	0
<i>exp_rev_t0</i>	% share of export revenue in total revenue in t0	18.52	30.9	0
<i>exp_ht_t0</i>	% share of high-tech export in total export in t0	9.91	25.8	0
<i>product</i>	Manufacturing of products (dummy)	0.56	0.5	1
<i>service</i>	Provision of services (dummy)	0.83	0.38	1

5. RESULTS

We used two econometric models measuring the impact of innovation/exporting in t on the interest in exporting/innovation in $t+1$. Firstly, we had to identify the propensity for product, process and organisation innovation and the propensity for export of products and services. The models are statistically significant while the multivariate Wald test showed high significance. In terms of individual coefficients in the first model (see Table 3), high significance we especially found in product innovation. Most of the variables showed a positive impact (only company size and focus on services had a negative one). Process innovation was negatively affected by company size, employment in innovation, collaboration with public administration and universities/research institutes and focus on both products and services. Organisation innovation was influenced negatively by company size, foreign ownership, import, collaboration with companies and universities/research institutes and again focus on both products and services. The negative constant for all three forms of innovation indicates a decreasing trend of innovation with other factors unchanged. Pseudo R-squared values show a lower but still appropriate level of the explanation of the variation of the dependent variable.

Table 3. Propensity to innovate. Source: the results from glm function in R

	<i>Product</i>	<i>Process</i>	<i>Organisation</i>
Variable	Estimated coefficient	Estimated coefficient	Estimated coefficient
(Intercept)	-2.263 ***	-1.140 **	-0.929 .
<i>exp_t0</i>	0.702 **	0.419	0.483
<i>size</i>	-0.134	-0.128	-0.290
<i>head</i>	0.500 *	0.357	-0.168
<i>imp_t0</i>	0.531 *	0.411	-0.172
<i>in_prod/proc/org_exp_t0</i>	0.206 ***	0.419 ***	0.716 ***
<i>in_prod/proc/org_emp_t0</i>	0.002	-0.001	0.003
<i>in_prod/proc/org_coop_1_t0</i>	0.379	0.902 **	-0.268
<i>in_prod/proc/org_coop_2_t0</i>	0.599 *	-0.887 .	1.501 **
<i>in_prod/proc/org_coop_3_t0</i>	1.500 ***	-0.089	-7.851
<i>in_prod/proc/org_cons_t0</i>	0.992 **	3.264 ***	9.473
<i>product</i>	0.801 **	-0.784 **	-0.290
<i>service</i>	-0.561 *	-0.806 *	-0.850 *
Joint p-value (Wald)	0	0	0
Log-likelihood	-108.370	-79.871	-56.602
Pseudo R2 (McFadden)	0.455828	0.487812	0.558869

In the second model (Table 4), only some of the coefficients in measuring the propensity to export had sufficient statistical significance. Both forms of export were negatively affected by innovation and import (other variables exposed a positive impact). In addition, there is a negative constant for both forms of export. Here, pseudo R-squared values show higher level of explanation.

Table 4. Propensity to export. Source: the results from glm function in R

	<i>Product</i>	<i>Service</i>
Variable	Estimated coefficient	Estimated coefficient
(Intercept)	-699.855	-605.530
<i>in_t0</i>	-1.192 *	-0.371
<i>size</i>	0.608 ***	0.605 ***
<i>head</i>	1.060 **	1.188 **
<i>imp_t0</i>	-0.682 *	-0.205
<i>exp_rev_t0</i>	7.568	6.537
<i>exp_ht_t0</i>	0.103	0.042
<i>product</i>	697.859	1.201 **
<i>service</i>	0.435	602.558
Joint p-value (Wald)	0	0
Log-likelihood	-47.083	-38.544
Pseudo R2 (McFadden)	0.820136	0.853241

Onwards we calculated the propensity score to which the company innovated/exported relative to others. The computation yielded 384 score values for each form of innovation/export. We identified 12 datasets for calculating the impact of innovation on export and eight for the impact of export on innovation (see Table 5). After matching, the number of observations was smaller but more robust and realistic. We tested the robustness through covariate equilibrium tests.

Table 5. After-matching datasets. Source: the results from MatchIt package in R

		Impact of innovation on export			Impact of export on innovation	
		<i>Product</i>	<i>Process</i>	<i>Organisation</i>	<i>Product</i>	<i>Service</i>
Nearest neighbour	Control	246	324	320	163	166
	Intervention	82	54	40	163	166
Optimal	Control	246	324	320	163	166
	Intervention	82	54	40	163	166
Full	Control	302	330	344	221	218
	Intervention	82	54	40	163	166
Genetic	Control	110	41	20	55	144
	Intervention	82	54	40	163	166

The intervention effects calculation we based on probit models with one dependent variable in $t+1$ and one independent (treatment) variable in t . While other variables were included in the matching criteria we omitted them from subsequent analysis and measured only the direct effects. The analysis discovered the positive impact in all cases with the effect of innovation on export being more pronounced. Some of the measured effects did not have sufficient statistical significance probably due to the lack of observations necessary for the proper functioning of the method. The outcome showed on average a 49 per cent higher likelihood of export interest for companies that are engaged in innovation (individual results are presented in Table 6 – left side). Product innovation's ATT on the interest in export of products was 52.1 per cent and export of services 53.9 per cent. In other innovation forms, the effects were slightly lower. While a similar ratio we measured using optimal matching, using full and genetic matching we got rather minor impacts. We found a significant effect (69.3 per cent) of process innovation on services export applying the latter method.

Table 6. Average treatment effects on the treated. Source: the results from Zelig package in R

ATT of innovation on export	Nearest neighbour		ATT of export on innovation	Nearest neighbour		
	<i>Product</i>	<i>Service</i>		<i>Product</i>	<i>Process</i>	<i>Organisation</i>
	ATT	ATT		ATT	ATT	ATT
<i>Product</i>	0.521 ***	0.539 *	<i>Product</i>	0.266 ***	0.184	0.408
<i>Process</i>	0.443	0.474 ***	<i>Service</i>	0.232 ***	0.186 **	0.407
<i>Organisation</i>	0.439 .	0.471 .				
ATT of innovation on export	Optimal		ATT of export on innovation	Optimal		
	<i>Product</i>	<i>Service</i>		<i>Product</i>	<i>Process</i>	<i>Organisation</i>
	ATT	ATT		ATT	ATT	ATT
<i>Product</i>	0.519 ***	0.540 *	<i>Product</i>	0.266 ***	0.183	0.381 *
<i>Process</i>	0.448	0.478 ***	<i>Service</i>	0.227 ***	0.178 ***	0.383 *
<i>Organisation</i>	0.436 .	0.466 .				
ATT of innovation on export	Full		ATT of export on innovation	Full		
	<i>Product</i>	<i>Service</i>		<i>Product</i>	<i>Process</i>	<i>Organisation</i>
	ATT	ATT		ATT	ATT	ATT
<i>Product</i>	0.443 ***	0.472 ***	<i>Product</i>	0.245 ***	0.182	0.407
<i>Process</i>	0.443	0.479 ***	<i>Service</i>	0.250	0.176 ***	0.405
<i>Organisation</i>	0.442 .	0.473 .				
ATT of innovation on export	Genetic		ATT of export on innovation	Genetic		
	<i>Product</i>	<i>Service</i>		<i>Product</i>	<i>Process</i>	<i>Organisation</i>
	ATT	ATT		ATT	ATT	ATT
<i>Product</i>	0.525 ***	0.461 ***	<i>Product</i>	0.350	0.207	0.445
<i>Process</i>	0.496	0.693	<i>Service</i>	0.234 ***	0.157 ***	0.403
<i>Organisation</i>	0.570	0.495 *				

The estimation of the opposite relation showed a lower average likelihood (28.1 per cent) and greater variability (individual results are presented in Table 6 – right side). The highest likelihood of the export impact (approximately 40 per cent on average) was found with organisation innovation, while ATT with product innovation was 25 per cent and process only 18 per cent. The largest percentage we recorded with genetic matching, product export and organisation innovation (44.5 per cent).

6. SUMMARY AND DISCUSSION

Many theoretical and empirical concepts discuss the relationship between innovation and export because it leads to a significant level of productivity and competitiveness of companies and consequently countries in which they operate. Hence the EU and its member countries are aware of the importance of the topic for the setting of their external economic policy. The paper presents the empirical research of the effects of innovation on the interest in export and export on the interest in innovation using the surveyed sample of Slovak companies. The results confirmed the existence of the two-way relationship for defined assumptions. Firstly, there was on average by about 49 per cent higher likelihood of the interest in export with innovative firms than with those that do not innovate. Changing the forms of innovation and matching technologies the results oscillated between 43.6 per cent and 69.3 per cent. In the opposite direction, we found a lower average percentage (28.1 per cent) and oscillation between 15.7 per cent and 44.5 per cent. Comparison of our results with selected conclusions from previous studies counts with different assumptions and empirical forms. Ebling and Janz (1999) identified a strong influence of innovation activities on exports in the German service sector. Our results in the Slovak conditions confirm this effect. Similar to Roper and Love (2002) and Cassiman and Golovko (2007), product innovation shows the greatest impact on the export in our research. Though Damijan *et al.* (2010) with a similar methodology did not find a positive impact of product and process innovation on the interest to become an exporter, according to their results the past export motivates SMEs to become process innovators. Two-way relationship in process innovation and service sector was confirmed by Palangkaraya (2012) too. Based on the knowledge we can conclude that the hypothesis of *learning-by-exporting* with process innovation is more prominent for larger companies. Exporting with all its complexity seems to be easier to manage and therefore more suitable for larger companies. On the contrary, the hypothesis of *self-selection* with product innovation is more prominent for smaller companies. This is mainly due to the importance of outwardly visible competitiveness for the ability to export. Based on the results we recommend the national decision-making entities to focus external economic policy support towards SMEs' with innovative outputs and support activities of large manufacturing companies with low value-added towards the outside world.

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COMPARATIVE STUDY ON GENDER EXPECTATIONS ABOUT THE REQUIRED DIGITAL ENTREPRENEURSHIP SKILLS

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Abstract: The environment of 21st century encourages many people to face the "digital entrepreneurship" and for the successful business development it is important they to have adequate skills. The aim of this paper is to discuss some of the outcomes from a comparative study about gender expectations on the required key digital entrepreneurship skills. The research tasks are: (1) to outline the essence of the digital entrepreneurship and the required / necessary skills through which the entrepreneurs would have been successful in the digital age; (2) to design a research methodology to study the attitudes of males and females regarding the skills of young entrepreneurs in the digital world; (3) to summarize the findings from a survey conducted in Bulgaria in 2020 among 774 people and analyse the differences in the opinions of the two gender populations; (4) to present some of the key conclusions and formulate a few proposals about further studies and practical applications. The analyses in this paper could be useful to other researchers, interested in digital entrepreneurship skills on gender approach, as well as to digital entrepreneurs.

Keywords: digital entrepreneurship, digital entrepreneurship skills

1. INTRODUCTION

The wide application of ICT, SMART devices and spaces, „Disruptive technologies“ such as 3D printers, Artificial intellect, Internet of the things and other “fruits of the Digital era” has already provoked different changes, such as: the entrepreneurial way of thinking; business models for entrepreneurs; digital entrepreneurship. As a consequence of these changes there is increasing demand for digital entrepreneurship skills. Therefore, the aim of this paper is to discuss some of the outcomes from a comparative study about gender expectations on the required key digital entrepreneurship skills.

The research tasks are:

- (1) To outline the essence of the digital entrepreneurship and the required / necessary skills through which the entrepreneurs would have been successful in the digital age;
- (2) To design a research methodology to study the attitudes of males and females regarding the skills of young entrepreneurs in the digital world;
- (3) To summarize the findings from a survey conducted in Bulgaria and analyse the differences in the opinions of the two gender populations;

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(4) To present some of the key conclusions and formulate a few proposals about further studies and practical applications.

The research thesis is: there are different gender expectations about required digital entrepreneurship skills.

The analyses in this paper could be useful to other researchers, interested in digital entrepreneurship skills on gender approach, as well as to digital entrepreneurs.

2. LITERATURE REVIEW

2.1. DIGITAL ENTREPRENEURSHIP

Strategic Policy Forum on Digital Entrepreneurship (2014) defines the term „digital entrepreneurship“ as: „*Digital entrepreneurship embraces all new ventures and the transformation of existing businesses by creating and using novel digital technologies.*“.

According to Balli (2020) the digital entrepreneurship could be defined as entrepreneurship realization on digital platforms, because the companies are enabled to facilitate their work through digital markets. Further understanding is given in Fig.1.

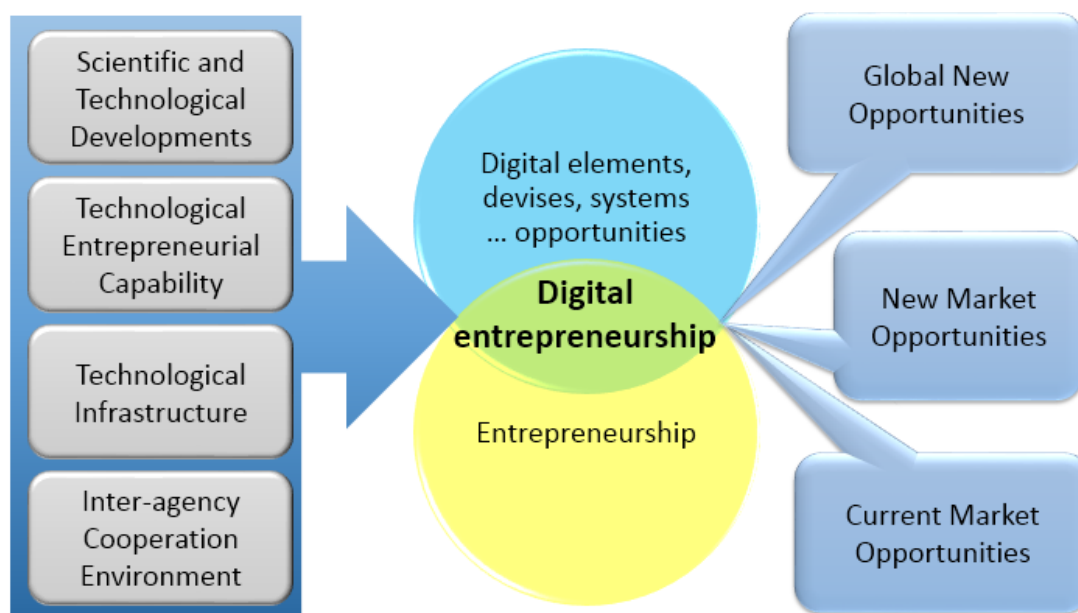


Figure 1. Digital Entrepreneurship – Genesis, Inputs and Outputs of the Digital Entrepreneurship Ecosystem (adapted from Chaston, 2017; Balli, 2020)

The research of different scientists has shown that the digital entrepreneurship covers variety of aspects, such as:

- ✓ digital business transformation and new business models (Chao et al., 2015; Boneva, 2018; Kraus et al., 2018; Kostadinova, 2019);
- ✓ project management in Industry 4.0 (Milijić et al., 2019);
- ✓ development of new products (Stoycheva & Antonova, 2018; Todorova et al., 2018);
- ✓ risk management (Sheludko & Kirova, 2018)
- ✓ access to global markets (Papazov & Mihaylova, 2019).

Besides, the small family business (Kotsev, 2019) creates competitive advantages for digital entrepreneurship (Kotsev, 2019), which could be also result of the academic education

(Pavlov, 2014). Also, different researchers put good attention on the entrepreneurship skills (Huđek et al., 2019; Nikolić et al., 2019).

Those firms, designed as intergenerational family businesses (Pavlov et al., 2017; Bakracheva et al., 2020), could successfully combine the fundamental knowledge and approaches with the new digital models. Thus they would increase their potential to be among the strategic units for the economic development of the European Union.

It is expected the digital entrepreneurship to spread away in many dimensions. It is logical the companies to estimate the digital technological innovations as opportunities and simultaneously to elaborate new organizational structures (Balli, 2020). Thus the managers would successfully face the new requirements from the rapidly changing business environment.

2.2. DIGITAL ENTREPRENEURSHIP SKILLS

The idea in Figure 2 is to compare the different models in digital entrepreneurship on the base of streams, skills and groups. The last column presents the understand of the authors of this article about the necessary digital entrepreneurship skills.

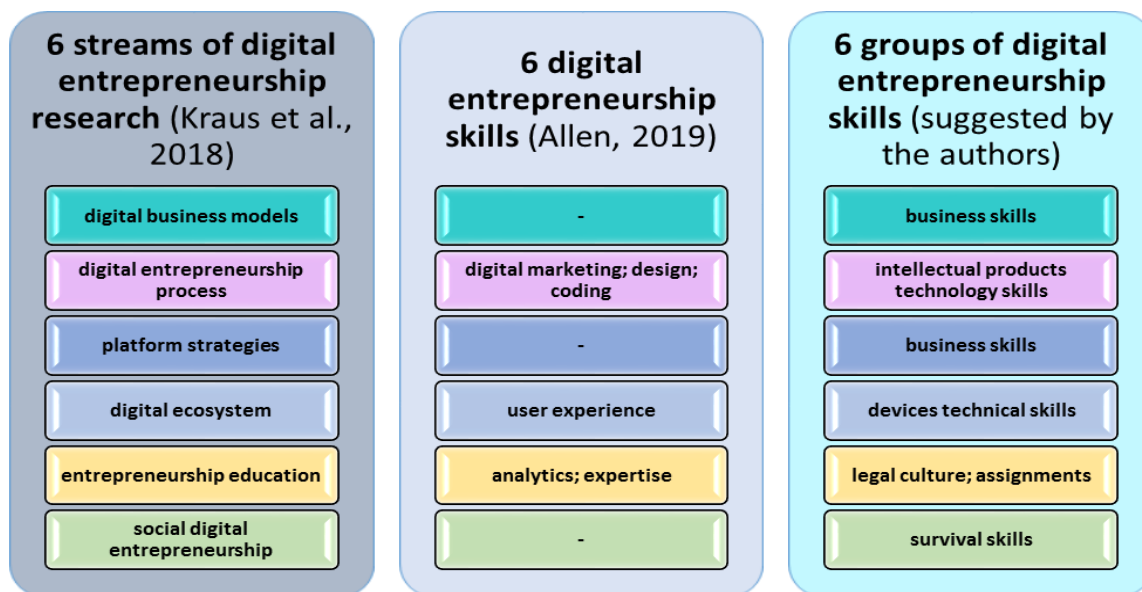


Figure 2. A model of 3x6 (streams, skills and groups) in digital entrepreneurship

The last column in Figure 2 is important for this paper, because it presents the fundament for the next methodology design. The application of the digital devices and information systems is already done in all sectors, not only the ICT. In results, the self-employed people and the employees look to acquire basic and specific digital skills by Long-life-learning programs.

The European Commission (2020) has approved a vision for the European industry development until 2030 and the digital skills of the EU citizens are among the among the basic ones, next to reading and calculating.

The Strategic Policy Forum on Digital Entrepreneurship (2015) has identified that the organizations have lack of digital leaders, as well as the lack of high-qualified specialists in cloud computing, big data analytics, cyber-security.

At the same time, it is hard to find studies on the gender expectations about required digital entrepreneurial skills. Therefore, the focus of this article is to provide such study.

3. METHODOLOGY DESIGN

The main purpose of the research methodology is to study the attitudes of males and females regarding the skills of young entrepreneurs in the digital world.

The main research methods used in the study are:

- ✓ Quantitative research - a survey conducted from 20 January 2020 to 01 April 2020 among 774 Bulgarians, who are well informed about the activity of the Ruse University Entrepreneurship Center.
- ✓ Desk research (analysis of relevant literature and secondary information derived from open sources).

A specially designed online questionnaire included 27 questions, using a standard 5-point Likert scale: 1 Strongly agree; 2 Agree; 3 N/A; 4 Disagree; 5 Strongly disagree.

In addition, there are three more questions related to identify their: gender, age and parenting. Here we give our specific focus on the ones, related to the given hypotheses:

Q1. Skills for digital marketing to supply on the international market some products/services, produced by their families.

Q2. Skills for e-commerce of products/services, produced by their families.

Q3. Skills for on-line banking and other forms of e-payments.

Q4. Skills to work with ERP (enterprise resource planning) systems.

Q5. Skills to submit documents to the National Tax Agency.

Q6. Skills to create (continue) small business with their families and friends.

Q11. Skills to deal with most popular devices like phone, tablet, laptop, etc.

Q12. Skills to deal with office equipment: printer, scanner, e-terminals, alarm system, etc.

Q28. What is your gender?

The answers have been stored in an electronic table of MS Excel for further scientific analyses.

4. FINDINGS

The initial analyses of the received statements on “Business skills” are presented in Tables 1 to 6.

The information about “Technical skills to work with devices” is given in Table 7. and 8.

The color code in each table indicates:

- green color is with the highest values;
- the yellow-orange color are the middle values;
- the red color is for the lowest values.

Table 1. Attitude of the respondents about the necessity of „Skills for digital marketing to supply on the international market some products/services, produced by their families“

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	172	170	114	46	24	526	32,70%	32,32%	21,67%	8,75%	4,56%	100,00%
Males	71	84	37	38	18	248	28,63%	33,87%	14,92%	15,32%	7,26%	100,00%
Total	243	254	151	84	42	774	31,40%	32,82%	19,51%	10,85%	5,43%	100,00%

The data show that 64,21% from the respondents (65,02% from the females and 62,50% from the males) have a positive attitude the entrepreneurs to have skills for digital marketing to supply on the international market some products/services, produced by their families.

Table 2. Attitude of the respondents about „Skills for e-commerce of products/services, produced by their families“

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	233	143	60	48	42	526	44,30%	27,19%	11,41%	9,13%	7,98%	100,00%
Males	91	79	41	19	18	248	36,69%	31,85%	16,53%	7,66%	7,26%	100,00%
Total	324	222	101	67	60	774	41,86%	28,68%	13,05%	8,66%	7,75%	100,00%

The answers indicate that 70,54% of the respondents (71,48% from the females and 68,55% from the males) give their agreement with the statement that it is important for the young people to have skills for e-commerce of products/services, produced by their families.

Table 3. Attitude of the respondents about “Skills for on-line banking and other forms of e-payments”

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	360	69	26	25	46	526	68,44%	13,12%	4,94%	4,75%	8,75%	100,00%
Males	159	34	20	10	25	248	64,11%	13,71%	8,06%	4,03%	10,08%	100,00%
Total	519	103	46	35	71	774	67,05%	13,31%	5,94%	4,52%	9,17%	100,00%

The need to have skills for on-line banking and other forms of e-payments is approved by 80,36% of the respondents (81,56% from the females and 77,82% from the males).

Table 4. Attitude of the respondents about „Skills to work with ERP (enterprise resource planning) systems“

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	204	153	94	46	29	526	38,78%	29,09%	17,87%	8,75%	5,51%	100,00%
Males	92	72	52	17	15	248	37,10%	29,03%	20,97%	6,85%	6,05%	100,00%
Total	296	225	146	63	44	774	38,24%	29,07%	18,86%	8,14%	5,68%	100,00%

The need for skills to work with a ERP systems has been recognized by 67,31% from the respondents (67,87% from the females and 66,13% from the males).

Table 5. Attitude of the respondents about „Skills to submit documents to the National Tax Agency”

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	269	129	54	38	36	526	51,14%	24,52%	10,27%	7,22%	6,84%	100,00%
Males	102	57	48	20	21	248	41,13%	22,98%	19,35%	8,06%	8,47%	100,00%
Total	371	186	102	58	57	774	47,93%	24,03%	13,18%	7,49%	7,36%	100,00%

The need to have skills to submit documents to the National Tax Agency is approved by 71,96% of the respondents (75,67% from the females and 64,11% from the males).

Table 6. Attitude of the respondents about „Skills to create (continue) small business with their families and friends“

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	182	145	129	33	37	526	34,60%	27,57%	24,52%	6,27%	7,03%	100,00%
Males	91	61	55	24	17	248	36,69%	24,60%	22,18%	9,68%	6,85%	100,00%
Total	273	206	184	57	54	774	35,27%	26,61%	23,77%	7,36%	6,98%	100,00%

The need to have skills to create (continue) small business with their families and friends is approved by 61,89% of the respondents (62,17% from the females and 61,29% from the males).

Table 7. Attitude of the respondents about „Skills to deal with most popular devices like phone, tablet, laptop, etc.“

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	428	33	6	3	56	526	81,37%	6,27%	1,14%	0,57%	10,65%	100,00%
Males	194	17	7	5	25	248	78,23%	6,85%	2,82%	2,02%	10,08%	100,00%
Total	622	50	13	8	81	774	80,36%	6,46%	1,68%	1,03%	10,47%	100,00%

The need to have skills to deal with most popular devices like phone, tablet, laptop, etc. is approved by 86,82% of the respondents (87,64% from the females and 85,08% from the males).

Table 8. Attitude of the respondents about „Skills to deal with office equipment: printer, scanner, e-terminals, alarm system, etc.“

Gender	Answer values (Count)						Relative share (%)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Females	408	52	4	10	52	526	77,57%	9,89%	0,76%	1,90%	9,89%	100,00%
Males	174	28	11	10	25	248	70,16%	11,29%	4,44%	4,03%	10,08%	100,00%
Total	582	80	15	20	77	774	75,19%	10,34%	1,94%	2,58%	9,95%	100,00%

The need to have skills to deal with office equipment: printer, scanner, e-terminals, alarm system, etc. is approved by 85,53% of the respondents (87,53% from the females and 81,45% from the males).

5. DISCUSSIONS

The findings in the Tables 1 to 8 show that over 2/3 from the respondents from both groups (females and males) have positive attitude about all discussed skills. It is noticeable that the respondents give higher support to devices technical skills than the business skills. The highest approval 86,82% (87,64% by the females and 85,08% from the males) has the statement about the entrepreneurship skills to deal with the office equipment (printer, scanner, e-terminals, alarm systems, etc.).

The lowest approval 61,89% (62,17% by the females and 61,29% from the males) has the statement about the entrepreneurship skills to create (continue) small business with their families and friends.

These tables show that there is high similarity in the answers of both genders. Using the “F-Test Two-Sample for Variances” we can confirm or reject the research theses. Therefore, we have two hypotheses:

(1) $H_0: \sigma_1^2 = \sigma_2^2$, which means that the females and males have the same expectations about the required digital entrepreneurship skills.

(2) $H_1: \sigma_1^2 \neq \sigma_2^2$, which means that the females and males have different expectations about the required digital entrepreneurship skills.

Table 9 presents the results from the F-Test per each question, in case $\alpha = 0,05$:

- We will accept H_0 , in case “F” < “F Critical one-tail”.
- We will accept H_1 in case “F” > “F Critical one-tail”.

The data in Table 9 show that, in general there are no differences in the gender expectations about the required digital entrepreneurship skills. The only gender difference is in the answers of Question 1 “Skills for digital marketing to supply on the international market some products/services, produced by their families”, because $p(0,026393) < \alpha(0,05)$.

Table 9. F-Test Two-Sample for Variances (authors' calculations)

Digital Entrepreneurship Skills	Mean1	Variance 1	Mean2	Variance 2	F	P(F<=f) one-tail	F Critical one-tail	Accepted Hypothesis
Q1. Skills for digital marketing to supply on the international market some products/services, produced by their families.	2,387097	1,558051	2,201521	1,265979	1,230709	0,026393	1,192906	H1
Q2. Skills for e-commerce of products/services, produced by their families	2,093156	1,635115	2,169355	1,469179	1,112945	0,168414	1,200976	H0
Q3. Skills for on-line banking and other forms of e-payments	1,822581	1,765966	1,722433	1,637096	1,078719	0,238808	1,192906	H0
Q4. Skills to work with ERP systems	2,131179	1,397997	2,157258	1,380028	1,013021	0,458076	1,200976	H0
Q5. Skills to submit documents to the National Tax Agency	2,197581	1,657160	1,941065	1,518425	1,091368	0,206701	1,192906	H0
Q6. Skills to create (continue) small business with their families and friends.	2,254032	1,534397	2,235741	1,422415	1,078726	0,238788	1,192906	H0
Q11. Skills to deal with most popular devices like phone, tablet, laptop, etc.	1,588710	1,635823	1,528517	1,586804	1,030892	0,385053	1,192906	H0
Q12. Skills to deal with office equipment: printer, scanner, e-terminals, alarm system, etc	1,725806	1,746376	1,566540	1,564135	1,116512	0,151763	1,192906	H0

The data in Table 9 prove that both genders have the same expectations about required digital entrepreneurship skills. It is also good indicator about the equal involvement of Bulgarian females and males in the digital reality.

6. CONCLUSION

The research proves that the females and males have quite similar expectations about the digital entrepreneurship skills. In fact, the 774 Bulgarian respondents confirm the importance of the digital world in the 21st century and the need for long-life-learning of the required skills. Both genders consider as quite important variety of entrepreneurship skills such as: digital marketing skills to supply on the international market some products/services, produced by their families; skills for e-commerce of products/services, produced by their families; skills for on-line banking and other forms of e-payments; skills to work with ERP (enterprise resource planning) systems; skills to submit documents to the National Tax Agency; skills to create (continue) small business with their families and friends; skills to deal with most popular devices and office equipment.

These findings could be also quite valuable for the academic community and facilitate the process of adaptation of the curriculums to the new digital world.

Also, these findings could trace the Agenda for workshops at the universities, attended by potential digital entrepreneurs. Thus the future managers would get better understanding about the skills they should improve in order to facilitate their business activities.

The 27 statements in the Questionnaire also give opportunities to present in next publications other comparative studies next to the gender ones, such as: the age differences; the differences between parents and non-parents.

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DELPHI METHOD APPLICATION TO FIND A MORE EFFICIENT MODEL FOR EVALUATING THE PERFORMANCE OF ADMINISTRATIVE SERVANTS

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Abstract: The aim of this paper is to evaluate the problems and challenges arising from the application of the process of evaluation of administrative servants and to identify the possibilities for changes in the process, in order to find a more efficient model that would maximize the benefits of the evaluation. The research is conducted by using the method of qualitative forecasting – the Delphi method, with the application of survey questionnaires in three rounds. Participants in the study are nine managers employed in a state institution, who answered the questionnaires between April 22 and May 12, 2020. The results of the research show that the evaluation procedure is not applied as imagined and thus does not give the intended results for which it was introduced. It is necessary to change the system for evaluation of administrative servants, either by revising some of the provisions in the current legislation, or by introducing a completely new system.

Keywords: qualitative forecasting, Delphi method, administrative servants, management of the effect, evaluation, work competencies

1. INTRODUCTION

The proper implementation of the process of evaluation of the work of administrative employees is an important requirement for the establishment and functioning of a merit-based system in the public administration. The model for evaluating the work of the administration based on competencies, popularly called "evaluation 360°", was introduced in North Macedonia in 2015, and since 2016 it is mandatory for all institutions in the public sector. The motivation for introducing a competency-based evaluation system is that, it should be an objective judgment of the individual work and the effect of the employee, in the context of his role and contribution within the organization, and the needs for professional improvement and career development (Ministry of Information Society and Administration & Center for Change management, 2016).

The subject of this paper is the system for managing the effect of administrative employees (evaluation, rewarding, punishment), regulated in the current Law on Administrative Servants, with an emphasis on the process of evaluation of the performance of employees. The need for research on the subject of the paper is understandable, given the

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importance and relevance of the topic. The system for evaluating the effect of administrative employees is one of the most discussed aspects of the Law on Administrative Servants. According to certain researchers, the current evaluation system in our country corresponds to the modern practices at European and world level. The main challenge facing the evaluation system is the large discrepancy between the evaluation results which are on average quite high, on the one hand, and the negative general perception and dissatisfaction of citizens with the work of administrative employees, on the other hand (Jahija, 2018).

The main purpose of the study is to evaluate the positive and negative aspects of the system for managing the effect of administrative employees, to identify the problems and challenges arising from its application, as well as to offer opportunities for improvement or to find a more efficient model that would maximize the benefits of this process. The main hypotheses that this paper is trying to prove is the following: The evaluation procedure is not applied as intended and does not give the expected results. In the empirical analysis we are using the method for qualitative forecasting – the Delphi method. The choice to use the Delphi method is due to the fact that it is considered one of the most important and most used methods of expert evaluation, which offers a significant improvement of the classical ways of obtaining forecasts achieved by joint consultation of a group of experts on a particular phenomenon (Cvetkoska & Dimovska, 2019).

Instead of the introduction part, in section 1 is explained the performance management system of the administrative employees in North Macedonia. Section 2 explained the used methodology and data. In Section 3 the results obtained from the Delphi method are presented and analyzed, followed by the conclusion.

2. THE PERFORMANCE MANAGEMENT SYSTEM OF THE ADMINISTRATIVE EMPLOYEES IN NORTH MACEDONIA

The Ministry of Information Society and Administration (2016) defines the management with the effect as a process that encompasses the overall work and performance of administrative employees employed in public sector institutions, in order to achieve a high level of work results. The purpose of the process of management with the effect is to provide an overview of what is expected of each individual in terms of tasks performed and competencies demonstrated, to evaluate employee performance, to promote learning and development, and to take measures to reward, improve and punish employees based on facts and arguments (Ministry of Information Society and Administration & Center for Change management, 2016).

In North Macedonia, the management with the effect of administrative employees is regulated in the Law on Administrative Servants (Official Gazette of the Republic of North Macedonia, No. 27/2014, 199/2014, 48/2015, 154/2015, 5/2016, 142/2016, 11/2018, 275/2019 and 14/2020), in Chapter X, articles 61 to 67. According to the Law, each institution is obliged to establish a system for managing the effect of administrative employees. The system consists of the processes of identifying the work goals and tasks and the determination of the individual plan for professional development, as well as the procedure for the evaluation of the effect of the administrative employee.

The evaluation process is conducted annually and is mandatory for all administrative employees, with the exception of managers in institutions and cabinet staff. The performance of the employees is evaluated with a grade from 1 to 5. The process is led by the immediate supervising officer. As part of the process of continuous monitoring of the effect of the

administrative employee, the immediate supervising officer conducts a semi-annual interview with the employee, no later than May 31.

The evaluation of the immediate supervising officer comprises the main component of the annual evaluation of the administrative employee, with 65% share in the total grade. Additionally, the evaluation process includes internal and external evaluators, i.e., four employees from the same institution (two at a lower position and two at the same position) and two evaluators who are not employed in the institution, but with whom the administrative employee had direct cooperation. The share of the assessment of the other evaluators in the total grade is 35%. Internal and external evaluators are selected by the employee, in agreement with his/her immediate supervising officer.

The Law lists the job competencies in relation to which the performance of administrative employees is evaluated. These are the quality, effectiveness and efficiency of the work, compliance with deadlines and the level of fulfillment of the work objectives and tasks, the level of involvement and commitment to the work, the contribution to the realization of the strategic plan of the institution, the realization of the individual plan for professional development and the behavior of the employee.

After the completion of the evaluation process for all employees, the manager of the institution prepares a ranking list of annual grades for all evaluated administrative employees in the institution for the current year. The law sets a limit on the number of employees in an institution that can be evaluated with the highest grade, ie up to 5% of the employees can be evaluated with a grade of "5", for the fulfillment of which the manager of the institution coordinates the evaluators. This is important because the Law provides for all employees who are evaluated with the highest grade to be awarded a bonus for their successful work in the amount of one salary.

One of the main objections to the system is that the evaluation procedure itself is too complex and does not contribute to the achievement of the goals for which it is applied and does not give the intended effects due to which the evaluation is introduced (Institute for Democracy Societas Civilis – Skopje & Center for Economic Analyses, 2019). Other shortcomings in the system include the practice of not keeping records of the performance of employees and the absence of a meeting between the employee and the immediate supervising officer to jointly discuss the performances in the current year and determine the work objectives for the next (Institute for Democracy Societas Civilis – Skopje & Center for Economic Analyses, 2019).

In his doctoral dissertation, Jahija (2018) notes that the main problem with the evaluation process is not so much in the rules themselves, but in their application. This stems from the low level of ability of top managers, which in turn leads to the emergence of subjectivism and conformism. This situation has a negative impact on career development and the evaluation system, which undoubtedly reduces the quality of functioning of the entire public administration.

3. RESEARCH METHODOLOGY AND DATA

The research was conducted by using the method of qualitative forecasting – the Delphi method, by examining nine respondents using survey questionnaires in three rounds. Details for the Delphi Method could be found in Cvetkoska and Dimovska (2019, p.p. 345-348) Participants in our research were nine managers employed in the Service of the Assembly of the Republic of North Macedonia. The original idea of the authors was to cover all managers who occupy the position of head of department in the Assembly, given that they are directly

involved in the evaluation process, both as evaluators of their employees, but also being evaluated for the effect of their work. In those sectors where there is currently no manager in the position of head of department, it was decided that the next highest manager in the organizational unit will be included in the research (occupying the position assistant heads of departments). The Service of the Assembly is composed of 13 departments and is headed by a Secretary General. Regarding the Secretary General, who is the chief manager of the institution, it was decided not to be included in the research, given that the position of Secretary General falls into the category of elected and appointed persons and as such is not subject to the standard evaluation process provided for administrative employees.

All potential participants were interviewed in order for the authors to explain to them the main purpose and the way in which the research will be conducted. The anonymity of their participation in the research was emphasized, in order to enable the respondents to freely express their opinions and views. The idea was met with positive feedback from most of the interlocutors. Out of a total of 13 heads of departments, nine agreed to be part of the survey. The three rounds of the research were conducted between April 22 and May 12, 2020.

3.1. FIRST ROUND OF THE RESEARCH

The first questionnaire was sent to the participants on April 22, giving them a period of seven days (including April 29) to submit their answers. All nine participants answered the questionnaire within the set deadline. This survey questionnaire consisted of five open-ended questions, in order to allow the respondents to be creative and freely express their opinion. The first questionnaire asked the respondents to express their general opinion regarding the current procedure for evaluating the performance, to identify the problems and challenges they face during the implementation and to define the reasons why the procedure is not always applied as imagined. Also, the goal of this questionnaire was to collect proposals regarding the possibilities for improving the process in order to maximize the benefits of the evaluation.

3.2. SECOND ROUND OF THE RESEARCH

The second questionnaire was sent to the participants on April 30, and they had six days (up until May 5) to answer them. This questionnaire was also answered by all participants. The second questionnaire consisted of four closed-ended questions, in which the respondents were asked to either assign a grade from 1 to 5 or to circle one of the proposed answers, depending on the question asked. The questions from the second questionnaire were based on the answers and results obtained from the respondents within the first round of the research. In order to preserve the anonymity of the participants in the research, but also so that each respondent could identify their answers in the next round, each participant was marked with a different color that only he/she knew.

3.3. THIRD ROUND OF THE RESEARCH

In the third round of the research, the respondents were once again asked the same questions from the previous questionnaire, but they had the opportunity to see the answers of the other respondents from the second round. In this round, the respondents had to decide whether they will keep the answers given in the second questionnaire or change them. Those respondents who decided to change their opinion on a particular issue were asked to explain why they decided to make such a change. The survey questionnaire was delivered to the

respondents on May 6 and they had six days (up until May 12) to send their answers. In the third round, three of the respondents chose to change some of their answers, while the other six decided to keep the answers given in the second questionnaire.

4. RESULTS AND ANALYSIS

From the answers received to the first question from the first questionnaire, that asked the respondents to comment on the positive and negative aspects of the current procedure for evaluating the effect of the administrative employees provided in the Law on Administrative Servants, the negative comments prevail regarding the procedure. Out of a total of nine respondents, none decided to list only positive aspects. In contrast, four respondents chose to cite in their answers only negative aspects of the current procedure. In the answers of five respondents, both positive and negative aspects of the procedure are listed. As the main positive aspects of the evaluation process, the respondents point out:

- the activity is an indicator of the performance in regard to the work competencies of each employee;
- it is a motivational or a corrective tool that influences the future performance;
- the process establishes a framework in relation to the work goals and tasks according to which the employee is evaluated;
- it offers a possibility to identify the work tasks that the employee performed outside the standard job description in the act for systematization of work positions;
- the semi-annual interview leaves room for improvement of the performance the employee.

The negative aspects of the process, stated by the respondents, are elaborated in detail in the next question that examines the problems and challenges faced by the participants during the implementation of the evaluation process.

The results to the second question, which asked respondents to list the problems and challenges they face while evaluating the effect of the employees in their sector/organizational unit, are shown in Table 1.

The results in Table 1 point to a total of 11 problems or challenges faced by the respondents in their experience with the evaluation process. The problems/challenges with the highest frequency, with four received answers, are the answers that procedure is perceived as a pure formality (filling out forms) and burdens managers with unnecessary bureaucratic work and that the evaluation done by external evaluators is problematic having in mind that in most cases the employees do not cooperate directly with the evaluators, so there is no way they could know how the employee performs his/her duties, so the evaluation often relies on friendly relations or a previous agreement. Three respondents each listed as main problems/challenges the fact that managers are forced to evaluate everyone with the same grades, in order to avoid punishing certain employees, that managers are limited in the number of their employees that can be assessed with the highest grade, as well as that the process disrupts the atmosphere and affects the relationship between employees and managers.

Table 1. Problems and challenges and their frequency

Problem or challenge	Frequency
The procedure is perceived as a pure formality (filling out forms) and burdens managers with unnecessary bureaucratic work.	4
Evaluation done by external evaluators is problematic having in mind that in most cases the employees do not cooperate directly with the evaluators, so there is no way they could know how the employee performs his/her duties; the evaluation often relies on friendly relations or a previous agreement.	4
Managers are forced to evaluate everyone with the same grades, in order to avoid punishing certain employees.	3
Managers are limited in the number of their employees that can be assessed with the highest grade.	3
The process disrupts the atmosphere and affects the relationship between employees and managers.	3
The grade often depends on the subjective will of the manager.	2
The evaluation procedure is too general and does not correspond to the type of work performed in the specific institution.	1
Some of the organizational units do not have a manager who closely monitors the work of the employees and can give a realistic evaluation on their performance.	1
Job descriptions, individual work processes and expected results from each employee are not precisely defined.	1
The employee himself/herself selects the people who evaluate him/her from the employees at a lower and at the same position, which affects the evaluation process.	1
There is pressure on the manager from a higher instance or other factor to evaluate an employee contrary to his/her objective assessment.	1

In the second questionnaire, the 11 answers received regarding the problems and challenges faced by the managers in the evaluation process were presented to the respondents, and they were asked to assess how often they have faced the specific problem/challenge during the evaluation of the effect of the employees in their department/organizational unit. The answers received were calculated in order to obtain an average grade for each problem/challenge. The results show that one problem has an average score corresponding with level 5 (problem or challenge that they face very often), five problems with level 4 (faced often), three problems with level 3 (faced sometimes), two problems with level 2 (faced rarely), while no problem has an average score corresponding with level 1 (faced very rarely). The problem with the highest score and the only one that the respondents face very often according to its average score, is the limitation that the managers have in terms of how many of their employees can be assessed with the highest grade. On the other hand, the two problems, that according to their average score the respondents face rarely, are the pressure exerted on the managers from a higher instance or other factor to evaluate an employee contrary to his/her objective assessment and the dependence of the evaluation on the subjective will of the manager.

From the answers to the third question from the first round, which referred to the adequacy of the job competencies listed in the Law, it can be concluded that the prevailing opinion is that the job competencies established in the Law are good and appropriate. Four of the respondents answered that they fully agree with the competencies set out in the Law and would not change them; four believe that the competencies are suitable, but suggest some changes, while only one respondent answered that the competencies are too general and not at all appropriate for evaluating the effect of employees, given that each job position is specific

and requires different job competencies that are suitable to the job description and the individual work processes. Within the proposed changes, one of the answers is that the competence regarding the level of involvement and commitment to the work should be revised, one refers to the removal of the competence regarding the realization of the individual plan for professional development and the behavior of the employee, while five answers propose the addition of few new work competencies. The following are mentioned as suggestions for amending the job competencies in relation to which the work of the administrative employees should be evaluated: willingness to work overtime, prudent financial operations, showing initiative by proposing additional work, taking on goals and tasks that go beyond the pay grade, as well as reducing work risks.

In the second round of the research, respondents were asked to assess the job competencies on a scale of 1 to 5 according to their significance to the process of evaluating the work of employees (1 = job competence of very low significance, 5 = competence of very high significance). Both the competencies stated in the Law and the competencies proposed by the participants in the first round were evaluated. The results indicate that two job competencies have received the highest possible average score, ie all of the respondents consider that these competencies are of very high significance (level 5). These are the competencies that refer to the quality, effectiveness and efficiency of the work and compliance with deadlines and fulfillment of task and objectives. Additionally, two other competencies have an average score corresponding to level 5 (competence of very high significance). Six competencies are assessed as being of high significance (level 4), one competency is considered as being of moderate significance (level 3), while none of the competencies is assessed with an average score corresponding to levels 2 or 1 (competence of low or very low significance). In general, almost all of the job competencies have received quite high average scores. Only the job competence for prudent financial operations is not assessed as a competence of high or very high importance. It is worth noting that the four highest rated competencies are job competencies that are already stipulated in the Law, indicating that the respondents consider the existing competencies more significant than the ones proposed by them in the first round.

The fourth question from the first questionnaire aims to provide the research with the reasons why the received grades do not always reflect the real performance of the employees and the factors influencing the evaluation procedure to not be applied as intended and to not give the expected results. The answers to this question are shown in Table 2.

The results in Table 2 show seven factors that influence the evaluation process. The respondents stated that the most common factor is the lack of objectivity in the evaluation and formalization of the whole process, due to which all employees receive the same grades. This answer was given by four respondents. Second most common factor is the legal limitation of up to 5% employees that can be assessed with a highest grade of "5". Two respondents chose this answer.

Table. 2. Factors influencing the process of evaluation and their frequency

Factor	Frequency
lack of objectivity in the evaluation and formalization of the whole process (all employees receive the same grades)	4
the legal limitation of up to 5% employees that can be assessed with a highest grade of "5"	2
the lack of accountability in managers	1
the lack of control over the evaluation process	1
the personal relationship between the employee and the manager	1
the desire to avoid dissatisfaction and negative reaction from the employees	1
insufficient familiarity or interest of the manager in the work of the employee	1

The answers received in the first round regarding the reasons why the evaluation procedure is not applied as intended and does not give the expected results, were given to the respondents in the second round, and they were asked to assess how often each factor influenced their work in their previous experience with the evaluation process. According to the average scores, the respondents believe that they have faced one factor very often, two factors often, one factor sometimes, three factors they have faced rarely, while for no factor did they estimate that they have faced very rarely. The factor with the highest score, ie which the respondents faced most often, is the lack of objectivity in the evaluation and formalization of the whole process, due to which the tendency is for all of the employees to receive the same grades. On the other hand, the factor that according to the respondents least influenced the evaluation procedure is the insufficient familiarity or interest of the manager in the work of the employee.

Regarding the fifth question, which referred to the changes that should be implemented to the system for managing the effect of the administrative employees in relation to the evaluation procedure, in order to improve this process and achieve the intended effects of the evaluation, the answers are listed in Table 3.

Table 3 shows a total of 11 proposed changes to the evaluation process. Most answers were received that propose that the employees should be obliged to submit a detailed report on the work done during the evaluation period. Three respondents proposed this change. Two respondents each proposed the changes regarding the complete change of the evaluation process in the law and regarding the need to define in detail the job description, the work processes and the expected results for each employee, based on which the evaluation would be performed. The figure shows that most of the proposals for change, a total of eight, have an average score corresponding to level 4 (change with high priority). For one proposal the respondents consider it to be of a very high priority. It is the proposal that refers to the fact that the other evaluators (internal and external) need to be directly related to the work process of the employee they are evaluating. On the other hand, according to the average scores, the respondents estimated that two proposals for change are of medium priority. Those proposals refer to the reduction of the scope of employees covered by the evaluation and the reduction of the share of the superior manager in the final grade to 50%. None of the proposed changes are rated as being of low or very low priority.

Table 3. Proposed changes to the evaluation process and their frequency

Proposed change	Frequency
The employee should be obliged to submit a detailed report on the work done during the evaluation period	3
Complete change of the law	2
Define in detail the job description, the work processes and the expected results for each employee, based on which the evaluation would be performed	2
Define in detail the job description, the work processes and the expected results for each employee, based on which the evaluation would be performed	1
Reduce the scope of employees covered by the evaluation	1
Reduce the share of the superior manager in the final grade to 50%	1
Evaluators should be obliged to describe in detail the grade they have assigned to the administrative employee	1
Other evaluators (internal and external) to be directly related to the work process of the employee they are evaluating	1
Remove the external evaluators from the evaluation process	1
The final grade should be based on the assessments made by all of the employee's supervisors (head of unit, head of department and the secretary general)	1
Put greater emphasis in the evaluation process on the contribution to the implementation of the strategic plan of the institution when selecting the employees who will be evaluated with the highest grade	1
Changes should be aimed at altering the awareness of all involved in the process	1

5. CONCLUSION

The evaluation process is a key segment of the system for managing the effect of the administrative employees. The importance of the process of evaluation can be seen in its role in providing real and objective indicators of the work performance of the employees, their role and contribution in achieving the goals of the organization, but at the same time in determining the needs for professional and career development of each administrative employee. In North Macedonia, the model for evaluating the work of the administration based on competencies, popularly called "evaluation 360°", is implemented since 2016. The main challenge facing the evaluation system is the large discrepancy between the negative general perception and dissatisfaction of citizens with the work of administrative employees and the very high evaluation results that the employees receive in the evaluation process. It seems that the problem is more in the application of the rules than in the rules themselves.

The main purpose of the study is to evaluate the positive and negative aspects of the system for managing the effect of administrative employees, to identify the problems and challenges arising from its application, as well as to offer opportunities for improvement or to find a more efficient model that would maximize the benefits of this process. In the paper, first an overview of the process of performance management of employees in North Macedonia was given, regulated in the Law on Administrative Servants, with special reference to the evaluation process. Then, the results of the research were presented, conducted in one state institution by applying the method of qualitative forecasting – the Delphi method. The goal of the research was to identify the possibilities for amending the Law on Administrative Servants in regards to the evaluation of the effect of the employees with the goal of finding a more efficient model that would maximize the benefits of the evaluation.

The general impression gained from the conducted research is that the evaluation process is seen mostly as a formality that must be executed (filling in forms), mainly due to the tendency for all of the employees to receive the same grades regardless of their actual performance and achievements in the work process. Respondents cited several reasons why this is the case, including the avoidance to punish certain employees who are underperforming in order not to disrupt the atmosphere in the workplace and the relationship between managers and employees.

The problem that managers most often face when evaluating their employees is the limit in the law on the number of employees in an institution who can be assigned with the highest grade, due to which the top manager of the institution coordinates the evaluators and, in most cases, the directive is that only one employee from an organization should receive the highest grade. This causes revolt and contributes to the lack of motivation of certain employees, who feel that they deserve the highest grade with their performance, but do not receive it due to the legal restrictions.

Another problem that often occurs during the process is the unrealistic assessment done by the other evaluators (internal and external), mainly due to the fact that they are selected by the employee who is being evaluated, so in many cases these persons have no real contact with the evaluated employee and there is no way they could know how the employee performs his/her duties, so the assessment often relies on friendly relations or a previous agreement.

Some of the respondents emphasized that many of the problems arise from the low level of awareness and self-criticism of the employees for their efforts and performance. Most employees tend to overestimate their performance and expect to get the grade they believe is realistic. Therefore, receiving a lower grade is viewed with discontent and is often interpreted as a personal intolerance or punishment by the manager.

Regarding the job competencies on the basis of which the work of the administrative employees is evaluated, the general impression is that, although certain additions to the list are possible, the competencies established in the Law are appropriate and there is no real need to change them. Analyzing the reasons why the grades do not always reflect the real achievements of the employees, the most common factors that influence the process are the lack of objectivity in the evaluation and the legal limitations. On the other hand, subjective factors such as the personal relationship between the employee and the manager, the lack of control over the process itself, as well as the manager's insufficient knowledge or interest in the employee's work, rarely appear as reasons why the evaluation process is not applied as imagined and does not give the intended effects.

Regarding the search for a more efficient model that would maximize the benefits of the evaluation, the proposals range between completely changing the existing system and revising certain aspects of the current procedure where the main problems and challenges in its implementation are identified. One of the proposals with the highest priority for change refers to the evaluation done by other evaluators (internal and external), for which the respondents believe that, either it should be abolished completely, or it needs to be changed considerably. Additionally, the obligation for submission of detailed reports by the employees on the work done in the evaluated period is emphasized, in order for the evaluation process itself to be based on facts and arguments. One proposal refers to the fact that only a revision of the regulation is not enough, and a significant effort should be made to change the awareness of everyone involved in the process, in the direction of greater self-criticism of the employees and willingness to accept criticism and constructive suggestions for improvement of their performance within the work process.

Overall, the results of the research show that the performance evaluation of administrative employees is not applied as imagined and does not give the intended effects due to which it was introduced. Hence, it is necessary to change the system, either by revising some of the provisions in the current legislation, or by introducing a completely new system.

The Law on Administrative Servants covers a wide range of employees in the public sector, for which the same procedure for managing employee performance applies. Having in mind the specificity of the work of different institutions and organizational units and the diversity of individual work processes, it is logical to expect that the problems and challenges that arise as part of the process of performance evaluation in different institutions, differ significantly from one institution to another. Considering that the research was conducted on respondents from only one state institution, in the future the scope of the research needs to be extended to several state institutions at different levels (central and local), in order to get a more complete picture of the posed problem and to identify possibilities for improvement.

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INTERNET FINANCIAL REPORTING PRACTICES IN BOSNIA AND HERZEGOVINA, SERBIA AND MONTENEGRO

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Abstract: Web based financial reporting has become a norm today and has changed traditional forms of corporate reporting. Internet Financial Reporting (IFR) is an inseparable part of the efficient and developed capital markets. In most cases investment public, particularly small investors based their company's performance analysis entirely on the data available on-line. For the companies aiming to maximize their fundamental value and shareholder wealth it is necessary to increase the scope and quality of information provided on-line.

The objective of this research is to analyze the level of Internet financial reporting and to examine the predictors of the IFR index for companies listed on Sarajevo, Banja Luka, Belgrade and Montenegrin Stock Exchange. We have created IFR index for all four markets and we found a limited voluntary disclosure of companies in all cases. By estimating multiple cross-section regression, we explored the influence of size, profitability, financial policy and market activity measures on the IFR. We found that size measured by total assets, total revenues or total market capitalization influences positively the level of IFR. Financial policy measures have significant and negative impact on the level of the IFR in all analyzed markets. Return on equity is significantly explaining the IFR index on Sarajevo Stock Exchange, while stock market turnover is significantly influencing the IFR on the Belgrade Stock Exchange. In general, larger companies disclose more information, while companies with more own financing or larger equity disclose less information on their websites in all analysed markets. This article confirms past findings about unsatisfying level of IFR in Western Balkan countries. This indicates the weak role of a market regulatory authority in the analysed markets.

Keywords: Internet financial reporting, SASE, BLSE, BELEX, MNSE

1. INTRODUCTION

Internet offers great possibilities for companies to increase their visibility, to promote and to communicate with their stakeholders. Investment public obtains relevant information about companies mostly online, like companies' profile, business reports, financial results or market activities. By financial reporting on the Internet, investors can easily, quickly and at

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low cost access the data relevant for making investment decisions. Through the transition from traditional paper reporting to online reporting, there is an opportunity for more flexible data manipulation. Availability of financial reports online is a key factor of effectiveness of capital markets, market transparency and reduction of information asymmetry.

Internet Financial Reporting (IFR) usually includes business reports and annual, semiannual and quarterly financial reports, as well as information about stock price and trading, general assembly meetings, management and ownership structure, media statements, etc. Internet Financial Reporting is unfortunately not widely accepted in analyzed transitional West Balkan countries, i.e. companies in general have not yet recognized the benefits of the Internet and the disclosure of financial and non-financial information.

The main objective of financial reporting is providing quality, useful, and also objective and truthful information to interested groups on the financial position of the company, changes in financial position, as well as the success of the company in the market. From investors' point of view purpose of financial reporting is to support investment, financing and working capital decisions that will have a positive impact on the company's value. The FASB and the IASB having a similar conceptual framework state that the financial statements should provide useful information for interested groups.

International Accounting Standards (IAS) and International Financial Reporting Standards (IFRS) seek to achieve transparency of financial statements in all activities and countries. IAS 1 defines the basis for the presentation of financial statements so that they can be compared with previous reports as well with other companies. The basic legal framework for mandatory accounting and financial reporting in analyzed countries is *accounting (and auditing) act* in every jurisdiction. These acts coordinate with EU Directives and accounting standards. The preparation of the financial statements is carried out with IASB regulations, with respect to IAS or IFRS. The presentation and audit of the financial statements is performed in accordance with International Standards on Auditing (ISAs) and the Code of Ethics. Additional provisions on financial reporting are subject to the Regulation on Disclosure of Information and Reporting. According to the Rules, all listed joint stock companies are obliged to publish semi-annual and annual reports, as well as external auditor's report and statement on events which significantly impact financial performance on company's official websites. They are obliged to submit their reports to the stock exchanges for publication on their websites, also. In addition, all listed joint stock companies should publish quarterly and nine-month operating reports and make them available on-line.

The objective of this research is to create IFR index measuring the level of Internet Financial Reporting of joint stock companies from four stock exchanges in three Western Balkan countries, namely in Bosnia and Hercegovina, Serbia and Montenegro and to empirically examine the predictors of the IFR level in analyzed markets. By this study we answer two questions: (1) what the level of Internet Financial Reporting in the analyzed markets is and (2) what factors influence the level of the IFR. We specify and estimate a multiple cross-section regression model explaining IFR level. By our explanatory analysis we measure impact of company's size, profitability, financial policy and stock market activity on the level of Internet financial reporting. Our study adds to the literature on the factors that predict the level of IFR. This is one of the first studies that investigate the determinants of IFR index of companies included in stock market indices from four Western Balkan stock exchanges.

The article starts with literature review on the topic of Internet financial literacy from different countries. The next section covers methodology and data, followed by IFR index assessment. Main findings are presented in section results and discussion, followed by conclusions.

2. LITERATURE REVIEW

Globalization has made the Internet the most widely used communication tool. According to Bonson & Escobar (2002), financial reporting on the Internet is a new way of accessing relevant financial and non-financial information for decision makers. As a result, there is a growing shift from traditional – paper reporting to modern – Internet reporting, as it offers many options and information to users.

This research aims to highlight the benefits of this practice. Previous research on this topic can be classified into three groups: descriptive research, which descriptively seeks to explain the use of financial statements on the Internet; comparative research, seeks to compare the surveyed countries with each other; exploratory research, seeks to discover which factors affect the Internet financial reporting.

In the UK, Craven & Marston (1999) surveyed the scope of voluntary financial reporting on the Internet in a sample of 200 companies, where 153 (74%) had their own website, 109 (53%) reported financial information, while only 67 (33%) companies published a detailed annual report. Hedlin (1999) conducted a survey in Sweden on 60 companies and almost all of them have a website (98%), 83% of companies publish financial statements, and only 12% of companies allow downloading of these documents. The usage of the Internet for financial reporting in Ireland was analyzed by Brennan & Hourigan (1999) at 109 companies. They found that only 50 (46%) companies have a website, of which 32 (64%) publish financial information and the balance sheet and income statement are published by 24 (75%) companies. Pervan (2005) conducted a survey on 38 companies in Croatia. The results showed that only 20 companies publish their financial statements, and only 15 (39.4%) companies publish a set of financial statements, while 4 companies publish quarterly or semi-annual reports. The most common format of published financial statements in 14 (36.8%) companies is PDF.

A surprising and encouraging study conducted in Greece by Despina & Demetrios (2009), where in a sample of 302 companies listed on the Athens Stock Exchange all have a website. 97.7% of companies publish annual reports, 98.3% publish annual reports of past years, 98.3% of companies publish balance sheet and cash flow, and 99% of companies report in PDF format. The practice of voluntary reporting was also analyzed in Bosnia and Herzegovina by Zaimovic et al. (2015). The total sample for analysis was 88 companies within two stock exchanges, the Sarajevo Stock Exchange (SASE) and the Banja Luka Stock Exchange (BLSE). 30% of companies had an available balance sheet on their website, 28% of companies had an income statement and 20% of companies had an available statement of changes in equity, cash flow and notes. Further analysis found that only 5 companies had their stock price data, while only 3 companies have disclosed dividend payment data. This study concluded that the level of financial reporting in B&H is relatively low.

Kamalluarifin (2016) conducted a survey in Malaysia on the top 100 companies listed on Bursa Malaysia Stock Exchange, where out of 100 companies, only 5 companies do not publish their annual reports on the Internet. In a further survey of 95 companies, 94% of them publish quarterly reports, while 74% publish their stock price. In a survey of Jordanian companies listed on the Amman Stock Exchange, Yassin (2017) examined 250 companies, with 22 companies excluded and the final sample comprised 228 companies. 149 (65.35%) companies have their own website, and 147 (98.7%) publish annual reports, of which 120 (80.5%) publish financial statements in PDF format.

Comparative research seeks to compare countries with the similar level of financial reporting on the Internet. Considering the importance of the Internet in European countries, Bonson & Escobar (2002) conducted a survey in 15 European countries and for a sample they

took the 20 largest companies from each country. Research has shown that 86.3% of companies most often publish balance sheets and income statements in PDF or HTML, while 77% publish an audit report and cash flow is published by 73% of companies. To identify the usefulness of the Internet, Geerlings et al. (2003) conducted research in Belgium, France and the Netherlands. The 50 largest companies were analyzed from each country. Internet usage was most prevalent in France (94%), followed by the Netherlands (92%), and in Belgium (70%), respectively companies from France and the Netherlands have better IFR practices than companies from Belgium. A survey conducted in the US, UK, Canada, Australia and Hong Kong by Allam & Lymer (2003) included a sample of 250 companies, or 50 companies from each country, found that almost all companies have a website, and publish their financial statements.

Marston & Polei (2004) analyzed financial information on 50 companies from a sample of DAX 100 German companies listed on the Frankfurt Stock Exchange in 2000 and 2003. It was found that in 2000, only 34% of companies published annual reports in the last three years, while in 2003 this percentage increased significantly to 93%. Also, there was an increase in publication of annual reports in PDF format from 88% to 98%, as well as publication in HTML format from 22% to 57%, and the information about current stock price increased from 86% to 93%. The practice of voluntary reporting was also analyzed with companies from Croatia and Slovenia. Pervan (2006) analyzed 85 companies, 55 companies from Croatia and 30 from Slovenia. It had been found that companies in Slovenia publish more information unlike companies in Croatia where the percentage is much lower. Publication of a set of financial statements for Croatian companies ranges from 23.6% to 32.7%, and for Slovenian companies this range goes from 70% to 93.3%.

To examine the voluntary disclosure of information by companies in Eastern Europe that have just been joined the European Union, 13 countries were analyzed by Bonson & Escobar (2006). The original sample consisted of 1543 companies, which later decreased to 805 companies that had a website. 630 companies have a page in English, and further optimization of the sample resulted in 266 companies, of which 34.5% publish an annual report, 27.91% publish an annual report of previous years, 13.95% publish a semi-annual, and 33.33% of companies have page map. In 2010 and 2011, a survey was conducted in Egypt by Ahmed et al. (2017) for the 172 non-financial companies listed on the Egyptian Stock Exchange. In 2010, 137 (79.7%) companies had a website, of which 17 (9.9%) had an unavailable website or a page under development. Thus, 120 (69.8%) companies had a page accessible and only 70 (40.7%) companies published financial information. In 2011, 141 (82.5%) companies had a website and 22 (12.9%) companies had an unavailable or page under development. 119 (69.6%) companies had an active page, of which 73 (42.7%) companies published financial information.

Explanatory research aims to discover factors that affect the level of financial reporting on the Internet. Without consideration of the benefits of voluntary reporting, Debreceeny et al. (2002) surveyed online financial reporting practices with 660 large companies in 22 countries. The results showed that the size of the company, listing on the US stock exchange and technology have a positive effect on financial reporting on the Internet, so these factors are significant for the amount of reporting on the company's website.

In a 2000-2003 survey of German companies, Marston & Polei (2004), using regression analysis, found a positive significant relationship between the size of the company and the percentage of stock free float in 2000. In 2003, they established a positive relationship between the size of a company and the listing of a company on a foreign exchange. Size of the company is significant for the publication of financial statements on the Internet. Andrikopoulos et al. (2013) surveyed 171 international transport companies and found a

statistically significant positive relationship between corporate disclosure and company profitability.

Garay et al. (2013) analyzed the relationship between IFR disclosure and the value of the company listed on the seven largest exchanges in Latin America. They came to the conclusion that there is a strong and positive relationship between IFR and Tobin's Q. A study conducted by Bartulovic & Pervan (2014) on a sample of 91 listed companies in: Zagreb, Ljubljana, Belgrade, Sarajevo and Banja Luka found that there is a difference in the level of IFR between countries. The highest IFR index was recorded with companies from Slovenia 23.25 while the lowest recorded with companies from Banja Luka 3.61. They founded that variables like official market quotation, stock turnover, assets and the industrial sector significantly influenced the IFR index. Zaimovic et al. (2015) found that the IFR index is influenced by size (total assets), stock turnover and dummy variable representing financial industry (Sarajevo Stock Exchange). For Banja Luka Stock Exchange they found return on equity, stock turnover and dummy variable standing for financial industry having statistically significant impact on IFR index.

Ahmed et al. (2017) by analyzing Egyptian companies concluded that the size of the company, leverage, liquidity, audit of reports, listing abroad and type of industry are significant in both 2010 and 2011, while profitability is not related to the volume of financial reporting on the Internet in both years. Weiling et al. (2017) in their research in China from 2011 to 2015 found a positive significant relationship between voluntary disclosure of information and corporate value of the company in the initial period, growth period and in the period of company maturity, and a negative relationship in the period of recession or withdrawal.

3. MATERIAL AND METHODS

To design the index, we used the results of methodological framework from the previous studies on this topic (Marston & Polei, 2004; Xiao et al., 2004; Pervan, 2006; Bartulovic & Pervan, 2014; Zaimovic et al., 2015). Our research methodology is a combination of qualitative and quantitative approach and follows a similar two-step process. The first part of the empirical research offers a comparative assessment measured through the Internet Financial Reporting Assessment, while the second part provides an explanatory analysis that estimates the variables related to the IFR Index of listed companies for four Western Balkan stock exchanges.

3.1. SAMPLE

Due to nonsynchronous trading problem in the observed stock exchanges and extremely high number of illiquid stocks for which market data like trading volume or current market capitalization is unavailable, our criteria for sample selection were: (1) active stock exchange trading in the first six months of 2018, (2) existence of company's website, (3) inclusion in one of the stock exchange indices and (4) sufficient trading volume in 2017. Since our study researches voluntary financial reporting on the Internet, companies that do not have own website are not included in the research.

Our original sample included 114 companies from five stock exchanges in the Western Balkan countries (beside earlier mentioned countries, including Republic of North Macedonia, also). The starting sample included all companies from stock market indices

SASX-30 and SASX-10 from Sarajevo Stock Exchange, all stocks from BIRS and ERS10 indices from Banja Luka Stock Exchange, then all companies from BELEX15 and BELEXline indices from Belgrade Stock Exchange, all companies from MNSE10 and MONEX indices from Montenegrin Stock Exchange and all companies from MBI10 indices from Macedonian Stock Exchange. Due to illiquidity and/or nonexistence of the company's webpage final sample includes 93 stocks from four stock exchanges. Due to small sample Macedonian Stock Exchange in the end was excluded from the analysis.

3.2. IFR INDEX ASSESSMENT

In order to examine the quality of financial reporting on the Internet of listed companies in observed Western Balkan stock exchanges, we create an Internet Financial Reporting Index (IFR index). The IFR index evaluates the reporting quality of the sample companies. The IFR index includes 33 elements, which are divided into six groups: technical aspects of the website, company financial statement information, company business reports, transparency of the company's management and supervisory boards, investor relations and other information. If the element was present on the company's website, it was rated with 1, otherwise with 0. The final grade, IFR index, is the sum of the ratings.

The next table summarizes descriptive statistics for the IFR score for all four groups of companies, i.e. stock exchanges. IFRSASE stands for IFR scores for companies from the Sarajevo Stock Exchange (SE), IFBLSE for Banja Luka SE companies, IFRBELEX for Belgrade SE companies and IFRMNSE are IFR scores for Montenegrin SE companies.

Table 1. IFR index descriptive statistics

<i>Characteristics</i>	<i>IFRSASE</i>	<i>IFRBLSE</i>	<i>IFRBELEX</i>	<i>IFRMNSE</i>
No. of observations	26	17	23	27
Mean	13.5	9.77	22.52	13.74
Min	2	4	14	3
Max	28	24	28	27
Variance	73.54	51.19	13.63	64.82
Standard deviation	8.56	7.16	3.69	8.05
Median	13.5	6	22	16

Source: Authors elaboration in Stata

The average IFR index for companies traded on the selected Western Balkans stock exchanges that have website is 14.88, while a maximum IFR index of 33 was not found in any country. The survey found that 93 companies out of the 106 companies own the website. The highest average IFR index of 22.52 was found on the Belgrade SE, while the lowest IFR index of 9.77 was found on the Banja Luka SE. A set of basic financial statements, i.e. a balance sheet and income statement can be found in 58 (62.37%) companies, a statement of changes in equity and a cash flow statement were found in 55 (59.14%) companies, and notes in 48 (51.61%) of the companies surveyed. Companies usually publish documents in Excel or PDF format, while data on stock prices were found in 10 and dividend payments in 15 cases.

4. RESULTS AND DISCUSSION

Through the explanatory analysis we aim to answer the question what factors affect the level of financial reporting on the Internet. We use a multiple linear regression model that seeks to examine a statistically significant relationship between the dependent variable (y), in this case the IFR index, and several independent variables (x1, x2, x3, ...), which will be explained in detail below. The beginning econometric model of multiple cross-section linear regression is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + e \quad (1)$$

We consider independent variables used in other studies and researches: *company size* (Ashbaugh et al., 1999; Brennan & Hourigan, 1999.; Pirchegger & Wagenhofer, 1999; Bonson & Escobar, 2002; Ettredge et al., 2002; Oyelere et al., 2003; Allam & Lymer, 2003; Marston, 2003; Marston & Polei, 2004; Xiao et al., 2004; Andrikopoulos et al., 2013; Basuony & Mohamed, 2014; Zaimovic et al., 2015; Sanad & Al-Sartawi, 2016; Kamalluarifin, 2016; Ahmed et al., 2017; Elfeky, 2017; Yassin, 2017), *profitability* (Ashbaugh et al., 1999; Oyelere et al., 2003; Allam & Lymer, 2003; Marston, 2003; Marston & Polei, 2004; Andrikopoulos et al., 2013; Basuony & Mohamed, 2014; Zaimovic et al., 2015; Kamalluarifin, 2016; Ahmed et al., 2017; Elfeky, 2017; Yassin, 2017; Dang et al., 2017), *market activity* (Pervan, 2005; Bartulović & Pervan, 2014; Zaimovic et al., 2015), *financial policy* (Dang et al., 2017.) and *dummy variables* for different industries. Table 2 shows the four groups of independent variables.

Table 2. Overview of independent variables

Variable	Label	Description
Size		
Total assets	UAKT	Balance sheet
Total revenues	UPH	Income statement
Total market capitalization	TKAP	Market capitalization
Profitability (performance)		
Tobin Q	TQ	Market capitalization/Total assets
Return of assets	ROA	Net income/ Total assets
Return of equity	ROE	Net income/equity
Financial policy		
Degree of own financing	SVF	Equity/total assets
Total equity	UKAP	Statement of changes in equity
Market activity		
Stock turnover	PROM	Stock turnover

Source: Authors elaboration

Data on independent variables was obtained from various sources, i.e. Stock Exchanges' and Securities Commissions' websites and annual reports of companies, depending on availability. Financial report and market data used as independent variables refer either to the calendar year 2017, or end of the year 2017. Our estimated model includes only the companies that have websites. We have run separate regression analyses for all the

stock exchanges. Based on the previous researches, we have formulated a general econometric research model:

$$IFR = \beta_0 + \beta_1 SIZE + \beta_2 PROFITABILITY + \beta_3 FINANCIAL POLICY + \beta_4 MARKET ACTIVITY + \beta_5 DUMMY + e \quad (2)$$

IFR index represents dependent variable, while independent variables are *size* variables (UAKT, UPH, TKAP), *profitability* or company's performance variables (TQ, ROA, ROE), *financial policy* variables (SVF, UKAP) and *market activity* variables (PROM). Dummy variable stands for industry and "e" stands for residuals. In some regression logarithmic values of independent variables are used.

Based on the general regression model, we estimated separate regression model for each Stock Exchange. The following multiple cross-section regression model was estimated for Sarajevo Stock Exchange, with results of estimated regression presented in table 3:

$$IFR = \beta_0 + \beta_1 \ln UPH + \beta_2 ROE + \beta_3 SVF + \beta_4 \ln PROM + \beta_5 d + e \quad (3)$$

Table 3. Results of estimated regression model for SASE

Source	SS	df	MS			
Model	1022.35244	5	204.470488	Number of obs	=26	
Residual	816.14756	20	40.807378	F (5,20)	=5.01	
Total	1838.5	25	73.54	Prob>F	=0.0039	
				R-squared	=0.5561	
				Adj R-squared	=0.4451	
				Root MSE	=6.3881	
ifr	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lnuph	3.154009	.6927251	4.55	0.000	1.70901	4.599009
roe	10.70354	4.09692	2.61	0.017	2.157515	19.24957
svf	-12.886	5.844431	-2.20	0.039	-25.07727	-.6947268
lnprom	-0.2027067	.5736562	-0.35	0.728	-1.399332	.9939191
d	8.924939	4.781456	1.87	0.077	-1.049004	18.89888
_cons	-31.89247	12.7639	-2.50	0.021	-58.51435	-5.270581

Source: Authors calculations in Stata

Estimated regression model has statistically significant predictive capability, with F statistics of 5.01 (p=0.0039). The 44.51% of the variance is explained by the estimated model. Statistically significant variables are total revenue (p=0.000), return on equity (0.017), the own financing variable with negative coefficient (0.039) and at significance level of 10% dummy variable representing pharmaceutical industry (p=0.077).

In order to test the possible multicollinearity in the estimated regression, the variance inflation factor (VIF) was calculated. Since all of the VIF's are smaller than 5, while mean VIT is 1.28, we conclude that there is no multicollinearity in the estimated model. Results of Ramsey Reset test that use the powers of fitted values to check for omitted variables shows that there is no specification error in the estimated regression (p=0.7516). Skewness-Kurtosis test (SK test) shows that residuals are identically and independently distributed (p=0.6516). The Breusch-Pagan test on heteroskedasticity is insignificant (p= 0.9719), so the variance of residuals is homogenous.

For Banja Luka Stock Exchange the following multiple cross-section regression was estimated, with results presented in table 4:

$$IFR = \beta_0 + \beta_1 UAKT + \beta_2 TKAP + \beta_3 ROE + \beta_4 UKAP + \beta_5 SVF + \beta_6 d + e \quad (4)$$

Table 4. Results of estimated regression model for BLSE

Source	SS	df	MS		Number of obs	=17
Model	581.38139	6	96.8968984		F (5,20)	=4.08
Residual	237.677433	10	23.7677433		Prob>F	=0.0249
Total	819.058824	16	51.1911765		R-squared	=0.7098
					Adj R-squared	=0.5357
					Root MSE	=4.8752
ifr	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
uakt	9.29E-09	4.82E-09	1.93	0.083	-1.45E-09	2.00E-08
tkap	3.61E-08	1.23E-08	2.93	0.015	8.65E-09	6.35E-08
roe	6.809278	18.4406	0.37	0.720	-34.27895	47.89751
ukap	-2.57E-08	9.12E-09	-2.82	0.018	-4.61E-08	-5.43E-09
svf	16.19579	11.75792	1.38	0.198	-10.00249	42.39406
d	-10.59386	3.907544	-2.71	0.022	-19.30041	-1.887313
_cons	1.955139	8.386788	0.23	0.820	-16.73179	20.64207

Source: Authors calculations in Stata

The IFR index of companies from Banja Luka Stock Exchange is statistically significantly influenced by the market capitalization ($p=0.015$), total equity ($p=0.018$) and dummy variable representing other sectors ($p=0.022$), and at 10% significance level by total asset ($p=0.083$). Coefficients with both variables related to company size (total assets and market capitalization) have a positive sign, while coefficients with the financial policy variable (total equity) and the dummy variable representing other industries have a negative sign.

The regression model does not suffer from multicollinearity, since all VIF's are lower than 5. The functional form (Ramsey Reset test) of the estimated model is good ($p=0.5616$). Skewness-Kurtosis test is significant ($p=0.0482$), i.e. residuals are not identically and independently distributed. The Breusch-Pagan test is insignificant ($p=0.5051$), i.e. the variance of residuals is homogenous.

The regression model estimated for Belgrade Stock Exchange is as follows:

$$IFR = \beta_0 + \beta_1 \ln UAKT + \beta_2 ROE + \beta_3 \ln UKAP + \beta_4 \ln PROM + \beta_5 d + e \quad (5)$$

Table 5. Results of estimated regression model for BELEX

Source	SS	df	MS			
				Number of obs	=23	
				F (5,20)	=5.09	
Model	179.647868	5	35.9295737	Prob>F	=0.0049	
Residual	120.091262	17	7.06419188	R-squared	=0.5993	
				Adj R-squared	=0.4815	
Total	299.73913	22	13.6245059	Root MSE	=2.6579	
ifr	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lnuakt	.9629553	.4708559	2.05	0.057	-.0304637	1.956374
roe	.6129934	1.820239	0.34	0.740	-3.227376	4.453363
lnukap	-.3168931	.1366649	-2.32	0.033	-.6052309	-.0285552
lnprom	.8462166	.3163844	2.67	0.016	.178704	1.513729
d	-1.1579	1.686948	-0.69	0.520	-4.71705	2.40125
_cons	-7.623855	8.687116	-0.88	0.392	-25.95207	10.70436

Source: Authors calculations in Stata

IFR index on Belgrade Stock Exchange is statistically significantly influenced by total assets ($p = 0.057$), total equity ($p = 0.033$) and turnover ($p = 0.016$). Total assets and market activity have positive impact on IFR index, while financial policy performs negative impact on IFR index, the same as we found on two other Stock Exchanges, Sarajevo and Banja Luka. We have run earlier mentioned diagnostic and functional form tests and all of them are insignificant, i.e. the model is good specified ($p=0.2639$, Ramsey Reset test), residuals are identically and independently distributed ($p=0.8737$, SK test) and the variance of residuals is homogenous ($p=0.5981$, Breusch-Pagan test). There are no multicollinearity problems, since all VIF's are lower than 5, with mean value of 1.40.

Regression model for Montenegrin Stock Exchange and results are as follows:

$$IFR = \beta_0 + \beta_1 UPH + \beta_2 ROE + \beta_3 UKAP + \beta_4 SVF + \beta_5 PROM + \beta_6 d + e \quad (6)$$

Table 6. Results of estimated regression model for MSE

Source	SS	df	MS			
				Number of obs	=27	
				F (5,20)	=3.69	
Model	885.47663	6	147.579438	Prob>F	=0.0124	
Residual	799.708556	20	39.9854278	R-squared	=0.5254	
				Adj R-squared	=0.3831	
Total	1685.18519	26	64.8148148	Root MSE	=6.3234	
ifr	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
uph	1.43E-07	4.90E-08	2.91	0.009	4.04E-08	2.45E-07
roe	2.109657	3.399489	0.62	0.542	-4.98155	9.200866
ukap	-2.67E-08	1.26E-08	-2.12	0.047	-5.29E-08	-4.53E-10
svf	7.876845	6.269743	1.26	0.223	-5.201611	20.9553
prom	-6.26E-07	1.91E-06	-0.33	0.747	-4.62E-06	3.37E-06
d	-8.430499	3.044092	-2.77	0.012	-14.78036	-2.080634
_cons	10.7611	4.454938	2.42	0.025	1.468264	20.05394

Source: Authors calculations in Stata

The level of the Internet Financial Reporting on Montenegrin Stock Exchange is positively and statistically significantly influenced by total revenue ($p=0.009$), while two other significant variables, total equity, i.e. financial policy ($p=0.047$) and dummy variable representing other sectors ($p=0.012$), have negative impact.

The estimated model does not suffer from multicollinearity. The functional form of the estimated model is checked by the Ramsey Reset test which is insignificant ($p=0.7403$). Regression model has insignificant diagnostic tests for residual normality ($p=0.5191$, SK test) and heteroscedasticity test ($p=0.1053$, Breusch-Pagan test).

Our study shows that significant predictors of IFR in analyzed markets are size of the company, measured either by book values (total asset or total revenues) or company's market value, i.e. stock market capitalization and financial policy variables measured either by degree of own financing or total equity. While the impact of the size variables is always positive, impact of the financial policy variables is always negative. The larger the company is, in terms of total asset, total revenues or market capitalization, the larger the IFR index. On the other hand, the more company uses own equity in financing its assets and operations, the lower the IFR index and lower the company's voluntary disclosure on the Internet. These findings are very interesting, indicating portfolio investments in highly capitalized companies will be accompanied by less transparent reporting.

In addition to previously said, we found only partly confirmation about the relevance of IFR predictors related to profitability and market activity. Return of equity is significantly influencing IFR level only for companies on Sarajevo Stock Exchange, while stock market turnover is significant only for companies from Belgrade Stock Exchange. Our findings are partly in line with previous researched that found that stock market activity, return on equity and total assets are explaining variations in IFR level (Zaimović et al., 2015). Financial policy was included as independent variable for the first time in empirical researches on analyzed markets, and it was found significant in all regressions.

5. CONCLUSION

In this research we analyzed Internet Financial Reporting practices of companies traded on stock exchanges from three Western Balkan countries. We found a limited voluntary disclosure of the analyzed companies, i.e. only 61.37% of companies made their balance sheet and income statement available online, while in only 10.75% cases stock price could be found on the company's website. We created IFR index for all four markets. The highest average IFR index of 22.53 was found on the Belgrade Stock Exchange, the lowest (9.77) on the Banja Luka Stock Exchange, with an overall average of 14.88 in all markets. Maximum IFR index value of 33 was not found in any country. In general, corporate governance practices in the analyzed markets are unsatisfying, while we can conclude that the situation is better in Serbia than in other capital markets.

In the second part of our research we answered the question of what variables influence the IFR voluntary disclosure. We estimated multiple cross-section regression models and found some interesting results. Size measured by total assets, total revenues or total market capitalization influences positively the level of IFR in all markets, i.e. one or more size measures are significant. Profitability proxied by return on equity is significantly explaining the IFR index only on Sarajevo Stock Exchange. Stock market turnover was significantly influencing the IFR on the Belgrade Stock Exchange. Undoubtedly, financial policy ratios have significant and negative impact on the level of the IFR in the analyzed markets. In every estimated model degree of own financing or total equity were significantly influencing the

level of Internet Financial Reporting and had negative sign. Pharmaceutical sector companies have higher level of IFR on Sarajevo Stock Exchange, while other sector companies have lower IFR index on Banja Luka and Montenegrin Stock Exchange. In general, larger companies disclose more information, while companies with more own financing or larger equity disclose less information. By our research we confirm some previous findings about factors explaining internet financial disclosure: profitability (Andrikopoulos et al., 2013; Kamalluarifin, 2016; Elfeky, 2017) and size measured by market capitalization (value) and/or total asset (Debreceny et al., 2002; Ettregde, 2002; Marson, 2003; Marson & Polei, 2003; Oyelere et al., 2003; Allam & Lymer, 2003; Bonson & Escobar, 2006; Basuony & Mohamed, 2014; Elfeky, 2017).

Since we analyzed actively traded stocks, we can only assume that IFR practices of other (less liquid) stocks are even worse. However, the main limitation of our research is the sample size. To increase the reliability of our generalizations, the sample should be increased according to the further development of the analyzed capital markets. The analyzed markets are underdeveloped, and we can expect faster development and higher trading volumes in the future. Today it sounds unbelievable that there are companies traded in the stock exchanges that do not have their own webpage, or do not disclose their financial statements and other important information online. This indicates the weak role of a market regulatory authority in the analyzed markets also. For the companies aiming to maximize their fundamental value and shareholder wealth it is absolutely necessary to increase the scope and quality of information provided.

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MULTIPLE CRITERIA ANALYSIS OF AIR POLLUTION IN AN URBAN ENVIRONMENT IN THE VICINITY OF A COPPER SMELTING PLANT

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Abstract: The aim of this study was to analyze the level of air pollution in the vicinity of a copper smelting plant and to identify the locations with the highest measured concentration of pollutants in the air. The research was conducted at four locations in Bor (Serbia) in the period from 2014 to 2018. Measurement stations were located in the urban area in the vicinity of the smelting plant. The concentrations of sulfur dioxide (SO₂) and suspended particulate matter (PM₁₀), as well as concentrations of heavy metals present in PM₁₀, such as lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As), were measured during this period. The obtained values were compared to the set pollutant thresholds proposed by the European Commission. The multiple-criteria decision analysis PROMETHEE/GAIA was used for ranking the measuring stations according to the level of air pollution. The graphical representation of the obtained ranking data was provided in the paper.

Keywords: air pollution, suspended particulate matter PM₁₀, heavy metals, SO₂, Multiple Criteria Analysis

1. INTRODUCTION

The environment encompasses all natural and created values whose relations constitute surroundings, areas, and living conditions. Natural resources, such as water, air, soil, forests, geological resources, flora, and fauna, represent natural values (Law on Environmental Protection, Official Gazette of RS. 2018, 2011, 2009, 2004). World Health Organization defines five main prerequisites for healthy environment: clean air, adequate water, nutritionally balanced diet, safe and peaceful communities, and stable ecosystems (Kićović, 2012). The air is deemed polluted if it contains additional components in concentrations that have harmful consequences for human health and biological systems in general.

The research presented in this paper was conducted at four locations in the vicinity of the copper smelting plant in Bor (Serbia) in the period from 2014 to 2018. The concentrations of sulfur dioxide (SO₂) and suspended particulate matter (PM₁₀), as well as concentrations of heavy metals present in PM₁₀, such as lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As), were measured during this period.

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Sulfur dioxide (SO₂) is a colorless gas with a strong odor formed when fuel containing sulfur (Wang et al., 2014), such as coal and oil (Nikolić, 2010), is burned. The processing of metal ores results in significant emission of sulfur dioxide into the atmosphere as well. It is also emitted during the process of refining crude oil in refineries, which causes the environment pollution. Cement factories and cars, as exhaust gas, emit SO₂ (Chan, 2008). It irritates mucous membrane and upper respiratory tract, and considerable amount of the inhaled sulfur dioxide is retained in the nose and throat, while only limited amount reaches lungs (Zhu et al., 2014).

Suspended particulate matter is a mixture of solid particles and liquid droplets found in the air (Wang, et al., 2014; Xie, et al., 2005) and it is formed due to the existence of fly ash, mineral dust, smoke, fluoride particles, and exhaust gases from diesel engines. Suspended particles which are <10 µm pose grave danger to human respiratory system. Their presence in the lungs can interfere with the exchange of oxygen and carbon dioxide and cause shortness of breath which can be the cause of increased stress to the heart and arrhythmia (Feng, 2019, Sunyer, 2003). When they are found in the human body they can increase the risk of coronary and respiratory diseases (Tasić, 2012, Tasić, 2010; Kappos et al, 2004). They can lead to kidney and liver failure as well. Lead (Pb) is usually present in the air in the immediate vicinity of a smelting plant and battery factories. Lead (Pb) found in the human body can damage the kidneys, liver, nervous system, and other organs, and can cause neurological damage, such as mental block, retardation, and behavior disorders. In adults, presence of lead can lead to high blood pressure and heart disease. Cadmium (Cd) can be found in the air due to the production of iron and steel, non-ferrous extractive metallurgy, waste incineration, and combustion of fossil fuels. Particle size fractions of Cd are mainly up to 10 µm. Exposure to the concentrations of this metal can cause kidney damage. Nickel (Ni) is present in the air to a lesser extent in particle size fractions of 10 µm. The particles can be transported over long distances and can cause allergic dermatitis. Its carcinogenic effect has been confirmed as well (Megido, et al 2017; Nikolić, 2010; Kovačević, 2010). Arsenic (As) can easily get into the respiratory system because it occurs in fine fractions that can be transported over long distances (Tasić, 2010). Almost all forms of arsenic in the air are in the form of particles with aerodynamic diameter of 10 µm (Mining and Metallurgy Institute Bor, Air Quality Plan for the Bor Agglomeration, 2012). The presence of arsenic (As) in the human body can cause acute, subacute, and chronic conditions. It can also cause lung cancer (Nikolić, 2010).

1.1. METHODOLOGY

The data were collected at four measuring stations located in the vicinity of the smelting plant in Bor (Serbia) for the purpose of the research. The city of Bor is located in the eastern part of the Republic of Serbia, covering 856 km², it lies 350-400 m above sea level with geographical coordinates 44°05'N and 22°06'E. The city of Bor (Serbia) is a mining and industrial city with developed non-ferrous extractive metallurgy. The smelting plant lies 400-600 m above sea level with geographical coordinates 44°04'40.22''N and 22°06'27.24''E. The measuring stations were located in the urban area in the vicinity of the smelting plant.

Location 1

Measuring station Institute is located at 35 Zeleni bulevar Street in Bor (Serbia) and it lay 386 m above the sea level with coordinates 44°03'35.72''N and 22°06'05.16''E. It is located in the city area in the vicinity of the Mining and Metallurgy Institute Bor, about 2 km southeast of the copper smelting plant.

Location 2

The measuring station Park is located in Moše Pijade Street in Bor (Serbia) and it lay 378 m above sea level with coordinates 44°04'33.61''N and 22°06'05.16''E. It is placed in the city park in the urban area of the city, about 650 m west of the copper smelting plant and it is directly exposed to the effects of pollution.

Location 3

The measuring station Technical Faculty is located at 15 Vojske Jugoslavije Street in Bor (Serbia) and it lay 412 m above sea level with coordinates 44°04'54.30''N and 22°05'42.00''E. It is placed in the urban and industrial area of the city, 1 km northwest of the copper smelting plant. There is an abandoned open pit with tailing dumps in the vicinity.

Location 4

The measuring station Jugopetrol is located in Nade Dimić Street in Bor (Serbia) and it lay 363 m above sea level with coordinates 44°03'15.36''N and 22°07'46.43''E. It is placed in the suburban and industrial area of the city, 2.5 km southeast of the smelting plant and 1 km northeast of the city landfill.



Figure 1. Locations of the measuring stations and the copper smelting plant in Bor (Serbia)

The samples of suspended particulate matter (PM₁₀) and sulfur dioxide (SO₂) collected at the immovable measuring stations and with manually operated sampler were automatically sampled during the period of 24 hours. The sampling and analyses of suspended particulate matter (PM₁₀), sulfur dioxide (SO₂), and the content of heavy metals present in PM₁₀ was performed by the Mining and Metallurgy Institute Bor in accordance with the regulations: Law on Environmental Protection (“Official Gazette of the RS” no. 75/10, 11/10, and 63/13) and the Regulation on Monitoring Conditions and Air Quality Requirements (“Official Gazette of the RS”, No.11/10, 75/10, and 63/13), and in accordance with the prescribed standards as well (SRPS ISO 4220:1997 for the testing of sulfur dioxide content, SRPS EN 14902:2008 for the determination of PM₁₀ mass concentration, and SRPS EN 12341:2015 for the determination of presence of lead, cadmium, nickel, and arsenic fractions in PM₁₀).

1.2. IMPLEMENTATION OF THE EU DIRECTIVE

The EU Ambient Air Quality Directive (AAQD) 2008/50/EC is comprised of Framework Directive 96/62/EC (1-3 Daughter Directives 1999/30/EC) on sulfur dioxide and nitrogen oxides limit values, and suspended particulate matter and mercury presence in ambient air (2000/69/EC, 2002/3/EC), and the Decision on Exchange of Information 97/101/EC. The Fourth Daughter Directive 2004/107/EC refers to the presence of arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air. The EU Ambient Air Quality Directive prescribed permissible concentrations of SO₂ of 350 µg/m³ for an hour (not to be exceeded more than 24 times during a year) and permissible concentrations of 125 µg/m³ for a day (not to be exceeded more than 3 times in a year). In terms of PM₁₀ concentrations, their maximum permissible concentration for one day is 50 µg/m³ and it cannot be exceeded more than 35 times in a year, while mean annual permissible concentration of this pollutant is 40 µg/m³. The EU Directive also prescribed mean annual limit values for heavy metal content in the air: Pb – 0.5 µg/m³, Cd - 5 ng/m³, Ni-20 ng/m³, and As - 6 ng/m³ (1999/30/EC, 2000/69/EC, 2002/3/EC; 2004/107/EC, 2008/50/EC). The aim of this study was to analyze the levels of air pollution in relation to SO₂, PM₁₀, and heavy metals Ni, As, Cd, and Pb in PM₁₀ in the vicinity of the copper smelting plant in Bor (Serbia). The obtained values were compared to the prescribed permissible concentrations for these pollutants proposed by the European Commission. The air pollution poses a serious threat to human health.

2. RESULTS

2.1. DESCRIPTIVE STATISTICS

Table 1 shows maximum and minimum concentrations of each pollutant, as well as the number of days during which the permissible concentrations were exceeded in the period from 2014 to 2018.

Table 1. Daily mean concentrations of PM₁₀, SO₂, and heavy metals in PM₁₀ in Bor (Serbia) at the measuring stations in the period from 2014 to 2018

		Measuring stations				
		Location 1	Location 2	Location 3	Location 4	
2014-2018	PM ₁₀ µg/m ²	min	3.9	3.3	3.8	7.8
		max	111.0	132.3	106.6	138.7
		No of days	291	284	412	227
		Exceedance	54	41	179	60
		Limit EU*	50 µg/m ³			
	SO ₂ µg/m ²	min	<30	<30	<30	<30
		max	530	116	775	1792
		No of days	1672	1708	1579	1613
		Exceedance	619	533	482	741
		limit EU*	125 µg/m ³			
	Pb µg/m ²	min	0.003	0.002	0.003	0.002
		max	1.306	0.973	1.618	2.673
		No of days	291	284	412	227
		Exceedance	-	-	-	0.541 _(2016.) 0.678 _(2017.)
		limit EU**	0.5 µg/m ³			
	Cd ng/m ²	min	<0.1	<0.1	<0.1	<0.1
		max	43.17	29.97	42.07	83.15
		No of days	291	284	412	227
		Exceedance	6.07 ₍₂₀₁₈₎	-	7.39 ₍₂₀₁₄₎	7.89 ₍₂₀₁₄₎ 8.54 ₍₂₀₁₅₎ 14.18 ₍₂₀₁₆₎ 18.53 ₍₂₀₁₇₎ 19.15 ₍₂₀₁₈₎
		limit EU**	5 ng/m ³			
		Ni ng/m ²	min	<2	<2	<2
	max		49.72	79.50	54.96	46.86
	No of days		291	284	412	227
	Exceedance		-	-	-	-
	limit EU**		20 ng/m ³			
	As ng/m ²	min	0.62	<0.05	1.01	1.70
		max	1970.24	833.62	1102.20	1535.52
		No of days	291	284	412	227
Exceedance		16.93 ₍₂₀₁₄₎ 22.84 ₍₂₀₁₅₎ 52.30 ₍₂₀₁₆₎ 139.13 ₍₂₀₁₇₎ 369.04 ₍₂₀₁₈₎	11.66 ₍₂₀₁₄₎ 48.12 ₍₂₀₁₅₎ 77.62 ₍₂₀₁₆₎ 130.40 ₍₂₀₁₇₎ 118.24 ₍₂₀₁₈₎	57.89 ₍₂₀₁₄₎ 63.25 ₍₂₀₁₅₎ 109.00 ₍₂₀₁₆₎ 187.59 ₍₂₀₁₇₎ 93.49 ₍₂₀₁₈₎	46.13 ₍₂₀₁₄₎ 97.27 ₍₂₀₁₅₎ 258.66 ₍₂₀₁₆₎ 685.46 ₍₂₀₁₇₎ 388.05 ₍₂₀₁₈₎	
limit EU**		6 ng/m ³				
Limit values according to EU Ambient Air Quality Directive 2008/50/EC (1999/30/EC, 2000/69/EC, 2002/3/EC; 2004/107/EC):						
*allowed limit value on a daily basis						
** allowed limit value on an annual basis						

Based on the results presented in Table 1, the measuring station Jugopetrol (Location 4) had the highest measured daily concentration of suspended particulate matter (PM₁₀) in the air, 138.7 µg/m³, which was 2.8 times higher value than the prescribed daily concentration. The minimal daily concentration of this pollutant, 3.3 µg/m³, was measured at the measuring station Park (Location 2), while the greatest number of exceeded daily concentrations occurred at the measuring station Technical Faculty (Location 3) where the prescribed permissible concentration of 50 µg/m³ was exceeded 179 times during the measuring period (43.45%).

Also, the measuring station Jugopetrol (Location 4) had the highest daily concentration of sulfur dioxide (SO₂) in the air, 1792 µg/m³, which was 14.3 times higher value than prescribed daily concentration. The minimal daily concentration <30 µg/m³ were recorded at all measuring stations: Institute (Location 1), Park (Location 2), Technical Faculty (Location 3), and Jugopetrol (Location 4). The measuring station Jugopetrol (Location 4) had the highest number of days when the permissible concentration prescribed in the EU Directive (125 µg/m³) was exceeded, that is, 741 exceedances during the observed period (45.94%).

According to the EU Directive and the prescribed annual limit values for heavy metal content in the air, for lead (Pb) 0.5 µg/m³, exceeded permissible annual concentrations were recorded at the measuring station Jugopetrol (Location 4) in 2016 and 2017. The highest concentration of lead in the air, 2.673 µg/m³, was measured at Jugopetrol (Location 4), while minimum concentrations, 0.002 µg/m³, were measured at the measuring stations Park and Technical Faculty (Location 2 and Location 3).

The highest concentration of cadmium (Cd), 83.15 ng/m³, in this period, was recorded at the measuring station Jugopetrol (Location 4), and the lowest values <0.1 ng/m³ were recorded at all measuring stations: Institute (Location 1), Park (Location 2), Technical Faculty (Location 3), and Jugopetrol (Location 4). The greatest number of exceedances of the permissible concentration of cadmium (Cd), 5 ng/m³, during all five years of testing, were recorded at the measuring station Jugopetrol (Location 4). Moreover, the exceedances of the prescribed limit values for cadmium were recorded at the measuring stations Institute in 2018 and Technical Faculty in 2014 as well. The exceedance of the permissible concentration of this metal was not recorded at the measuring station Park (Location 2) during this period.

The exceedance of the permissible concentration of nickel (Ni), 20 ng/m³, was not recorded at any measuring station during this period. The highest concentration of Ni, 79.50 ng/m³, was recorded at the measuring station Park (Location 2). The lowest annual concentrations <2ng/m³ were recorded at all measuring stations: Institute (Location 1), Park (Location 2), Technical Faculty (Location 3), and Jugopetrol (Location 4).

The exceedances of the annual limit value for arsenic (As), 6 ng/m³, were recorded at all measuring stations in every year during the testing period from 2014 to 2018. The highest concentration of arsenic (As), 1970.24 ng/m³, was recorded at the measuring station Institute (Location 1). The lowest annual concentration <0.05 ng/m³ was recorded at the measuring station Park (Location 2).

2.2. PROMETHEE METHOD

In order to rank the observed locations according to the level of air pollution within the defined period, the multi-criteria PROMETHEE method and GAIA plane were used for visual representation of the problem.

The PROMETHEE method (Preference Ranking Organization Method for Enrichment Evaluations) represents a multi-criteria analysis of a set of alternatives and preparation for

their ranking. The PROMETHEE also establishes the corresponding preference functions for each criterion the given preference function refers to (Brans, 2016; Mareschal, 1984). Six preference functions represented by a specific shape are included in the PROMETHEE method.

The PROMETHEE method is used for the calculation of the positive (Φ^+) and negative flow (Φ^-) of preferences for each alternative according to the defined criterion. The positive flow of preferences expresses the extent of each alternative dominance over other alternatives. The higher the positive flow ($\Phi^+ \rightarrow 1$), the better the alternative will be ranked. The negative flow of preferences expresses the extent to which each alternative is preferred to other alternatives. The lower the negative flow ($\Phi^- \rightarrow 0$), the better the alternative will be ranked (Anand, 2008).

Using the GAIA plane (Milijic et al., 2016), the visual representation of the problem is performed through geometric interpretation. With the PROMETHEE I method, we partially rank actions, while full ranking can be achieved using the PROMETHEE II method. PROMETHEE II shows the relationship between positive and negative flow (Amaral, 2014, Prvulovic, 2008).

After defining the locations of measuring stations and levels of air pollution based on the obtained concentrations of suspended particulate matter (PM_{10}), sulfur dioxide (SO_2), and heavy metals present in PM_{10} , such as lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As), the ranking of locations according to the level of air pollution was performed by the multi-criteria PROMETHEE method. The GAIA plane was used for graphical representation of the most polluted locations based on the defined criteria.

The PROMETHEE method was used to determine the influence of the criteria suspended particulate matter (PM_{10}), sulfur dioxide (SO_2), and heavy metals in PM_{10} , such as lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As), at the measuring stations Location 1, Location 2, Location 3 and Location 4, with a tendency to reduce it. The V-shape of the preference function was used for all preferences. The weighting coefficients were obtained based on the level of air pollution and number of days in which the prescribed limit values (provided in the EU Directive) were exceeded.

Table 2. Preference adjustment

Criteria	PM_{10} $\mu g/m^2$	SO_2 $\mu g/m^2$	Pb $\mu g/m^2$	Cd ng/m^2	Ni ng/m^2	As ng/m^2
Preference						
Min/Max	min	min	min	min	min	min
Weight	0.15	0.25	0.15	0.10	0.05	0.30
Preference function	V-shape	V-shape	V-shape	V-shape	V-shape	V-shape
Trashold	absolute	absolute	absolute	absolute	absolute	absolute

After the alternatives (locations of the measuring stations) and criteria were defined, the PROMETHEE method was used for their ranking. Moreover, the Decision Lab software was used for the calculation. Based on the data presented in Tables 1 and 2, the values of the positive flow (Φ^+) and negative flow (Φ^-), as well as for the net flow (Φ) were obtained.

Table 3. Values of the positive flow ($\Phi+$), negative flow ($\Phi-$), and net flow (Φ)

	$\Phi+$	$\Phi-$	Φ
Location 1	0.4374	0.3480	0.0894
Location 2	0.7641	0.0251	0.7390
Location 3	0.3653	0.4508	-0.0854
Location 4	0.0503	0.7933	-0.7430

PROMETHEE II Complete Ranking and PROMETHEE NETWORK were used for the final ranking and overview of the locations of measuring stations from the best ranking to the worst ranking location based on the presence of pollutants in the air (Figure 2 and Figure 3).

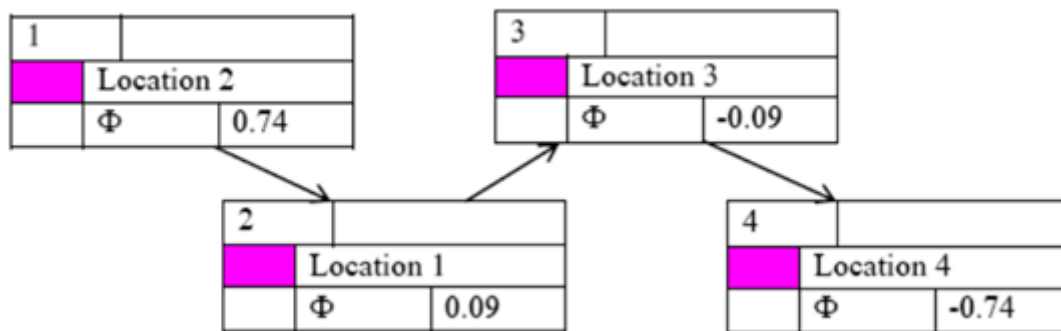


Figure 2. PROMETHEE II Ranking of the measuring stations' location

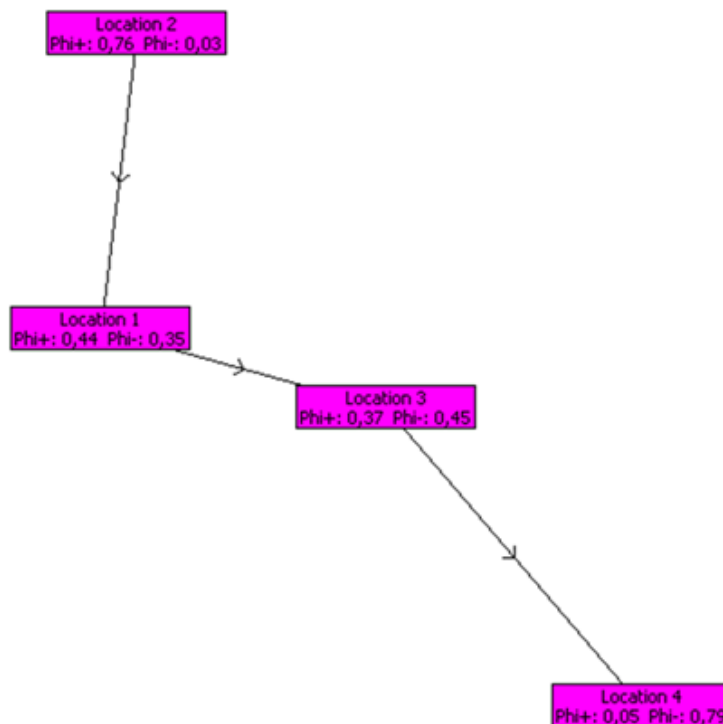


Figure 3. PROMETHEE NETWORK Results of the complete ranking of measuring stations

The PROMETHEE II complete ranking was used to identify the best location from the aspect of air pollution (Figure 2). Based on the obtained results, the measuring station Park

(Location 2) was the best ranked location according to the defined criteria. This station had the lowest level of air pollution compared to other locations located in the vicinity of the copper smelting plant in Bor (Serbia). The second ranked location was the measuring station Institute (Location 1), followed by the measuring station Technical Faculty (Location 3). The most polluted location in this case was the measuring station Jugopetrol (Location 4), however, the measuring station Technical Faculty should be mentioned as well due to the low value of the net flow.

Based on the criteria (suspended particulate matter (PM₁₀), sulfur dioxide (SO₂), and heavy metals in PM₁₀, such as lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As)), the positions of the alternatives (Location 1, Location 2, Location 3, and Location 4) were presented in the GAIA plane (Figure 4). The GAIA plane was presented in 3D view (Balali, 2014) in order to provide better and more comprehensive view of the alternatives and criteria. The eccentricity of the criteria positions represented the strength of the influence of each criterion on the defined location. The agreement between the certain criteria was reflected in the approximately same orientations of the axis of the defined criteria.

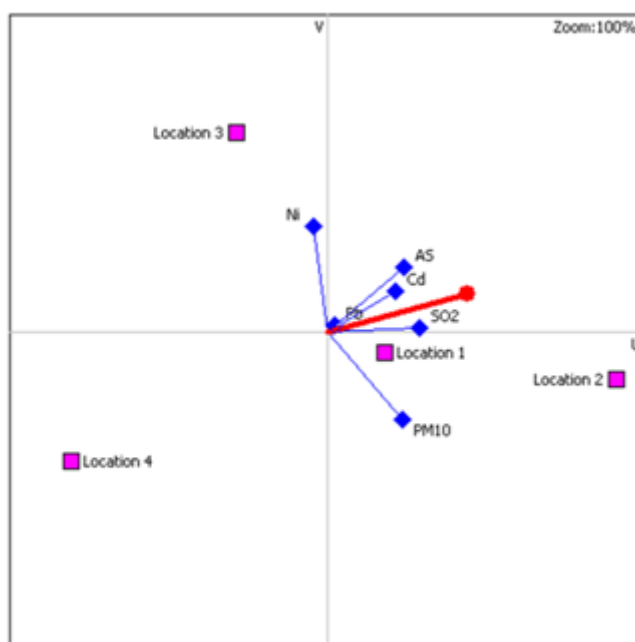


Figure 4. GAIA analysis

The coordinate axes were dimensionless axes used only for a better overview of the alternatives and criteria strengths. The distance from the coordinate origin was assessed using the coordinate axis. Measuring stations Jugopetrol (Location 4) and Technical Faculty (Location 3) were the worst alternatives because they were positioned in the opposite direction from the decision stick pi that represented a compromise solution. The measuring stations Institute (Location 1) and Park (Location 2) were positioned on the other side. Location 2 represented the best alternative by a large number of criteria: suspended particulate matter (PM₁₀), sulfur dioxide (SO₂), and heavy metals in PM₁₀, such as lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As).

3. DISCUSSION

Based on the presence of suspended particulate matter (PM₁₀), sulfur dioxide (SO₂), and content of heavy metals present in PM₁₀, the highest pollution was recorded at the measuring stations Jugopetrol (Location 4) and Technical Faculty (Location 3). The air pollution at these locations was noticeable due to the proximity of the copper smelting plant and atmospheric movement that caused dispersion of pollutants. The measuring station Technical Faculty (Location 3) was located 1 km northwest of the copper smelting plant near the abandoned open pit with tailing dumps. The measuring station Jugopetrol (Location 4) was located 2.5 km southeast of the smelting plant and 1 km northeast of the city landfill. The fact that wind transports pollutants from the surface of the open pit and tailing dumps additionally contributed to the increase of pollution. The abandoned open pit should undergo rehabilitation and vegetation in order to prevent spreading of the dust and thus reduce the existing pollution. There was increased air pollution with metals, such as lead (Pb) and arsenic (As), at the measuring station Jugopetrol (Location 4) during this period due to melting and processing of copper. The proximity of the smelting plant, city landfill, smelting plant' warehouses, copper wire factory, city's heating plant, and former The State Petroleum Company Jugopetrol's storage facility for petroleum products all contributed to Jugopetrol (Location 4) being the most polluted measuring station in the city of Bor (Serbia).

4. CONCLUSION

Based on the collected data from the measuring stations, that is, locations used for air sampling, in the vicinity of the copper smelting plant in Bor (Serbia) in the period from 2014 to 2018, excessive pollution levels and exceedance of permissible concentration prescribed in the Ambient Air Quality Directive 2008/50/EC (1999/30/EC, 2000/69/EC, 2002/3/EC; 2004/107/EC) were evident. The PROMETHEE/GAIA method was used for the graphical presentation of the ranked measuring stations according to the level of pollution. Based on the presence of suspended particulate matter (PM₁₀), sulfur dioxide (SO₂), and content of heavy metals present in PM₁₀, such as lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As), the most polluted measuring stations were Jugopetrol (Location 4) and Technical Faculty (Location 3). The air pollution in Bor (Serbia) represents a serious danger to human health and the environment as well. If Serbia wants to become a full member of the EU, the government will have to resolve the problem of air pollution, which has posed a problem in Bor for years. The results presented in this paper will be used as a basis for further research.

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EFFECT OF MOTIVATION FACTORS ON EMPLOYEES' JOB PERFORMANCE: EVIDENCE FROM ALBANIA

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Abstract: Employee performance is important to public organizations. The public sector by considering the motivating factors and properly motivating its employees will affect the increase of employee performance. Therefore, the motivation of employees in the public sector is very important. The purpose of this paper is to explore the effects of motivation factors and job performance for public sector employees. The dependent variable in this study is job performance. Independent variables are motivating factors, namely payment, promotion, work environment, superiors' collaboration and co-workers collaboration. According to the purpose of this study there are following the qualitative and quantitative methods. The research instrument used in this study is a structured questionnaire. The list of the public organizations was obtained from Vlore Employers' City (Albania). A total of 140 questionnaires were sent to the selected organizations. A total of 110 questionnaires were returned but only 97 useable. Secondary data for this study had been collected from journals articles, books and newspaper, which contributed to the review of literature. Data analysis was performed using SPSS. Multiple regression analysis using enter method was used to determine the relationship between the independent variables and the dependent variable. The results show that there is significant relationship between payment and job performance. However the relationship between promotion and job performance, work environment and job performance, supervisor's collaboration and job performance, and co-workers collaboration and job performance were found to be not significant.

Keywords: motivation, job performance, public sector employees

1. INTRODUCTION

Employee performance is important to public organizations. Employee performance fundamentally depend on many factors like performance appraisals, employee motivation, employee satisfaction, compensation, organization structure and other, but he area of research is focused only on employee motivation as this factor influence the performance of employees. The public sector by considering the motivating factors and properly motivating its employees will affect the increase of employee performance. Therefore, the motivation of employees in the public sector is very important. Motivation and performance are closely related. Since employee performance is important to the public sector, this sector should consider improving employee performance by encouraging, motivating them to perform tasks

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as efficiently and effectively as possible. Therefore, motivation is absolutely important and necessary because by properly meeting the needs of employees at the same time they can observe an increase in performance in their work.

To better understand the role of motivation, we should know the meaning of motivation. Motivation derives from the Latin word and means "To move" (Wade & Tavris, 2008). Psychologists believe that motivation is the process that leads, promotes individual towards achieving a goal. So motivation is synonymous with the words: encouragement, push, aspirations, need, etc. Moreover, nowadays, managers are interested in motivation and need to know how to motivate their employees because it affects the improvement of productivity of the organization.

Previous studies have highlighted that motivational factors can affect employee performance. According to Onanda (2015) there is a relationship between motivation and performance at the workplace as all the variables studied pointed to the fact the way employees feel about themselves, their work and treated by management goes a long way to determine their output. Also, work environment are positively and significantly related to job performance (Said, et.al., 2015).

Albania is a developing country and to become part of the EU the state is investing heavily in the public sector. Moreover, public organizations in Albania play important roles both socially and economically. In the public sector motivation can be an important predictor of individual job performance. When their needs are met, employees are likely to take responsibility and thus they will perform better to achieve the goals of the organization.

1.1. PROBLEM STATEMENT

In this study, the relationship between motivational factors and employee performance is examined. Motivating factors are payment, promotion, work environment, superiors' collaboration and co-workers collaboration. According to many researches, show that motivation factors can affect the performance of employees. This study was created to better understand the factors of employee motivation and their impact on employee performance in public organizations in the city of Vlore (Albania).

1.2. OBJECTIVE OF THE STUDY AND RESEARCH QUESTIONS

The objective of the study is to examine the effects of motivation factors and job performance for public sector employees. This study aims to address the following problem: Is there a relationship between motivational factors and employee performance in public organizations in Albania?

2. LITERATURE REVIEW

Employee performance fundamentally depend on many factors like performance appraisals, employee motivation, employee satisfaction, compensation, organization structure and other, but the area of research is focused only on employee motivation as this factor influence the performance of employees.

Managers in business organizations face challenges to manage the motivating factors of their employees in order to satisfy the personal needs of employees, this will affect the

improvement of organizational performance (Alonso & Lewis, 2001). In fact, most researchers found that many firms in the world focus on employee performance and incentives that can contribute to their performance and productivity of their operations (Brewer & Selden, 2000). To improve performance should be based on motivation and skills of employees, because when they show high levels of motivation and skills they will perform at and above the required standards (Noe, Hollenbeck and Wright, 2011). Employees want to earn reasonable salary and payment and desire their work to feel that is

Employees want to earn reasonable salary and payment and desire their work to feel that is what they are getting. Money is the fundamental inducement; no other incentive or motivational technique comes even close to it with respect to its influential value (Sara et al., 2004). It has the supremacy to magnetize and motivate individuals towards higher performance. Research has suggested that reward now cause satisfaction of the employee which directly influences performance of the employee (Kalimullah et al, 2010). Meanwhile a study done by Lazear (2000) found that when employers increase wages and workers, most employees work their jobs carefully. All businesses use pay, promotion, bonuses or other types of rewards to motivate and encourage high level performances of employees (Rena et.al., 2009).

Work place environment play a vital role in improving and efficiency of the workforce where improving work organization is one of the best ways to increase productivity (Swathi, 2013). Furthermore typically involves factors relating to the place of employment, such as the quality of the air, noise level and additional perks and benefits of employment (Tjare. et.al., 2000). According to a study by Blumberg and Pringle (1982) one of the interacting with their expectations about environments and how those variables in the work environment impact employee behaviour. Poor job performance, boredom and lack of satisfaction are often the result of psychological problems that are characteristic of a mismatch between an individual and his / her environment (Lubinsky, 2000). Working conditions for the employee boost their morale which in turn boosts their productivity (Kirande & Rotich 2014)

Another factor that influences employee performance is the relationship between supervisors, co-workers and employees. Co-workers relations are different from supervisor relations. Employee interactions with supervisors based on the position in the hierarchy of authority, while co-workers relations are flat without any formal authority elements (BASFORD & OFFERMANN, 2012). Support, not control, and good relations with the leader can enhance the creativity of employees (Deci et al., 1989). According to Dorothea, W.A. (2015) supervisor who encourage a supportive work environment, especially the attention to the needs and feelings of employees will provide positive feedback and encouraging the development of skills and able to solve problems in the workplace. Supervisory support will encourage self-determination or employee attitude in their work. The relationship between employees and supervisors as well as good relationships with co-workers will lead well in better employee performance.

Promotion to employees is another important factor for an organization to continuously improve their productivity. Promotion is an increase of employee at a field a better job and the responsibility is greater. Sikula (2000) defines promotion as a movement within an organization of one position to another that involves either an increase or an increase in status. According to Saharuddin and Sulaiman (2016) promotion is a magnet for capable and qualified employees in the organization, encouraging employees to stay motivated, qualified to remain faithful, ensure fairness, control costs, follow the rule of law, improving the efficiency and effectiveness as well as maintaining and / or improve employee productivity. Promotion of employees significantly influences on performance, it shows that the promotion of employees will determine the motivation of employee work, if the implementation of the

campaign appropriate / in accordance with the experience and skills of employees (Abdul et.al. 2018).

2.1. THEORETICAL FRAMEWORK AND HYPOTHESIS

Based on the literature review, a theoretical framework has been established to represent the relationship between motivation factors and job performance. Factors influencing performance in this study consists of pay, job security, promotion, freedom, environment friendly and training. The dependent variable in this study is job performance. The theoretical model for this study is presented in Figure 1.

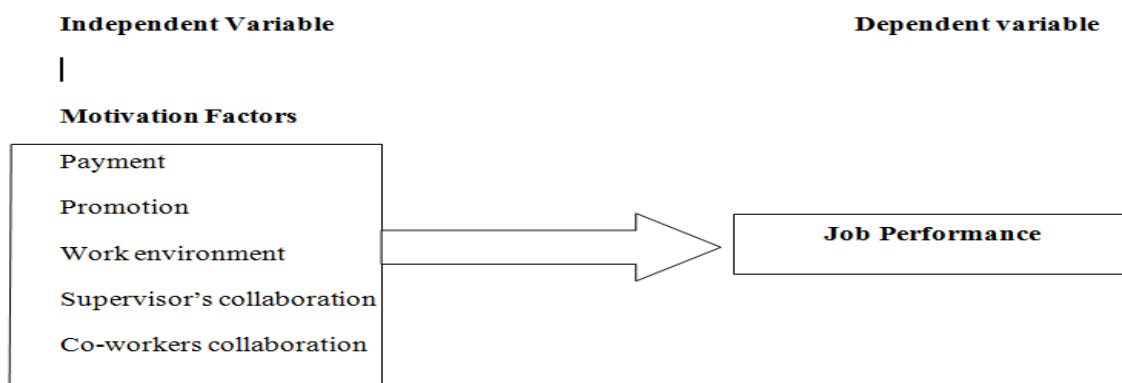


Figure 1. Conceptual model of Relationship between Independent Variables and Dependent Variable

Based on the framework of the concept of research, it can be formulated five (5) hypothesis statement as follows:

- H1: There is a positive relationship between payment and job performance.
- H2: There is a positive relationship between promotion and job performance.
- H3: There is a positive relationship between work environment and job performance.
- H4: There is a positive relationship between supervisor's collaboration and job performance.
- H5: There is a positive relationship between co-workers collaboration and job performance.

3. RESEARCH METHOD

This is substantially a correlation research that applies quantitative approach and uses the survey method to collect data. The focus of this research is on employees of public organizations in city of Vlore (Albania). This study focuses on the motivation factors consisting of payment, promotion, work environment, superiors' collaboration and co-workers collaboration as independent variable and their influence on job performance as dependent variable. The research instrument used in this study is a structured questionnaire. The list of the public organizations was obtained from Vlore Employers' City (Albania). The primary data are collected through a structured questionnaire. A total of 140 questionnaires were sent to the selected organizations. A total of 110 questionnaires were returned but only 97 useable. This represents a response rate of 69.28 percent. Secondary data for this study had been collected from journals articles and books which contributed to the review of literature.

Data analysis was performed using Statistical Packages of the Social Science (SPSS). Multiple regression analysis using enter method was used to determine the relationship between the independent variables and the dependent variable. The level of significance was set at $p = 0.05$.

4. RESEARCH RESULTS

This section presents results of the multiple regression analysis where motivation factors are regressed with job performance using the enter method to determine the correlation between the independent variables and dependent factor. This is also to determine the total contribution of the motivation factors studied to job performance.

Table 1. Multiple regression of analysis with motivation factors as predictors of job performance

Model	R	R-Square	Adjusted R Square	Std. Error of the Estimate
1	,426 ^a	,231	,136	11,66081

a. Predictors: (costante), coworkers_collaboration, work_environment, Promotion, Payment, Supervisor's_collaboration

In table 1, the R-squared value from model summary is 0.231 which means 23.1% of the variance in job performance is affected by variation in the 6 motivation factors namely, promotion, Payment, co-workers collaboration, work environment and supervisor's collaboration in the public organizations.

Table 2. ANOVA for enter method

Model	sum of squares	ANOVA ^a			
		df	Mean square	F	Sig.
Regression	2740,360	5	548,072	4,031	,002 ^b
Residual	12373,682	91	135,975		
Total	15114,041	96			

a. Variabile dipendente: job_performance

b. Predictors: (costante), coworkers_collaboration, work_environment, Promotion, Payment, Supervisor's_collaboration

The results of ANOVA are presented in table 2. $F(5, 97) = 4,031$ and $p < 0.05$. That means that least one of the 5 independent variables can be used to explain job performance in the public organization.

Table 3. Coefficients*for the relationship between predictor variable and job performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std.error	Beta		
(Constant)	21,803	7,794		2,797	,006
Promotion	-,478	,245	-,211	-1,949	,054
Payment	1,299	,518	,319	2,510	,014
work environment	,018	,211	,009	,083	,934
Supervisor's collaboration	,516	,509	,130	1,013	,314
Co-workers collaboration	,448	,422	,113	1,061	,291

Table 3 presents the correlation between motivation variables and job performance. The results show that there is significant relationship between payment and job performance (B = 0,319 p < 0.05). However the relationship between promotion and job performance (B = 0.478, p > 0.05), work environment and job performance (B = 0,018 P >0.05), Supervisor's collaboration and job performance (B = 0.516, P > 0.05), and co-workers collaboration and job performance (B = 0.448, p > 0.05) were found to be not significant. Therefore H2 is not rejected. H1, H3, H4 and H5 are rejected.

5. CONCLUSION AND RECOMMENDATION

This study aims to provide empirical evidence about the relationship between motivational factors namely promotion, payment, work environment, Supervisor's collaboration, co-workers collaboration and job performance of employees in Albania public organizations. Multiple regression analysis was used to analyse the data.

The motivation factors of payment, job security, promotion, freedom, friendly environment and training were found to contribute a total of 42.5% of job performance. This suggests that variables other than the motivation factors studied could be contributing to job performance. Only one motivation factors that is payment was found to be significant predictors of job performance contributing 23.1% of job performance.

The results are also similar to a study presented by Stringer et. al. (2011) that examines the implications of a pay-for-performance system on Intrinsic and Extrinsic motivation factors and job satisfaction. They concluded pay and benefits have strongest association with job satisfactions. In Malaysian context, a research carried out by Ibrahim and Boerhaneoddin (2010) also suggested factor of compensations has a significant effect on job satisfactions. Ismail (2008) have concluded their results where factor of pay was found effective in motivating their respondents.

Human resource management in public organization should provide some incentive factors such as payment, promotion, work environment, supervisor's collaborations and co-workers collaboration to motivate their workers to improve their productivity.

The results of this study found payment to be the most important motivational factors. Thus human resource management should provide an increase of pay, promotion, bonuses or other types of rewards to motivate and encourage high-level performances of employees. By using pay as a motivational strategy we have kept and motivated individuals towards a higher performance.

5.1. LIMITATION OF THE STUDY

This study has some limitations. The first limitation is related to the research sample. The respondents for this study were only 110 employees. Another limitation in this study is that the research has just concentrated on major motivational factors namely payment, promotion, work environment, supervisor's collaboration and co-workers collaboration in job performance of employees in Albania public organizations.

Further research needs to be carried out on a larger population and sample size. More motivation factors and other factors that could have influenced on job performance must be included.

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EFFECTIVENESS OF CRYPTOCURRENCY PORTFOLIO MANAGEMENT BEFORE AND DURING COVID-19 PANDEMIC

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Abstract: This paper presents the diversification role of cryptocurrencies by analysing the possibility of creating new investment opportunities based on historical data. Applying different portfolio models (1/N, Markowitz model, minimum variance model, maximum return model and portfolio model with the highest Sharpe ratio) we analyse whether there are diversification effects, as well as whether the inclusion of gold and/or market index to cryptocurrency portfolio leads to improvement in portfolio performance measured by Sharpe ratio. We also analyse whether the implementation of a buy and hold strategy with selected portfolios represents a good investment decision in a period of big financial markets turmoil caused by the emergence and expansion of COVID-19. Data were collected for the period from May 26, 2014 to June 30, 2020, on a weekly basis.

The results we obtained indicate the fact that there are diversification effects by creating a portfolio of cryptocurrencies, as well as that the addition of gold and/or market index significantly improves the efficiency of the cryptocurrencies portfolio. The buy and hold strategy from December 2019 till June 2020 proved to be a good investment decision in the case of the portfolio of cryptocurrencies and gold, while the portfolios that include stock market index negatively affects the returns of the buy and hold strategy. These results indicate a significantly faster recovery of the cryptocurrency market compared to traditional financial markets.

Keywords: cryptocurrencies, mean-variance analysis, diversification, Sharpe ratio, COVID-19 Pandemic, buy and hold strategy

1. INTRODUCTION

Cryptocurrency is a phenomenon that has been attracting significant investor attention lately. On the one hand, they are based on a completely new technology whose potential is not fully understood, while on the other hand, at least in their current form, they fulfill similar functions as other, more traditional assets. Is cryptocurrency another form of currency, commodity, share of technological breakthrough, or a completely different instrument? Which industries can be affected by the development of blockchain technology (Tsyvinski & Liu, 2018)? These are just some of the questions we can ask when analyzing this phenomenon of the modern age. Cryptocurrencies have different nature from conventional currencies. Conventional currencies such as the dollar and the euro are highly dependent on the state and

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conditions of the global economy such as inflation, trade, crisis, politics, and so on. Consequently, their movements can be determined quite precisely. However, the price and fluctuations of cryptocurrencies are much more difficult to determine. The price of Bitcoin increased from zero value at the time of its inception in 2009 to approximately \$1,100 at the end of 2013. In late 2014, its price dropped to about \$250, but has been rising again ever since. Such market volatility with huge price movements ($\pm 8,000\%$) is not common for traditional currencies, suggesting that there must be other determinants of price formation, which are specific to digital currencies (Ciaian, et al., 2015).

If cryptocurrency is viewed in the same class as commodities, the question that arises is how different it is in terms of its risk and return structure? Some questions are also raised about the potential of cryptocurrencies as an investment class. Correlations between cryptocurrencies and traditional assets have shown to be very low which makes them very attractive as diversifiers in an investor's portfolio (Lee, et al., 2018). From all of the above, we can conclude that the cryptocurrency market is increasingly becoming attractive to investors, as indicated by the growing number of research papers in this area. Given that it is a relatively new speculative instrument in the financial markets, cryptocurrencies continue to be an under-explored area. Most research to date have been based solely on analyzing the diversification potential of Bitcoin as the market-leading cryptocurrency (Baur, et al., 2018; Baur, et al., 2018; Eisl, et al., 2015), while very few papers have focused on other cryptocurrencies. Despite the huge growth of the cryptocurrency market, research on the portfolio diversification is rather limited (Liu, 2018). Precisely because of this, the aim of this paper is to show the diversification possibilities of a larger number of cryptocurrencies while observing the performance of various asset allocation models. We will also observe the performance of the cryptocurrency portfolio after the addition of gold and / or the market index through a return to risk ratio expressed through the Sharp ratio. As well as observing the behavior of the cryptocurrency portfolio before and after the period of global financial market turmoil caused by the emergence and expansion of COVID-19.

Ultimately, we can conclude that the cryptocurrency market, as an under-researched phenomenon, represents a very attractive area of analysis for researchers, opening up new opportunities for them to contribute to the development of financial markets. This research aims to further enrich the existing literature on this volatile asset whose attractiveness is growing significantly especially during a period of major financial market crises.

The article starts with literature review about the cryptocurrency portfolio management, followed by data and methodology. Main findings are presented in section empirical results, followed by conclusions.

2. LITERTURE REVIEW

Given the explosive attention from investors in recent years, a number of studies have been conducted focusing on both Bitcoin as the most dominant cryptocurrency on the market (Weinmayer, et al., 2019; Kajtazi & Moro, 2019; Baur, et al. ., 2018; Yermack, 2015), as well as other cryptocurrencies whose number is constantly increasing (Andrianto & Diputra, 2017; Bjordal & Opdahl, 2017). When analysing cryptocurrency market, researchers have also focused on the efficiency of the cryptocurrency market (Urquhart, 2016; Nadarajah & Chu, 2017), but also on the factors that affect the price of cryptocurrencies (Ciaian, et al., 2015; Sovbetov, 2018; Tsyvinski & Liu, 2018).

In addition to being very often used as a speculative instrument, cryptocurrencies are increasingly being used as diversifiers in the portfolio. Theoretically, if Bitcoin is mainly used

as a currency to pay for goods and services, it will compete with fiat currency such as the US dollar, and thereby influence the value of the fiat currency and ultimately affect monetary policies implemented by a central bank. Recently, however, cryptocurrencies have been used as a form of speculative investment due to their high volatility and large returns (Baur, et al., 2018). Many researchers such as Brauneis & Mestel (2018), Liu (2018) and Platanakis et al., (2018) have shown that there are significant diversification effects by creating a portfolio of cryptocurrencies, while Ćosić and Čeh Časni (2019), Eisl et al., (2015) and Kajtazi & Moro (2019) showed that adding Bitcoin to the portfolio of traditional assets leads to an increase in the efficiency of the portfolio, i.e. to an increase in the Sharp ratio, as Gangwal (2016) pointed out. Symitsi & Chalvatzis (2018) also found statistically significant diversification benefits from including Bitcoin in the portfolio.

What particularly attracts investors attention is the fact that cryptocurrencies show extremely low correlations with other forms of traditional assets such as stocks, bonds, and even gold and oil (Eisl, et al., 2015), which further emphasizes their diversification benefits. Aslanidis, et al. (2019) showed that there are statistically significant positive correlations between cryptocurrencies that have varied over time, while the correlations between cryptocurrencies and traditional financial assets are negligible. Also, Anyfantaki et al., (2018) have shown that cryptocurrency markets are segmented from equity and bond markets and exhibit characteristics of a unique asset class. Inci & Lagasse, (2019), while analyzing the role of cryptocurrencies in improving the performance of a portfolio composed of traditional assets, they came to the conclusion that cryptocurrencies play a very useful role in creating an optimal portfolio, as well as the contribution of cryptocurrencies to an optimal portfolio evolves over time. Corbet, et al., (2018) also show that cryptocurrencies are isolated from the financial and economic assets and that cryptocurrencies may offer diversification benefits for investors with short investment horizons.

Given the current crisis in the financial markets, which has resulted in entering a bear market after a long period of growth, there has been a growing interest from investors and researchers in cryptocurrencies as they have shown significant deviations from the price movements of traditional forms of financial asset. The results of research conducted by Mnif, et al. (2020) show that COVID-19 has a positive impact on the cryptocurrency market efficiency, while Jabotinsky & Sarel (2020) showed that there is a positive correlation between the identified cases of Coronavirus and the market capitalization of cryptocurrencies. However, the effect of the spread of the COVID-19 pandemic on the cryptocurrency market has not yet been deeply researched because of its recent emergence, but also because of the ignorance of the structure and behavior of the virus itself. This research therefore attempts to contribute to the literature by investigating the impact of the recent COVID-19 pandemic on the behavior and efficiency of the cryptocurrency market.

3. DATA AND METHODOLOGY

The purpose of this paper is creating a portfolio of cryptocurrencies, and observing how different asset allocation models behave and what impact have traditional asset such as gold and the market index on portfolio performance. The subject of the research was chosen precisely because of the growing attractiveness of cryptocurrencies in recent years, but also their increasing use in portfolio diversification. Their specific characteristics that separate them from other forms of traditional assets, as well as non-correlation, indicate the reason for the growing number of investors interested in this asset.

In this study, historical data for cryptocurrency prices were collected from the website <https://coinmarketcap.com/> and they cover the period from May 26, 2014 to December 2, 2019. We collected weekly data for 5 cryptocurrencies: Bitcoin, Litecoin, XRP, Monero and Dash, and ultimately obtained 289 historical data on cryptocurrency prices for the observed period. Historical data for S&P 500 value were also collected, as well as for the price of gold for the observed period from the website <https://finance.yahoo.com/>. All collected data were processed using Microsoft Excel 2013 applying the appropriate formulas.

When creating an efficient frontier, we rely on modern portfolio theory, or Markowitz's model of portfolio optimization, which is a mathematical problem that requires solving a series of simultaneous equations and which essentially comes down to a quadratic programming model solved by finding weights that show the amount of fundings that will be invested in each asset, which will ultimately minimize the variance in accordance with the expected return constraint.

Portfolio models used in the study are: 1 / N model of equal weights (Naive diversification), Markowitz model (where E in constraint is set to be corresponding mean under 1/N model of equal weights), minimum variance portfolio model, portfolio model with maximum yield, and the portfolio model with the highest Sharp ratio.

Table 1. List of various asset allocation models

	Models	Objective function	Constraints
1.	Naïve diversification	no	$w_i = \frac{1}{N}$ $\sum_{i=1}^N w_i = 1, w_i \geq 0,$
2.	Minimum variance	$\min \sigma^2 = \sum_{i=1}^N \sum_{j=1}^N w_i w_j Cov(R_i, R_j)$	$\sum_{i=1}^N w_i = 1, w_i \geq 0,$
3.	Markowitz	$\min \sigma^2 = \sum_{i=1}^N \sum_{j=1}^N w_i w_j Cov(R_i, R_j)$	$\sum_{i=1}^N \bar{R}_i w_i \geq E$ $\sum_{i=1}^N w_i = 1, w_i \geq 0,$
4.	Maximum return	$\max R_p = \sum_{i=1}^N w_i \bar{R}_i$	$\sum_{i=1}^N w_i = 1, w_i \geq 0,$
5.	Maximum Sharpe ratio	$\max S = \frac{R_p - r_f}{\sigma_p}$	$R_p = \sum_{i=1}^N w_i \bar{R}_i$ $\sigma_p = \sqrt{\sum_{i=1}^N \sum_{j=1}^N w_i w_j Cov(R_i, R_j)}$ $\sum_{i=1}^N w_i = 1, w_i \geq 0,$

To compare the performance of different portfolio models, we used the Sharpe ratio, which represents the relationship between the return above the risk-free rate and the risk of a given portfolio, or the risk premium of the portfolio per unit of total risk and represents the parametric index of portfolio performance.

$$S = \frac{R_p - r_f}{\sigma_p} \quad (1)$$

Where R_p is the expected return of the selected portfolio, r_f is the rate of return on risk-free asset, while σ_p is the standard deviation of the portfolio return. Table 2 shows descriptive statistics of the discrete returns on selected cryptocurrencies, as well as on gold and stock index.

Table 1. Descriptive statistics

	Bitcoin	Litecoin	XRP	Monero	Dash	Zlato	S&P 500
Mean	.01406	.01717	.03776	.02917	.01952	.00058	.00191
Std. Deviation	.103665	.173174	.292511	.211790	.171283	.017507	.019463
Skewness	.453	2.386	5.843	1.621	.830	.104	-1.010
Kurtosis	2.084	10.023	43.956	5.501	3.055	.447	4.546
Minimum	-.384	-.388	-.476	-.446	-.697	-.049	-.100
Maximum	.453	1.055	2.596	1.130	.740	.062	.066
Statistics	0.098	0.173	0.250	0.104	0.103	0.027	0.126
Sig.	0.000	0.000	0.000	0.000	0.000	0.200	0.000

Source: Authors calculation

It can be found that all cryptocurrencies have a positive skewness, which leads us to a conclusion that returns increase rapidly but decrease slowly, indicating a good volatility to generate additional investment opportunities (Lee, et al., 2018). If we observe kurtosis, we can see that the return distribution of cryptocurrencies deviates a lot from the normal distribution, indicating a leptokurtic distribution. Leptokurtic distribution indicates the fact that individual returns deviate significantly less from the average return compared to the normal distribution, however, there is a significantly higher probability of extreme outcomes, i.e., returns. Among the selected cryptocurrencies, XRP, according to the kurtosis and skewness, deviates the most from the normal distribution, but also has the highest average return (3.78%), which is to be expected. Bitcoin is the most stable cryptocurrency whose return distribution is closest to normal, but consequently has the lowest average return (1.40%). Gold and S&P 500 can be considered as a safe investment because their return distribution does not deviate significantly from normal distribution. Since they are considered to be safe investment for investors, the returns on these assets are very small, which can be seen from the table 2. We can also observe that, based on the results of the Kolmogorov-Smirnov normality test, no cryptocurrency follows the normal distribution, nor the stock index. In this case, we conclude that only gold returns follow the normal distribution.

Table 3 shows the correlation coefficients of cryptocurrencies, gold and stock index, and the corresponding p-values on the basis of which we can conclude whether these correlations are statistically significant.

Table 2. Correlation matrix

		Bitcoin	Litecoin	XRP	Monero	Dash	Gold	S&P500
Bitcoin	Pearson Correlation	1	.643**	.273**	.446**	.459**	.014	.086
	Sig. (2-tailed)		.000	.000	.000	.000	.817	.145
Litecoin	Pearson Correlation	.643**	1	.519**	.370**	.398**	-.074	.134*
	Sig. (2-tailed)	.000		.000	.000	.000	.209	.023
XRP	Pearson Correlation	.273**	.519**	1	.210**	.186**	.006	.055
	Sig. (2-tailed)	.000	.000		.000	.002	.917	.348
Monero	Pearson Correlation	.446**	.370**	.210**	1	.463**	.028	.039
	Sig. (2-tailed)	.000	.000	.000		.000	.631	.510
Dash	Pearson Correlation	.459**	.398**	.186**	.463**	1	-.021	.084
	Sig. (2-tailed)	.000	.000	.002	.000		.729	.153
Gold	Pearson Correlation	.014	-.074	.006	.028	-.021	1	-.166**
	Sig. (2-tailed)	.817	.209	.917	.631	.729		.005
S&P500	Pearson Correlation	.086	.134*	.055	.039	.084	-.166**	1
	Sig. (2-tailed)	.145	.023	.348	.510	.153	.005	

Source: Authors calculation

We can conclude that Litecoin, Monero and Dash are relatively highly correlated with Bitcoin. This is a positive correlation that is statistically significant, which Aslanidis, et al. (2019) have also showed. On the other hand, correlation between XRP and Bitcoin is at a relatively low level, but it is still statistically significant. When observing other cryptocurrencies, we can see that Litecoin is relatively highly correlated with XRP, as is Monero with Dash. The relatively low correlations between different cryptocurrencies indicate the fact that we may benefit from combining several cryptocurrencies into a portfolio. If we look at the correlation coefficients of cryptocurrencies with the stock index S&P 500, we can conclude that this correlation is not higher than 0.134 (with Litecoin), and that only in that case is it statistically significant ($p = 0.023$). Very low correlations with other traditional assets reinforce the assertion that cryptocurrencies may be a promising investment class in terms of hedging the risk of mainstream assets (Lee, et al., 2018). As in the case of the stock index S&P 500, the correlations of cryptocurrencies with gold did not prove to be statistically significant. Based on the values of the correlation coefficients, we can see that there is a very small positive / negative correlation between cryptocurrencies and gold which is not statistically significant. If we observe the correlation between the S&P 500 and gold, we will see a negative correlation (-0.166) which is statistically significant ($p = 0.005$).

4. EMPIRICAL RESULTS

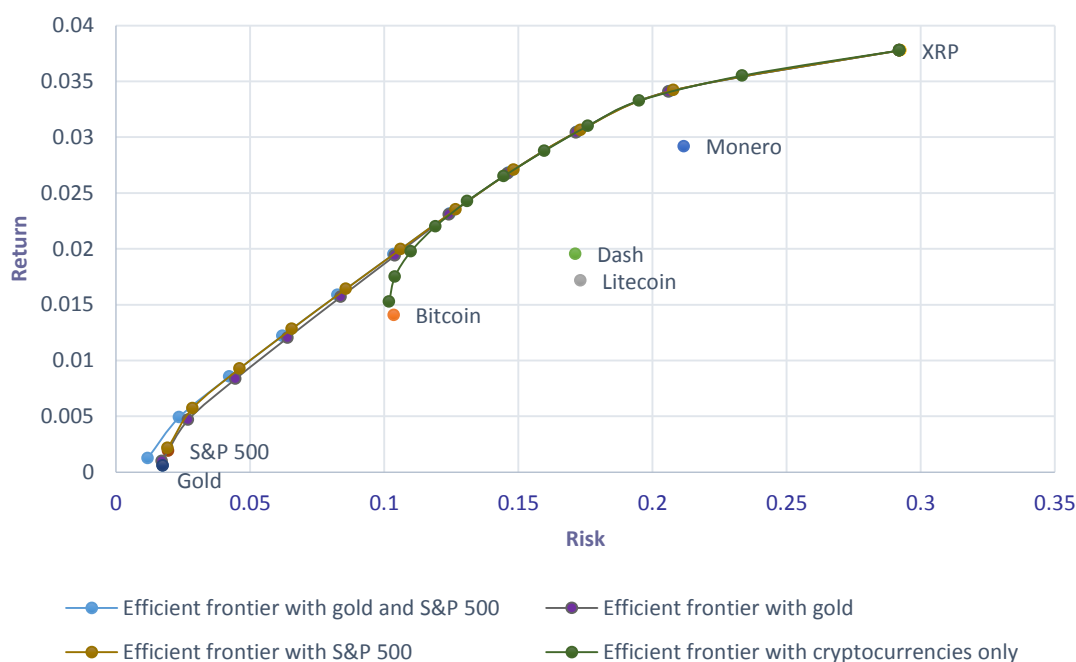
In this section, we compare the performance of selected portfolio models through a return-to-risk ratio expressed through the Sharpe ratio under the assumption that the risk-free rate is equal zero. Table 4 shows the characteristic values of the portfolio composed of cryptocurrencies, gold and stocks in four scenarios (mean return, standard deviation and Sharpe ratio) created on the basis of model 1 / N (1), minimum variance model (2), Markowitz model (3), the maximum return model (4) and the maximum Sharpe ratio model (5).

Table 3. Return, risk and Sharpe ratio of portfolio with cryptocurrencies, S&P 500 and gold

Asset allocation models	Expected portfolio return	Risk	Sharp ratio
Portfolio with cryptocurrencies			
1/N equal weighted model	0.023535809	0.135058499	0.174263811
Minimum variance model	0.015256932	0.101850788	0.149796902
Markowitz model	0.023535809	0.126903291	0.185462559
Maximum return model	0.037759943	0.292002538	0.12931375
Maximum Sharpe ratio	0.024258137	0.130915568	0.185296043
Portfolio with cryptocurrencies and S&P 500			
1/N equal weighted model	0.019930992	0.112935153	0.17648174
Minimum variance model	0.002152093	0.019327949	0.11134617
Markowitz model	0.019930992	0.105952334	0.18811282
Maximum return model	0.037759943	0.292002538	0.12931375
Maximum Sharpe ratio	0.009273663	0.046116399	0.201092517
Portfolio with cryptocurrencies and gold			
1/N equal weighted model	0.019710441	0.112555787	0.175117078
Minimum variance model	0.000992046	0.017171677	0.057772202
Markowitz model	0.01971044	0.105830487	0.186245391
Maximum return model	0.037759943	0.292002538	0.12931375
Maximum Sharpe ratio	0.012022415	0.063982855	0.187900564
Portfolio with cryptocurrencies, S&P 500 and gold			
1/N equal weighted model	0.017167079	0.096795702	0.17735373
Minimum variance model	0.001247101	0.011862334	0.105131128
Markowitz model	0.017167079	0.090113858	0.190504317
Maximum return model	0.037759943	0.292002538	0.12931375
Maximum Sharpe ratio	0.004898385	0.023565971	0.207858384

Source: Authors calculation

Based on the results, we can conclude that there was an improvement in performance of each portfolio model expressed through the Sharpe ratio after adding the stock index S&P 500 except for the minimum variance portfolio, which indicates that although there was a significant reduction in risk by including the S&P 500 in the cryptocurrency portfolio, extremely low returns were not sufficient to compensate for the high volatility in cryptocurrency returns. We came to the same conclusion after the inclusion of gold in the cryptocurrency portfolio, where the cryptocurrency portfolio with gold showed slightly lower performance compared to the cryptocurrency portfolio with the S&P 500. This is reflected in a slight shift of the efficient frontier to the left, i.e., in greater risk reduction expressed through the standard deviation in the cryptocurrency portfolio with a S&P 500 as shown in Figure 1. We also came to the conclusion that Markowitz portfolio model outperformed the 1 / N model of equal weights according to portfolio performance, offering less risk to investors. What is also very interesting to notice is that there has been a significant stretching of the efficient frontier after the inclusion of gold and / or the S&P 500 in the cryptocurrency portfolio, which clearly indicates the diversification effects of traditional assets in the cryptocurrency portfolio. The risk of the cryptocurrency portfolio before the inclusion of gold and / or the S&P 500 ranged from 10.18% to 29.20%, while after the inclusion of the stock index this interval ranged from 1.93% to 29.20%, and after the inclusion of gold in the range from 1.71% to 29.20%.



Source: Authors elaboration

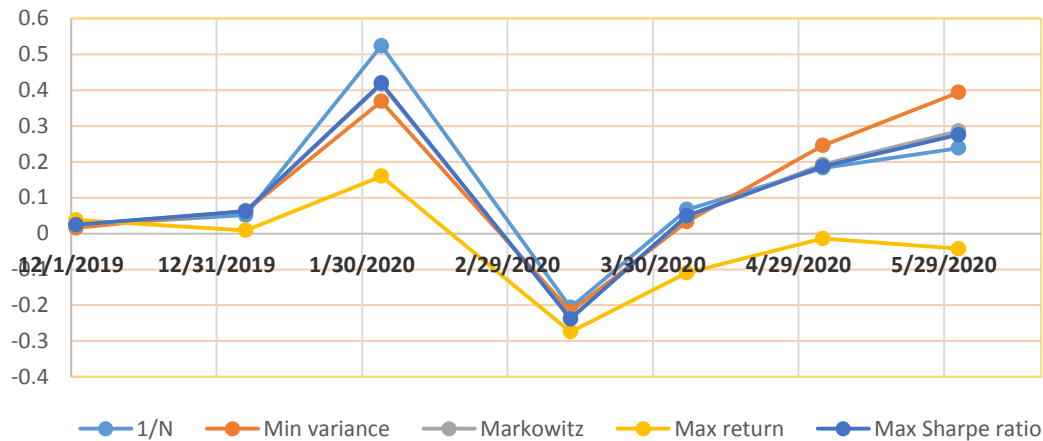
Figure 1. Efficient frontier of cryptocurrency portfolio before and after adding gold and / or S&P 500

After observing the performance of different portfolio models within each created portfolio, we wanted to observe how cryptocurrency markets reacted to a big financial markets turmoil caused by the emergence and expansion of COVID-19 which led to a stock market crash and a significant decline in financial asset prices, and to observe their recovery after heavy losses and intense volatility not seen since the onset of the 2008 world financial crisis. The damage caused by the emergence and spread of COVID-19 is enormous and will certainly have long-term consequences for the global economy. Traditional financial markets reacted negatively to the news of the virus, and stock prices experienced an unprecedented decline during the first quarter of 2020. However, this crisis has provided us with an ideal opportunity to explore the ways in which a global crisis, such as this one caused by COVID-19, affects the cryptocurrency markets.

On the one hand, cryptocurrencies are supported by a decentralized mechanism, which is independent of governmental functions and available anywhere in the world. Thus, people may respond to the threat of global instability by switching from traditional currencies to cryptocurrencies. On the other hand, cryptocurrencies may be both tightly related to economic activity and, due to lack of sufficient regulation, subject to manipulations by sophisticated investors, so that they cannot escape the fate of traditional markets (Jabotinsky & Sarel, 2020).

Figure 2, 3 and 4 show the actually realized cryptocurrency portfolio returns before and after the inclusion of gold and / or the S&P 500 stock index, which were created on the basis of 5 selected portfolio models. In order to determine the efficiency of the buy and hold strategy, we observed the movement of actually realized returns during each month until June 2020. We assumed that the portfolio was created on December 2, 2019, using the input data for the period from May 26, 2014 until December 2, 2019. In order to more easily notice the

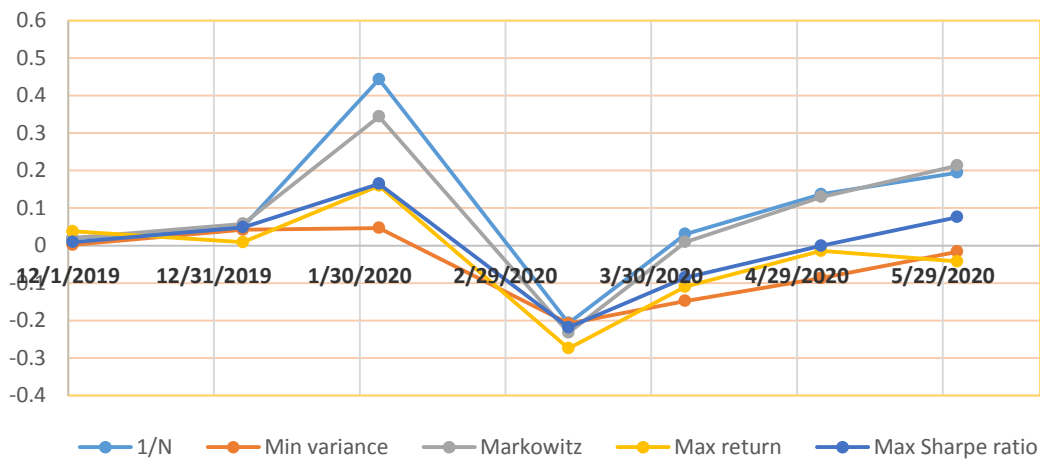
movements of actually realized returns during the observed period, as well as the speed of recovery of the cryptocurrency market as traditional financial markets entered the bear market after a long period of growth, we presented them on the same graphs with 7 characteristic points (creating a portfolio, buy and hold strategy until January, February, March, April, May and June 2020).



Source: Authors elaboration

Figure 2. Performance of buy and hold strategy of cryptocurrency portfolios

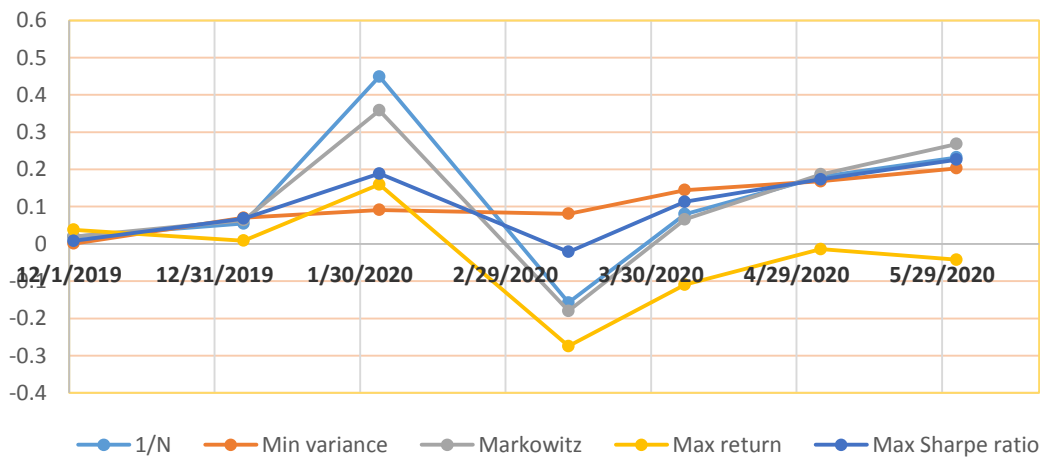
Based on the Figure 2, we can see that all portfolio models brought a big loss to investors after the financial markets entered the bear market in March 2020. Here we can clearly see the domino effect of the pandemic spreading to both traditional financial markets and cryptocurrency markets. What is also very interesting to notice is the fact that cryptocurrency prices rose significantly in February 2020 which can be explained by the fact that investors saw the importance of cryptocurrencies in a period of instability in traditional financial markets. We can also easily notice a rapid recovery of the cryptocurrency market after the period of crisis in traditional financial markets. In this case, the passive buy and hold investment strategy seems like a good investment decision in February, as well as in May and June 2020 when investors would have an opportunity to make a profit. We can see that the best performance was shown by the minimum variance model who gave the highest weight to Bitcoin, whose price also had the highest percentage growth after the period of the financial market turmoil in March 2020 (by 82.74%).



Source: Authors elaboration

Figure 3. Performance of buy and hold strategy of cryptocurrency and S&P 500 portfolios

After including the S&P 500 in our analysis, we can see that stock markets had a significantly weaker recovery compared to cryptocurrency markets after financial markets entered the bear market in March 2020. For comparison only, the value of the stock index S&P 500 rose in June 2020 by only 23.10% compared to March 2020, which is a significantly lower percentage increase compared to cryptocurrency prices. Markowitz portfolio model, as well as the 1 / N model of equal weights, showed the best performance both during February 2020 and after the period of crisis followed by the recovery in the financial markets.

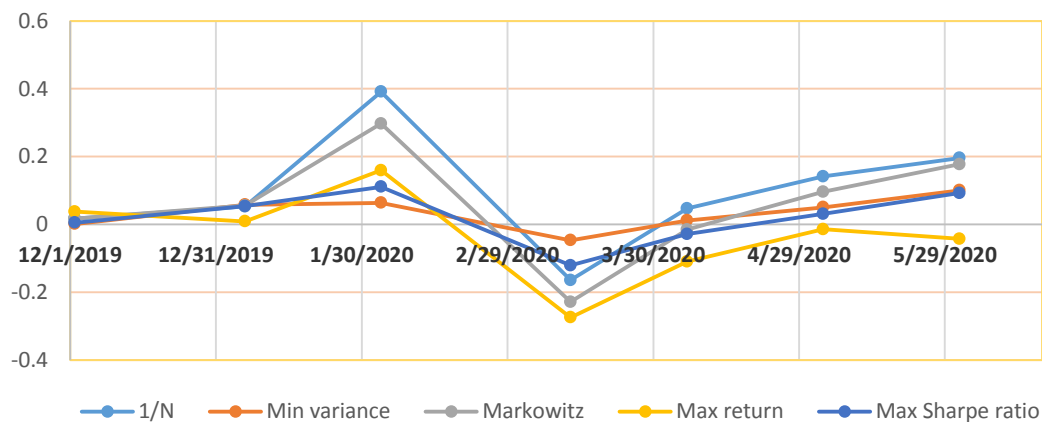


Source: Authors elaboration

Figure 4. Performance of buy and hold strategy of cryptocurrency and gold portfolios

The only effective investment decision in March 2020 is to invest in gold whose price rose during the period of the financial market turmoil, which ultimately brought a profit for investors with a minimum variance portfolio model after the inclusion of gold in the cryptocurrency portfolio. This can be explained by the fact that during the crisis period,

investors are trying to find refuge in a gold as a means of preserving the value of their assets, whose price is constantly growing compared to December 2019.



Source: Authors elaboration

Figure 5. Performance of buy and hold strategy of cryptocurrency, gold and S&P 500 portfolios

As in all previously created portfolios, after adding gold and the S&P 500 to the cryptocurrency portfolio, the portfolio with the highest return showed the worst performance during the observed period. Given that the price of XRP, the cryptocurrency that represents the core of this aggressive portfolio, had a significantly weaker recovery compared to other cryptocurrencies after the turmoil in the financial markets, this scenario was to be expected.

5. CONCLUSION

By conducting this research, we contribute to the development of literature related to the analysis of cryptocurrency market and portfolio management by observing different portfolio models of cryptocurrency portfolios with and without gold and / or stock index, and observing the behavior of cryptocurrency portfolio before and after the emergence and expansion of COVID-19.

The results we obtained indicate the fact that there are diversification effects by creating a portfolio of cryptocurrencies, as well as significant reduction in risk after adding gold and / or S&P 500 to the cryptocurrency portfolio, expressed through a stretching of the efficient frontier. We also showed that there is very little difference in the effective sets of the cryptocurrency portfolio with gold and the S&P 500, which is reflected in a larger shift to the left in the portfolio with stock index, where the cryptocurrency portfolio with stock index showed better performance compared to the cryptocurrency portfolio with gold, which was also noticeable by observing the Sharpe ratio.

We also came to the conclusion that Markowitz portfolio model outperformed the 1 / N model of equal weights in each created portfolio, which was reflected in a higher Sharpe ratio and which is not consistent with the results of previous research conducted by Brauneis & Mestel (2018) and Liu (2018). Observing the efficiency of the buy and hold strategy in each month until June 2020, assuming that the portfolio was created in December 2019, we can conclude that this passive strategy proved to be a good investment decision in each month

except March, in the case of cryptocurrency portfolio for all portfolio models except portfolio model with maximum return, when investors faced with a heavy loss during the observed period. If we include the S&P 500 in the analysis, we come to the conclusion that the stock market negatively affects the returns of the buy and hold strategy, i.e., the higher the weight assigned to the S&P 500 index, the lower the return for the holding period. This can be explained by the fact that the stock market had not yet recovered by June 2020 after the global market turmoil in early March 2020 caused by the emergence and expansion of COVID-19. If we include gold in the cryptocurrency portfolio instead of the S&P 500, the buy and hold strategy seems like a good investment decision, especially in periods of great market instability, such as the current situation. What is very interesting to notice is the fact that the price of gold has surged in the wake of COVID – 19. We come to the same conclusions by looking at the cryptocurrency portfolio with gold and stock index, where the negative impact of the S&P 500 on holding period return was offset by the positive impact of gold and cryptocurrencies, especially Bitcoin.

The increased interest of investors in cryptocurrencies during the period of financial markets turmoil, which ultimately led to an increase in cryptocurrency prices, can be associated with a decline in confidence in the capital market, banks and financial systems in general. This unexpected increase in cryptocurrency prices can also be caused by the implementation of the "pump and dump" strategy, when investors cause an artificial increase in cryptocurrency prices by spreading false and exaggerated statements about their value. During downturns and financial crises, there is also an increase in investors' interest in gold, as a safe haven as well as a store of value.

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THE ETHICAL FOUNDATIONS OF MODERN MANAGEMENT METHODS

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Abstract: Rapid strengthening of general potential at the disposal of modern humanity, taking into account continuous development of science and technology, as well as the global connection and interdependence of business entities, leads to a change in the paradigm for achieving basic goal of a business entity, so that appropriate and continuous observance of relevant ethical principles of respecting interests of employees, consumers, company owners/shareholders, other stakeholders, as well as following the basic principles of respect and observance of public interest and social responsibility, become a counterpart and a prerequisite for financial profitability. If a certain business entity aspires to achieve the basic goals of its existence, then the methodology of entity's operation must be based on certain relevant ethical principles, beliefs and attitudes. Modern business entities that will put ethics on an appropriate axiological pedestal and will recognize ethics as a prerequisite for successful business activity and also as an essential prerequisite for their own profitability, will be those entities that will provide a basic comparative advantage over the competition and will build assumptions for long-term sustainable business development and prosperity.

Keywords: business ethics, morality, social responsibility, sustainable development

1. INTRODUCTION

The accelerated development of science and the advancement of modern technologies that enable formation of a global market based on principles of a free market economy, implies a need and a certain obligation to design and implement modern ways of managing business processes in which any interest of the basic stakeholders of the process would be observed (eg capital owners, managers, workers, consumers, the state, regulatory bodies, relevant international bodies, etc.), and, at the same time, to research and to respect the public interest. Managers, as well as members of managing, supervisory boards or other responsible administrative bodies, are directly responsible for respecting the interests of capital owners (Daft & Marcic 2006), managers, workers, consumers, the state, regulatory bodies, relevant international bodies and the public interest. Complexity of the challenge is multiplied when set priorities face effects of a free market. This freedom to act within a free market has its binding aspects, which means that there are no rights without duties, or powers without personal responsibility. In the economic process, there is a direct or indirect connection of all

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actors (investors, managers, regulatory bodies, supervisory bodies). Consequently, managing of a business entity, bearing in mind that mission of the entity is to form a consumer of its own products or services and to meet the needs of the consumer more appropriately than the competition (Druker, 2001), is an extremely complex process facing all the challenges that arise in the economic sector within the companies and in the market itself. This dynamics forces organizations and business people to continually learn and follow new trends in corporate governance by adapting their decisions to changes. There are priorities in the corporate governance processes and business management processes, while market survival requires managers to focus on business economy and to achieve a competitive advantage in the corporation (Ferrell et al., 2011). Corporate governance is an extremely complex process both in the field of management and in the field of law and finance. Corporate governance, within the frameworks of modern legislation, is largely regulated by economic and institutional frameworks for building a good practice of corporate governance on postulates of the rule of law and socially responsible business activity.

2. THE ESSENTIAL PERVASION BETWEEN SOCIAL AND BUSINESS ETHICS

Business activity of modern economic entities faces a large number of visible, but also a number of hidden challenges, unknown to the general public. One of these extremely important, but hidden problems for the general public, is the immediate need for a strict and consistent recognition and observance of certain ethical rules and standards that every business entity, with regard to itself and its future, has incorporated them in its own identity, and they represent its inherent part that enables its recognition and strengthening of individual integrity and dignity. Dominant businesses entities realize that they are no longer exempt from sophisticated criteria for assessing their integrity and the ethics of their business activity (Daft, 2004). Criteria for success and status of a certain business entity are no longer only financial indicators, but also, individual identity, integrity and dignity increasingly represent an essential factor for assessing or perceiving the success and status of a particular business entity. Accordingly, ethics and ethicality are increasingly becoming a basic element that enables a certain business entity to properly use its own resources in order to maximize long-term profit and ensure adequate status and reputation within the business community and the general public. Business entities are increasingly entering into competition with each other in public demonstrations of moral intelligence, in order to prove to potential customers, consumers, service users, investors, business partners, and other categories of stakeholders that a given business entity is also a moral entity, that in addition to profit, has an appropriate social mission worthy of respect and attention.

Successful global and domestic organizations have become aware of the fact that in a competitive arena, business ethics enables growth and development, it increases efficiency and productivity. Numerous studies show that business ethics and profitability are not mutually exclusive, but enter into synergy, and business entities that have a built-in system of business ethics in their business concept show better business results than entities that have not developed their own, unique, immanent system of business ethics for the existing entity. Globalization creates a common world space where business entities around the world face homogeneous ethical issues, and the more business activities acquire universal characteristics, the more they become exposed to the moral and general cultural values and practices characteristic of certain specific regional cultural units.

In order to understand the essential principles on which basic tendencies of development of ethical consciousness in the relevant business entities on a global level are based, it is extremely important to perceive and understand basic principles of social ethics, which has been developing as a form of social consciousness since ancient times, and is basically a foundation from which emerges a modern ethical consciousness of business entities as a unique form of moral action, a social ethics as a form of moral awareness of ethical principles on which human relations and the relationship of subject-social group-society are based (Cordourier-Real C.R, 2010). Social ethics is an area of applied ethics that explores ethical principles, on which interpersonal relationships are based, the relationship between a person and social groups, the interrelationship between social groups, and the ethical foundation and importance of customs, traditions, cultural phenomena, rules of good behavior, etc. Within its research, social ethics collaborates with a number of other sciences with which it shares part of the subject of its research, such as: sociology, psychology, history, pedagogy, legal sciences, political science, etc. Social ethics covers a large number of areas, among which the following can be distinguished: ethical foundation of culture, cultural phenomena, customs and traditions; family ethics; moral function of the family; family morality; good family relationships; rules for good and decent behavior, etiquette, good manners; ethical foundation of good interpersonal relations, respect for the other, respect for differences, respect for different opinions and attitudes, social tolerance, ethical principles of social tolerance; mutual respect of different social groups with different traditions, customs and moral characteristics (Räikkä, 2014); overcoming the troublesome social phenomena that result from immoral and harmful behavior of individuals and certain social groups, such as: rampage of fan groups and other types of hooliganism; addiction diseases; antisocial behavior of certain sub-cultural groups, such as certain sects that often act illegally outside the legal framework or groups, young people dissatisfied with their social status who express their revolt through threats or physical attacks on individuals or social groups they consider that they are to blame for their current position. Values characteristic of social ethics are: solidarity, respect, love, justice, responsibility, care, tolerance, cooperation, friendliness. Moral norms characteristic of social ethics are: respect other people; respect: opinions, interests and desires of other people; take care of material and financial existence; respect the elderly; do not cause conflicts; be tolerant; be dignified; take care of the children; respect youth; respect the future; take care of your family. Within the framework of social ethics, problems and issues are explored that with their topicality cause a wider social interest, but are also a subject of discussion within the professional academic community. Characteristic issues and problems of this kind are: ethical principles of respect, social responsibility, sustainable development, tolerance and cooperation between different social groups and overcoming historical disagreements, prejudices, mistrusts and intolerances; care; providing material security for oneself and one's own family; place and role of the family within society; basic ethical family values; preservation of family values; gender equality within family relationships; child care; educational role of the family; nurturing a social spirit of cooperation and solidarity; care for social security and social prosperity; standardization and regulation of social rules of good and decent behavior in accordance with changes in social conditions, and in accordance with the current way of life; conceiving good and decent behavior in areas where there were no previously generally accepted standards, such as courtesy of online communication; scheduling and holding video conferences, etc.

It is extremely important to understand direct connection between principles of social ethics and basic views and teachings of economic ethics which is a form of social consciousness aimed at studying and standardizing ethical postulates on which are based: economic life, attitude towards work and attitude towards work obligations. Economic ethics

is an applied philosophical discipline that studies basic ethical postulates of economic life of society, attitude towards labor, work responsibilities and creativity. Within its research, economic ethics often has a multidisciplinary attitude towards the subject of research, and it cooperates with a number of scientific fields and disciplines, including: economics, sociology, political science, legal sciences, psychology etc. Economic ethics explores a number of areas related to ethical attitude towards economy and ethically grounded attitude towards labor, where the following areas stand out as the important ones: business ethics; research of the basic ethical postulates of ethical attitude towards economic activities and business practice; business ethics; managerial ethics; research of the basic ethical principles of the attitude towards managing of economic entities; labor ethics; work ethic; research on the ethical basis of the attitude towards labor, work tasks and responsibilities, etc.; ethical attitude towards human resources; building human resources (Crane & Matten, 2016). Values characteristic of economic ethics are: diligence, business efficiency, responsibility, cost-effectiveness, professionalism, collegiality, solidarity, respect, care, cooperation. Moral norms characteristic of economic ethics are: perform your work liabilities responsibly and on time; nurture your work habits and always take your work responsibilities seriously; nurture the spirit of cooperation and collegiality in the relationship with people you work with and collaborate with; take care of the success of the institution in which you work; the manager (executive) should take care of safety of the employees, their health and material security, as well as for preservation and promotion of dignity of the employees. Within the framework of economic ethics, problems and issues are explored that with their relevance cause a wider social interest, but are also a subject of discussion within a professional academic community: developing awareness of ethical responsibility for ensuring socio-political stability as a prerequisite for economic and social development of society; social responsibility; sustainable development; ethical principles for the role and attitude of the state in the process of prevention of economic crises, as well as in the process of dealing with consequences of the existing economic crises; development of entrepreneurial spirit; ethical basis of the responsible attitude towards development of the economy; basic ethical principles of managerial ethics; responsibility of managers for the safety, health and material security of employees; principles for building collegial spirit and cooperation among employees; principles on which employees are motivated; principles on which sanctions are imposed on employees who have improperly performed their duties; ethical attitude towards labor; care for dignity of the employee; labor rights; the right to strike and to freely express dissatisfaction with working conditions or the material compensation for the labor invested; fair remuneration of the employee's labor; employee health care; right to a pension; the right to a free education for children of the employees; legal protection of employees from possible unjustified termination of their employment by the employer; proper education of children and youth in order to develop their work habits and to form an awareness of the importance of business and social responsibility.

It is also very important to understand a direct connection between principles of social ethics, economic ethics and basic views and teachings of professional ethics as an area of applied ethics that studies ethical principles on which responsibilities and rules of conduct of employees in a particular profession are based. Bearing in mind specific characteristics of a given profession, as well as obligations and responsibilities faced by the professionals who are dedicated to a profession, professional ethics tries to clearly and precisely determine and define ethical foundation of a given profession. Intellectual considerations on ethical foundation of the professional relationship, ethical dignity, and a moral approach to professional responsibilities originate from a period of the beginnings of our civilization. The first intellectual-philosophical conceptions emphasize the virtues, human qualities and abilities that should be possessed by the persons who perform most important functions in

society. In antiquity, the term arete (ἀρετή - virtue, good characteristic) was used to name those essential human characteristics and abilities, ie virtues that are essential for performing certain important social function (Jaeger, 1946). In accordance with the duties, responsibilities, obligations and the general importance that a certain social position, ie profession has, individuals should possess specific human qualities, skills and virtues. Within modern conceptions of professional ethics, basic principles of standards of behavior and an attitude towards responsibilities of holders of activities from different professions are explored. Professional ethics studies basic moral responsibilities of professional attitude towards work, possible consequences of immoral, unprofessional behavior, as well as positive effects of responsible, moral, professional performance of duty. Today, many institutions and professional associations have developed a code of ethics that standardizes moral principles of employee behavior. Certain codes of ethics for professional attitude of the executives, ie managers, emphasize responsibility of the management staff for the success of operation of the company, ie the institution they manage, their responsibility for health, physical safety and material security of employees in the institution, as well as their responsibility for impact that the company they manage has on the narrower and wider social environment (such as issues of care for the local population, organization of cultural and sports events, care for preservation of the environment, etc.). The Code of Ethics for Judicial Professionalism emphasizes importance of their work to a wider community, emphasizing a need to preserve moral integrity and dignity of judges. Performance of their activity should be based on respect for principle of fairness and operation in accordance with the law. The codes of ethics for professional standards for behavior and respect of professional obligations and duties of professionals from different fields determine basic regularities of moral attitude of the employees in certain professional fields.

3. THE RELATIONSHIP BETWEEN ETHICS AND PROFITABILITY OF MODERN BUSINESS ENTITIES

One of the basic attributes of humanity refers to the meaning and construction of human personality, human nature and the power of man for a spiritual creation. Immanently of his creative nature, by building himself, man designs his life and the directions and values of his action. He strives to design, ennoble, and elevate his own existence. A great challenge is to understand and perceive business activity as an area that enables and encourages refinement and exaltation of human nature, and thus of human existence. Business ethics is a multidisciplinary field of science. It aims to explore the basic ethical and moral principles, on which a business activity is based, as well as to study and regulate the basic moral principles that should be respected by business entities. It seeks to understand ethical principles that should be observed by business professionals that directly affect development of organizational culture of business entities, which means that the same principles should be observed in the work of business management and in the professional operation of business administration. Business ethics as a multidisciplinary scientific field unites knowledge of ethics and business activity, and within the research can be consulted and used the knowledge of complementary scientific disciplines. It is a discipline whose goal is to explore the basic conceptual elements, on which the idea of managing a profitable socially responsible business entity is based, ie, the essence of business operation and morality (Shaw, 1991).

In order to enable proper research or study of the ethical foundation of a business activity, it is necessary, first of all, to study basic principles of ethical research, to master

basic ethical categorical apparatus, and that's why it is necessary to realize that ethical value (eg goodness, honesty, diligence) is a thought about a certain ethically and value-determined essence. Ethical value is a term, a basic philosophical and ethical category that signifies awareness of the meaning of a given ethically and value-determined essence, such as goodness, honesty, diligence, courage, sincerity, solidarity, etc. Within ethical conceptions there is no agreement whether values are absolute, eternal, unchangeable and persist unchangeable in eternity or if values are changeable and relative ideas characteristic of a particular society, a particular historical period or a particular culture. In order to enable proper research or study of ethical foundation of a business activity, it is also necessary to study and master the basic views of most influential ethical teachings that directly influenced development of civilization and also conceive the foundations of modern business activity.

Rapid strengthening of the general potential of modern humanity, taking into account a continuous development of science and technology, as well as the global interconnectedness and interdependence of business entities, leads to a change in the paradigm for achieving basic goal of business entity, so that appropriate continuous observance of relevant ethical principles of respecting the interests of employees, consumers, owners of capital/shareholders of the company, or other stakeholders, as well as following basic principles of respecting and observing of public interest and social responsibility become a counterpart and a precondition of financial profitability of the subject. Business ethics is a system of interconnected and harmonized principles and rules that define: the spirit of management, managerial methods and the approach to performing core business within the business entity. If a certain business entity aspires to achieve basic goals of its existence, then methodology of the entity's operation must be based on certain relevant ethical principles, beliefs and attitudes. Modern business entities that will put ethics on an appropriate axiological pedestal and will recognize ethics as a prerequisite for successful business activity and also as an essential prerequisite for their own profitability will be those entities that will provide a basic comparative advantage over the competition and build a sustainable business development and prosperity. For many successful and financially powerful modern business entities, and especially large multinational joint stock companies as one of the most important phenomena in economic history, it is characteristic that the owners of capital, if they do not have a managerial position in the business, are no longer personally responsible for liabilities arising from management of the economic activity that causes separation of the ownership function from the management function, ie from functions of managing and administering resources of the company (Means, 2017). Modern economic entities have a certain number of essential legal features that establish a determinative framework of the operations of entities, where the most determinants ones, of course, are separation of functions of capital ownership, management and business activity, and separation of the disposal of company assets from the right to have at disposal shares of the company, ie the equity, as well as the legally regulated enabling of an independent external audit of the financial operations of economic entities.

Economist Michael Eugene Porter has developed a model that defines five forces that determine power of competition and market attractiveness, ie overall profitability of the industry. Although the theory itself was not intended to indicate a direct relationship between business ethics and profitability, by analyzing settings of the theory, it is obvious that it indicates a clearly determined process of immediate conditionality of ethics and profitability of a business entity. Porter points out that a competitive strategy must stem from an understanding of sophisticated competition rules that fundamentally determine attractiveness of a business area (Porter, 1998). In any business area, whether it offers products or services, whether it is international or it is within national frameworks, competition rules are based on five competing forces: Threat of substitutes (Potential factors: Buyer propensity to substitute;

Relative price performance of substitute; Buyer's switching costs; Number of substitute products available in the market; Ease of substitution; Availability of close substitute), Threat of new entrants (Potential factors: Supply-side economies of scale; Customer switching costs; Access to distribution channels; Demand-side benefits of scale; Capital requirements), Bargaining power of customers (Potential factors: Buyer concentration to firm concentration ratio; Degree of dependency upon existing channels of distribution; Bargaining leverage, particularly in industries with high fixed costs, Buyer switching costs, Buyer information availability; Availability of existing substitute products; Buyer price sensitivity; Differential advantage of industry products), Bargaining power of suppliers (Potential factors: Buyer concentration to firm concentration ratio; Degree of dependency upon existing channels of distribution; Bargaining leverage, particularly in industries with high fixed costs; Buyer switching costs; Buyer information availability; Availability of existing substitute products; Buyer price sensitivity; Differential advantage (uniqueness) of industry products), Competitive rivalry (Potential factors: Sustainable competitive advantage through innovation, Competition between online and offline organizations, Level of advertising expense, Powerful competitive strategy which could potentially be realized, Firm concentration ratio). Each of these forces affects the ability of a business entity to be competitive in a given business area and each of the forces has several determinants. The five competing forces determine profitability of the business area as a whole, as they affect the prices, costs and required investments of companies in the industry - an element of return on investment. For example, the powers of a customer, as well as the threat of replacement, affect the prices that companies can charge. Customer power also affects costs and investments, as more powerful customers demand more expensive services. Furthermore, bargaining power of suppliers determines the price of raw materials and other inputs. Intensity of the rivalry affects the prices, but also the costs of competition in the field of plants, product development, advertising and sales. A threat of new entrants limits prices and shapes the investment needed to deter new entrants. The strength of each of these five competing forces (potential participants, customers, suppliers, substitutes, rivalry) is a function of the industrial structure, ie the background economic and technical characteristics of the industry. The industrial structure is relatively stable, but may change as the industry develops. Change in the structure changes the absolute and relative strength of competing forces and can therefore positively or negatively affect profitability of the industry. Accordingly, current conditions of global economic trends impose the need that each business entity faces up in order to provide a competitive advantage and to achieve certain goals that in addition to increasing profitability include issues related to ethics, reputation, corporate social responsibility and other related issues with morality and commitment to the public interest. These goals include achieving and maintaining customer, employee and shareholder satisfaction. It is necessary to achieve the goals and fulfill the tasks that exceed satisfaction of all the stakeholders in the organization, as well as achieving these goals in the best possible and most acceptable way for the organization. In order for individuals within the organization and the organization itself to succeed in these goals, their actions and activities must be based on business and ethical principles, ethical attitudes and beliefs. Organizations are the ones that manage to harmonize and establish a balance between the principles of profitability and ethics, and they will be the organizations that will have a long-term perspective of growth and development.

4. CONCLUSION

Modern successful business entities have developed an appropriate knowledge of the fact that adhering to the principles of business ethics allows continuous growth and development of a business entity, and also allows increasing efficiency and productivity of the entity. Numerous studies, as well as relevant business practices and experiences show that business ethics and profitability establish a proper synergy within a business entity, and entities that have a well-functioning appropriate system based on business ethics within the operation of their business systems show better results than business entities that do not have it. Business ethics is a system of interconnected and harmonized principles and rules that define: the spirit of management, managerial methods and the approach to performing basic business activity within the business entity. Principles of business ethics are becoming more relevant in all spheres of management and operation of business entities. Today, there is no business area, market or business model that has not harnessed its own resources to determine an appropriate concept of adequate ethical practice that will enable construction of a desired image of the entity in the general public, which will allow gaining a respectable status of the entity within a business community and which will enable maximization of profitability within business activities of the entity. If a certain business entity aspires to achieve the basic goals of its existence, the methodology of entity's operation must be based on certain relevant ethical principles, beliefs and attitudes. Business ethics in the modern globalized world is a necessary part of business practice and a prerequisite for achieving business success not only in the short but also in the long run. Business ethics acquires strategic importance because it creates a management system based on ethical principles that enable the organization to respond well to the requests of all stakeholders - customers, employees, shareholders, but also those stakeholders, who are indirectly related to the organization, such as, a social community and environment, ie society as a whole. Significant business successes achieve business entities that do not separate ethics from profitability. Business entities that manage to establish a balance between principles of profitability and ethics, and which will continuously develop a same principle of operation, will be the entities that in the long run can expect significant growth and development. Modern business entities that will put ethics on an appropriate axiological pedestal and will recognize ethics as a prerequisite for a successful business activity, and also as an essential prerequisite for their own profitability will be those entities that will provide a basic comparative advantage over the competition and build a prerequisite for a long-term sustainable business development and prosperity.

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THE IMPORTANCE OF THE BOSS PLATFORM FOR THE DEVELOPMENT OF ENTREPRENEURSHIP IN THE ACADEMIC ENVIRONMENT

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Abstract: The sudden development of the market, stimulated by globalization on all levels, leads to an ever increasing need for the input of fresh knowledge, efficiency and investments. The modern economy recognizes knowledge and innovation as the most important resources, the most profitable products and the basis for all successful and advanced business. The academic society is becoming more and more recognized as a key component in national innovation systems, therefore it is necessary that a sense of entrepreneurial spirit is developed in this field. Universities and research organizations are increasingly expected to intensify cooperation not only with high-tech organizations but also with small and medium enterprises. This paper showcases the “Business Opportunity Support System“ platform (BOSS platform), which responds to all the needs previously stated. The aim of this paper is to point out the value of the existence and the need for the advancement of such platforms, using the aforementioned tools for self-assessment, planning and the growth of business opportunities, which will be applied to a project, which did not employ a system of this kind previously.

Keywords: knowledge management, entrepreneurship, BOSS platform, innovation

1. INTRODUCTION

The new economy recognizes knowledge and innovation as the most important resource, the most profitable product, and the key to business management (Stewart, 2001), there is an obvious and growing need for improving collaboration between science and business. The long-neglected academic community has started to be accepted as a key driver of innovations and is expected to expand its traditional activities, which have so far usually been limited to education and research. This has been done by including a third mission, production, practical application and exploitation of knowledge and other skills outside academia (Molas-Gallart, et al., 2002). Universities, created as an institution for the preservation and transfer of knowledge, have evolved into an institution where knowledge create and put into use (Etzkovitz, 2013).

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Increasing activities would bring economy to recognize the innovation as the only way for surviving in modern business, realizing that the most efficient way for achieving competitive advantage is through cooperation with scientific organizations. At the same time, it is essential to educate the academic community about the necessity for creation and encouragement of entrepreneurial initiative, striving for scientific work to move increasingly in the direction of applied and development research, i.e. towards implementation on the market. The University of Belgrade, Meta Group and University of Liege have recognized this need within the project “Upgrading the business opportunity support system to strengthen the European innovation system”, and developed the platform “Business Opportunity Support System” (BOSS platform) as an instrument that encourages entrepreneurial thinking in researchers and students, helping them to transfer innovation from academia to the business sector (BOSS, 2020).

The aim of this paper is to, using the tools presented in the BOSS platform and applying them on a project lacking the support of this kind of system, answer the research question on the importance of developing an entrepreneurial university and impact that this system can have, helping to develop the entrepreneurial spirit through education.

2. ENTREPRENEURSHIP AND THE ACADEMIC COMMUNITY

The range of definitions of entrepreneurs and entrepreneurship is wide and ranges from Schumpeter's definition of entrepreneur as an innovator who performs “creative destruction” (1934), Drucker's as “someone who maximizes business opportunities” (2006), all the way to Dollinger's idea that entrepreneurship is “creating an innovative economic organization (or network of organizations) for the purpose of profit or growth in conditions of risk or uncertainty ”(1999). In essence, it can be said that the field of entrepreneurship encompasses the discovery, assessment and exploitation of opportunities and the individuals who discover, evaluate and exploit them (Shane, et al., 2000).

Entrepreneurship imposed itself as one of the necessities of the new millennium, characterized by globalization, rapid change and the daily development of new technologies. In order to answer to all these fast changes, modern society becomes a knowledge society, implying a new economy in which knowledge is a key resource for survival and development (Lekić, et al., 2018) and the need to develop knowledge entrepreneurship, which can be seen as a kind of link between innovation and entrepreneurial needs. Knowledge entrepreneurship emerges from "the need to extract the juices of the highest quality from the knowledge base in the form of new technologies and new companies that contribute to the development and competitiveness of the economy and society" (Levi Jakšić, et al., 2010). We can say that knowledge entrepreneurship aims to create and develop better knowledge, which then produces a competitive advantage, and therefore greater chances for achieving sustainability. The academic community can be recognized as the crucial actor of this activity, being the institution capable of taking up leadership in establishing the links between science and society, thereby creating opportunities to learn how to realize innovations as well as entrepreneurship, in the aim of raising awareness about science and technology in society (Grau, 2014). Therefore, the concept of an entrepreneurial university is, according to the requirements of a knowledge-based society, established as the best course of evolution for the university (Goldstein, 2010). Realizing that the university is more than an institution for generating scientific publications and patents (Audretsch, 2014), we can say that it is also the accelerator of entrepreneurship (Guerrero, et al., 2014), focused on training and research activities as well as being the initiator of new ideas and business opportunities.

However, although the academic environment is regarded as the basic nucleus of scientific research, innovation and knowledge transfer, in order to maintain the sustainability of the entrepreneurial spirit and to ensure the implementation of innovations, it is crucial to strengthen the relations and cooperation between universities and the business sector. Schumpeter (1934) stated that applying the results of research and development is the basic function of entrepreneurial activity in the innovation process. Later literature confirms this statement as well, underlining the research done on the university as a main platform for developing powerful industrial and technological hot-spots (Audretsch, 1998; Grimaldi et al., 2011; Svensson et al., 2012).

3. CONTRIBUTION OF THE BUSINESS SECTOR IN R&D AND ENTREPRENEURSHIP DEVELOPMENT IN THE REPUBLIC OF SERBIA

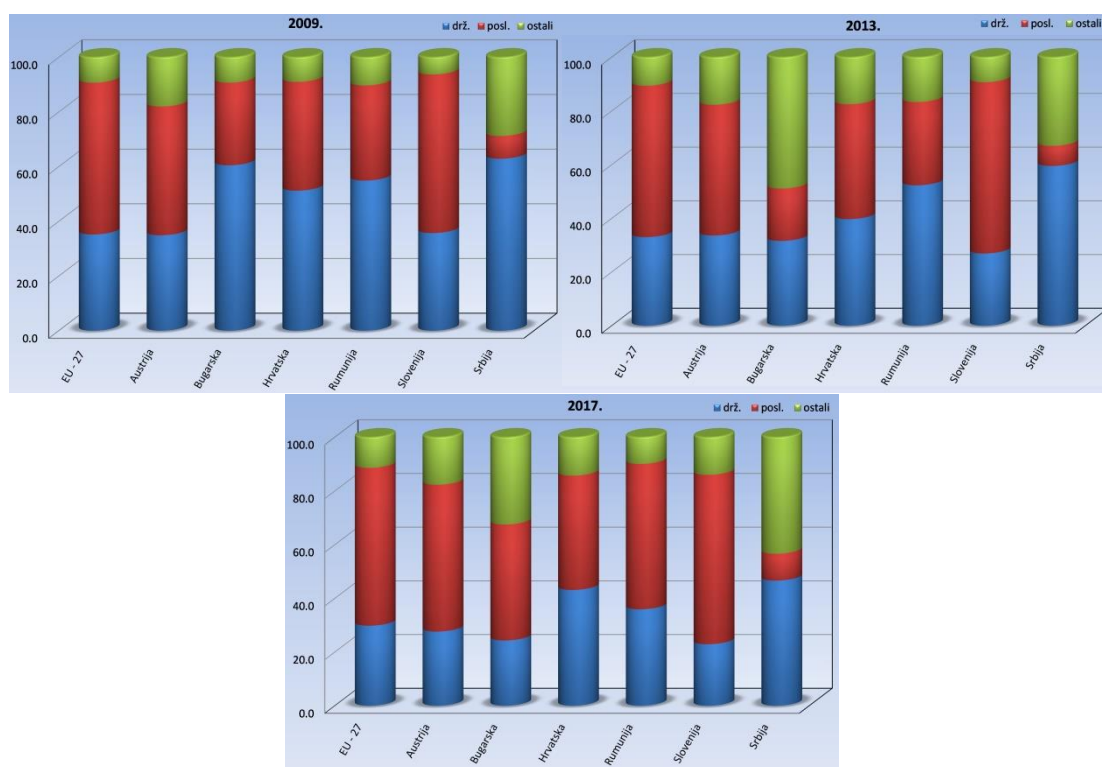
Despite the fact that within the various networks of sustainability and innovation the role of universities and science is still in its infancy, investing in knowledge is crucial for scientific and technological research and innovation. (Kronja et al., 2011) The role of science in sustainable innovation partnerships ranges from knowledge leaders and basic research to technology transfer and dissemination (Sarkis et al., 2010). In a knowledge society, the competitive advantage of enterprises and national economies are based on knowledge and the exploitation of potential opportunities. Because of that, most developed countries maintain the increase of investment in research and development (R&D) and innovative activities as their basic and development goals. Allocations in the purpose of science and research and development leads to the acceptance of new technologies, as a method of driving development, and representing a key element of the social development of every company, branch, region, economy, country. Along with the development of science and the reinforcement of scientific research activities, by gaining competitive advantages the courses of technological progress are determined, for both the economy and the whole of society as well (Levi Jakšić et al., 2015). It should be noted that the most competitive economies are the most innovative ones, and that they have a strong knowledge-based economy, in which both the state and private sectors invest equally in development and innovation (Jovičić et al., 2018).

The main goal of the Europe 2020 Strategy (2010), which emphasizes smart growth as one of three defined priorities, i.e. the development of an economy based on knowledge and innovation, and that it is to reach at least 3% GDP investment in research and development. In order to recognize the necessity of stronger links between the academic environment and the business sector so that entrepreneurship is developed through the application of results and the development of fundamental research, we will mention the Lisbon Agenda (2000). According to it, the two thirds of the funds allocated for science, technology and innovation should come from investors, i.e. the business sector.

In the Republic of Serbia, government sector is the main financial resource for scientific research, while the investments of the business sector, which would encourage the intensification of applied research and lead to the development of entrepreneurial spirit in the academic environment, are at a negligible level. If we look at the period from 2009 to 2017, it can be seen that, both in the European Union (27 countries from 2020) and in the region, the allocations of the economic sector for R&D are significantly higher than in the Republic of Serbia (Graph 1). It should also be noted that the category of “others” consists of foreign investments, but also the non-profit sector and all investments in accordance with the “System of National Accounts” – SNA (Eurostat, 2020), which may partly originate from the state.

Despite the fact that the scientific research activities of the Republic of Serbia are rather highly ranked on the international level, indicating existing potential, we have to note that among them, fundamental research prevails and, while patents and technical solutions, possessing the greatest potential for cooperation with the business sector and entrepreneurship, barely exceed 2%. In the last 10 years, there is not a single patent application filled in European Patent Office (EPO) originating from Serbia (Eurostat, 2020). Although the data above (among the other factors) indicates a lack of interest in entrepreneurship in the academic environment, it should be noted that, based on the data provided by the Statistical office of the Republic of Serbia, a trend of gradual increase of applied and developed research compared to fundamental research has been observed.

However, aforementioned does not mean that fundamental research is of no importance for the development of innovation and entrepreneurship. Fundamental research expands the boundaries of scientific knowledge, and together with existing technological information and invention, creates the needed conditions for the realization of applied research. If right conditions are met, further development of research, leads to transformation and reduction of uncertainty, and thus, through laboratory research, test plants, prototype production, market research and economic justification, etc., to the decision for commercializing an idea or invention and turning it to innovation (Levi Jakšić et al., 2015).



Source: Eurostat, Edited by: author

Graph 1. Summary of percentage allocations for R & D of the Republic of Serbia and the region in the period 2009 to 2017

4. BUSINESS OPPORTUNITY SUPPORT SYSTEM IN STRENGTHENING INNOVATION

Innovation is very unpredictable, full of risks, expensive and demanding to manage. Entrepreneurial progress, in the development of innovation requires organization of key ideas and principles, and underlines the need to develop system. Therefore, Morris (2011) recommends five basic questions that should precede any entrepreneurial endeavor and approach to the innovation process: *why, what, how, who* and *where* to innovate. Although at first glance these questions seem trivial, the answers are, in fact, complex and require thorough and complete commitment and professionalism. Through the example given below, representing extremely innovative and high-quality design and product, an attempt will be made to illustrate the actual complexity of the questions above, as well as to highlight the need for professional support in the creation and transfer of innovations from academia to the business sector (BOSS, 2020).

4.1. PRODUCING LOW-CALORY DIETARY FIBERS FOR HUMAN DIET

Having in mind the increased need of dietary fiber in diet recent years, and based on results from long research, the research groups of the Institute of Chemistry, Technology and Metallurgy and the Faculty of Chemistry - Laboratory for Experimental Biochemistry and Biotechnology (BBH) has developed a new product, “Super fibers”. The product consists of natural dietary fibers from triticale grain, currently not produced by anyone. The product itself has many advantages over other imported products that have a similar purpose, while having a significantly lower caloric value. Triticale (x *Triticosecale*, Wittmak) is a hybrid of wheat (*Triticum* sp.) and rye (*Secale* sp.). Combining wheat yield and resistance to diseases and climatic conditions from rye, initially increases the yield with significantly reducing the amount of necessary plant protection chemicals. An innovative technology including the use of endogenous amylolytic enzymes combined with specific fungal enzymatic cocktails was applied in obtaining the dietary fiber of triticale grain (“Super fibers”).

The “Super fibers”, obtained through innovative technology, prevent constipation, which is a well-known cause of a number of gastrointestinal diseases (e.g. colon cancer), ensures better digestion, and by prolonging the feeling of satiety, help regulate body weight. Additionally, they positively affect the immune system, due to the fact that they assure better intestinal blood circulation which ensure faster removal of toxins from the body, as well as food residue, they also prevent periodontitis due to prolonged chewing.

According to research done by the Gallup Agency (2020), about 46% of humanity has an unhealthy diet, which emphasizes another advantage of “Super fibers”, which have a lower caloric input than other commercially available dietary fibers. The low calorific value of the product allows potential users – manufacturers of confectionery or bakery products - greater variety of combinations with other ingredients, increasing the overall quality and taste of the final product, and allows for more precise dosing. “Super fibers” do not contribute to an additional increase in total caloric value, providing at the same time guaranteed fiber content present in the final product, which, by no means, is the case with other commercially available fibers used for this purpose today and represent a key advantage of “Super fibers” over their competition.

“Super fibers”, obtained on a small scale, were short-term placed on the market as an additive in “Vieko” fruit purees, manufactured by DBD System in Kačarevo. The product was unique on the market and the response from consumers was more than satisfying. In

cooperation with colleagues from the Faculty of Agriculture in Belgrade, “Super fibers” were added to yogurt, resulting in an interesting new product from the functional food category (Miočinović et al., 2017).

This was a new, domestic and environmentally innovative finished product, capable of improving the quality of life. This product was the result of an innovation project funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, and received first prize on the “Competition for Best Technological Innovation”. It was included in priority areas for entrepreneurial discovery in the Smart Specialization Strategy for the period 2020 to 2027 (2020) in “Food for the future” program, as a “functional product or nutraceutical having one or more nutritional or health benefits (rich in fiber, protein, minerals, antioxidants ...)”. Nevertheless, there was no implementation or market launch. We cannot help but ask: What happened?



Figure 1. Schematic representation of innovation

4.2. PRACTICAL APPLICATION OF BUSINESS OPPORTUNITIES SUPPORT SYSTEM TOOLS

Usually, we associate entrepreneurs with the terms like “new, innovative, flexible, dynamic, creative and risk-taking” (Coulter, 2001). There is a plethora of discussions in the literature about so called “entrepreneurial personality”, but it should be pointed out that people that do not feel comfortable as innovators or entrepreneurs will not do these jobs, anyway. However, if a person has the necessary disposition, these tasks can be performed equally well by people of different personalities, backgrounds and ages (Drucker, 2006). The goal of entrepreneurship education is to train individuals who possess the inclinations and the needed characteristics, such as being independent, creative and opportunity seeking, courageous, someone willing, to take risks and to adapt to the needs of future society (Li-li et al., 2015). Entrepreneurial education is an activity intended to nurture, develop and educate potential entrepreneurial talents who possess entrepreneurial awareness, quality, knowledge and abilities.

The Business Opportunity Support System (BOSS) platform, developed in cooperation with the University of Belgrade, the META Group and the University of Liège, is just one of the instruments responding to the needs for constantly developing and improving the link between education, research and business. It can be valuable in implementing and improving the entrepreneurial way of thinking, both with the, somewhat sluggish and sleepy,

academic community, as well as with students, to whom this way of thinking is indubitably more natural. In addition to the tools available, the platform itself is very well technically processed and easy to handle. Enriched with educational material, both in PDF and in video format, it provides all the necessary information on important topics such as team, market, intellectual property, technology (BOSS, 2020), in a comprehensive and professional manner, in addition it contains an accompanying dictionary within every tool, explaining each new term related to entrepreneurship and business.

Starting from the basic goal of the BOSS platform, which is to enable the evaluation of the potential of idea as a support system for business opportunities, after getting acquainted with the educational material, a project was created, entitled “Obtaining low-calorie dietary fiber from triticale for human diet using endogenous and fungal enzymes” and testing started on analyzing possibilities for the implementation of the new product, “Super fibers”.

The first step is the **business opportunity self-assessment tool**, designed in the form of a questionnaire, covering all areas relevant so as to assess the feasibility of the product implementation in the market. These areas are technology, team, market, unique value proposition, intellectual property and finances. By going through all 59 questions and selecting one of the offered answers for each, the user is able to get a first insight into the strengths and weaknesses of his business idea through a visual display (Figure 2), defining the self-assessment of the project.

Based on the generated graph, the market is determined to be the major weakness of the project. This can be expected, since the team is composed exclusively of scientists who are highly capable in their research field; however, the entrepreneurial idea is still a largely unknown field for them. This explains low positions in the finances fields of team as well. At the same time, the tool confirmed that the technology applied was highly positioned and that the unique value proposition stood out, thereby pointing out the uniqueness of the product, and showing that it is capable of meeting the needs of customers.

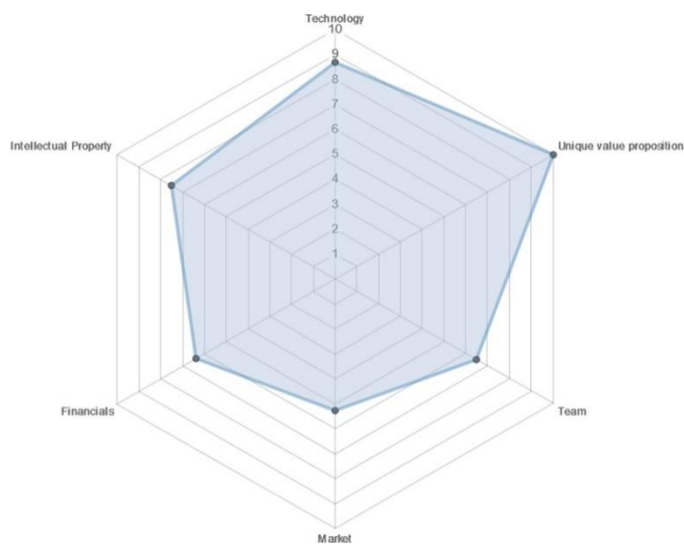


Figure 2. Visual representation of the business opportunities self-assessment tool results for “Super fibers”

The next step on the BOSS platform is the **Business Opportunity Planning Tool**, defined in the form of a canvas and intended to view all the elements relevant to business opportunity development. It consists from three blocks and is more demanding than the first tool, as the user need to concentrate, focus, precisely define the problem, the reference market

and the development and profitability of the business opportunity, in as much detail as possible. The goal of this tool is to clarify the problem, as well as existing and new solutions and provide an answer to the question: which problem is worth solving and what solution can be offered to satisfy a sufficiently large number of stakeholders (BOSS, 2020). The output of this tool should be a simplified version of the business model.

Already on this smaller example of an output (Figure 3), differences can be seen in the answers given to the questions of “problem, alternative solution” etc. The answers given were extensive, however judging by the results of this tool, they were not always inputted into the appropriated field. After the business opportunity planning tool finished processing, it conveyed a concise business model which redistributed the inputted text, found the essence of it, and adapted it for all stakeholders, be they from an academic, business or any other background.

PROBLEM

TITLE: Naš proizvod čine prirodna dijetetska vlakna žitarice tritikale koji trenutno niko ne proizvodi, a u veliku prednost u odnosu na konkurentne proizvode obezbeđuje značajno nižom kalorijskom vrednošću

DESCRIPTION: Dijetetska vlakna imaju nižu kalorijsku vrednost od sličnih vlakana koja se trenutno nalaze na tržištu. Takođe ističu se sledeće funkcije: obezbeđuju bolje varenje, regulišu telesnu težinu zbog dužeg osećaja sitosti, povećavaju odbrambenu moć organizma zbog bolje prokrvljenosti creva čime se obezbeđuje njihova obnova i detoksikacija organizma, sprečavaju parodontozu zbog potrebe za dužim žvakanjem.

ALTERNATIVE SOLUTION

TITLE: Trenutno dostupni proizvodi na našem tržištu su iz uvoza

DESCRIPTION: Preparati koji su trenutno u ponudi sadrže vlakna koja imaju visoku kalorijsku vrednost, čime je ograničena njihova konzumacija od strane osoba sa specijalnim režimom ishrane. Navedeni proizvodi namenjeni su isključivo regulisanju digestivnog trakta i stvaranju osećaja sitosti

UNIQUE SELLING POINT USP - UNIQUE VALUE PROPOSITION UVP

TITLE: Super vlakna svojom niskom kaloričnošću predstavljaju inovativan proizvod u svetskim razmerama

DESCRIPTION: Inovativnost super vlakana ogleda se u niskokaloričnosti dijetetskih vlakana oslobođenih svih lako varljivih šećera. Vlakna se dobijaju isključivo iz žitarice tritikale (hibrid pšenice i raži) koja je pored dobrih nutritivnih karakteristika otporna na bolesti, insekte i siromašna zemljišta

MARKET - MARKET TARGET

TITLE: Ciljno tržište u prvoj fazi su MSP koje su voljne da implementiraju inovativnu tehnologiju

DESCRIPTION: Kao krajnji korisnik se definiše široka populacija ljudi koja bi konzumirala konditorske, pekarske i dijetetske suplemente bogate super vlaknima. Zato se kao prvenstveno tržište definišu konditorska i pekarska MSP, kao i farmaceutska industrija

Figure 3. Results of the business opportunity planning tool for “Super fibers”

The Business Opportunity Form tool is designed for gathering information need for understanding and evaluating research results in order to assess the commercial potential. This tool is just partially covered because it requires rather detailed answers (such as financial benefits so far, with sources and contracts attached, optional submission of material transfer or confidentiality contracts, as well as inventor shares) in some parts, that the research group is not willing to share at this time. Moreover, as this team consists exclusively of researchers with limited entrepreneurial experience, there was ambiguity in the exactness and validity of the answers, so for some questions only partial answers were given. The final product of this tool is a concise report of material entered so far, making it very suitable for eventual use in negotiations with potential investors and business partners.

Having in mind the primarily educational character of the entire platform, in its introductory part the tool warns that “the whole exploitation process may prove to be an expensive”, and that starting the complete exploitation process is not recommended when the commercial potential is limited (BOSS, 2020). Therefore, it is important to discern the correct moment. Aforementioned facts thus lead towards a complete summation of the research and point us towards a specific conclusion.

5. CONCLUSION

The process of innovation process is long, complex, rather expensive and risks and requires activities such as business opportunity assessment, strengths and weaknesses analysis, partner identification, strategy decision making so that best tactical alliance can be made, market knowledge, negotiation, managing and marketing activities. As the academic environment is finally accepted as a vital actor in innovation, there is an obvious necessity to develop an entrepreneurial spirit among the scientific research population, so that the concept of an entrepreneurial university, based on knowledge entrepreneurship, can be achieved. The aforementioned facts indicate the importance of intensifying the activities towards economic organizations to recognize that the path to innovation and to competitive advantages leads through cooperation with scientific organizations. Education of the academic community on the need for establishing and nurturing entrepreneurial initiative is of equal importance as well. Progress in innovation, economic development in society as a whole and true sustainability is impossible to achieve without the cooperation of science and economy. Academic environment and the business sector should work together, developing new technologies through joint action and symbiosis.

State and public institutions in the Republic of Serbia intensified activities aimed at establishing an optimal triple helix model and adequate cooperation mechanisms through new organizational models and tax policies in recent years following the trends from European Union. Examples of good advancements include the establishment of the Council for Cooperation of Science and Economy, advanced programs financed through the Innovation Fund, such as the program of co-financing innovations, the program of cooperation between science and economy, technology transfer program, etc. These examples are strengthened with the BOSS platform and its mission to empower the existing system that was designed to support business opportunities and encourage cooperation between universities and industry, as well as further entrepreneurial ideas in the academic environment.

Designed as an open and automated support system, the BOSS platform is a very helpful tool for perceiving business ideas, as well as their conceptualization and adaptation to all stakeholders and potential investors. With further development and improvement, the BOSS platform could become a necessary link between the academic community and the economy, with the potential to become a common ground where these two groups will meet and intertwine. In addition, the BOSS platform can be of use to the general population during the process of submitting various projects designed for different purposes.

ACKNOWLEDGEMENT

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MANAGEMENT OF SUSTAINABLE CITIES – A SINGLE INTEGRATED APPROACH

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Abstract: In the last few decades, cities have been centers with increased economic activity, innovation and jobs. The pace of development of urban areas is accelerating, which leads to the need to focus attention and study the changes that are taking place in cities. The economic, social, cultural and environmental dimensions of urban life need to be intertwined in a single integrated approach in order to achieve economic development, education, social inclusion and environmental protection. The subject of this report is sustainable cities, and its theme is the concept of sustainable development.

The aim of the research is based on a theoretical review and analysis of various statements related to sustainable development in settlements, to present those of them to be used to define conclusions and guidelines for urban development.

Keywords: sustainable, development, cities, environment, concepts

1. INTRODUCTION

In recent decades, cities have been centres of increased economic activity, innovation and jobs. They face the opportunities and challenges of globalization. We are witnessing a steady acceleration in the pace of development of urban areas. This leads to the need to focus attention and study the changes that are taking place in cities. The topicality of the considered scientific issues is related to the increasing role and importance of cities both nationally and globally and their highlighting as a key factor in the expanding concept of sustainable development.

Suburbanization, globalization, environmental pollution (air, soil and water) and scientific and technological progress in all spheres of social development lead to the beginning of sustainable urban development. The economic, social, cultural and environmental dimensions of urban life need to be intertwined in a single integrated approach. The aim of this approach is to achieve economic development, education, social inclusion and environmental protection. The object of study in this report are sustainable cities, and its subject is the concept of sustainable development.

The purpose of the report is, based on a theoretical review and analysis of various statements related to sustainable development in settlements, to present those of them to be used to define conclusions and guidelines for urban development.

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2. SUSTAINABLE CITIES

According to the United Nations Population Fund, in 2019 the world's population is 7,713 468 million people. The most populous continent is Asia, with 4,601 371 million people (about 60% of the world's population). The most populous countries in the world are China (1439,324 million), India (1381,624 million), USA (330,366 million), Indonesia (273,524 million), Brazil (212.739 million), Pakistan (221,408 million), Nigeria (190,96 million), Bangladesh (164,885 million), Russia (144.343 million), Mexico (129,095 million), Japan (125,710 million) and Ethiopia (115,308 million) (Data sources - World Bank, United Nations, Census). Since 1950 until 2020, the average annual change by periods varies from 1,78% to 1,9%. Europe has the lowest annual rate of change.

Table 1. Average annual rate of population change by geographic regions (percent)

	1950 - 55	1960 - 65	1970 - 75	1980 - 85	1985 - 90	1990 - 95	1995 - 2000	2000 - 05	2005 - 10	2010 - 15	2015 - 20
World	1,78	1,91	1,95	1,77	1,79	1,51	1,34	1,26	1,23	1,18	1,09
Africa	2,08	2,44	2,64	2,82	2,78	2,58	2,46	2,44	2,52	2,58	2,51
Asia	1,95	2,11	2,28	1,95	1,99	1,59	1,37	1,23	1,13	1,04	0,92
Europe	0,97	0,95	0,60	0,40	0,37	0,17	-0,04	0,10	0,19	0,18	0,12
Latin America and Carribean	2,65	2,71	2,37	2,14	1,93	1,74	1,55	1,32	1,18	1,07	0,94
Northern America	1,65	1,40	0,95	0,95	0,98	1,02	1,19	0,93	0,96	0,79	0,65
Oceania	2,07	2,07	1,72	1,61	1,64	1,48	1,34	1,39	1,81	1,56	1,37

Source: United Nations Population Fund

According to the United Nations Development Program (UNDP), by 2050 two thirds of all humanity will live in cities, i.e. 6,5 billion people. In 2006, the urban population was only 3,252 billion people, in 2009 – 3,477 billion, in 2012 – 3,708 billion, in 2015 – 3,947 billion and in 2016 it reached 4,027 billion. The term “urban population” refers to people living in cities designated by the National Statistical Services for the country concerned.

Figure 1. shows the percentage distribution of the urban population worldwide. In 2006, nearly 49,5% of the world's population lived in cities. In 2010, it increased to almost 52% (51,646%). While in 2019 more than half of the world's population (55,714%) live in urban areas.

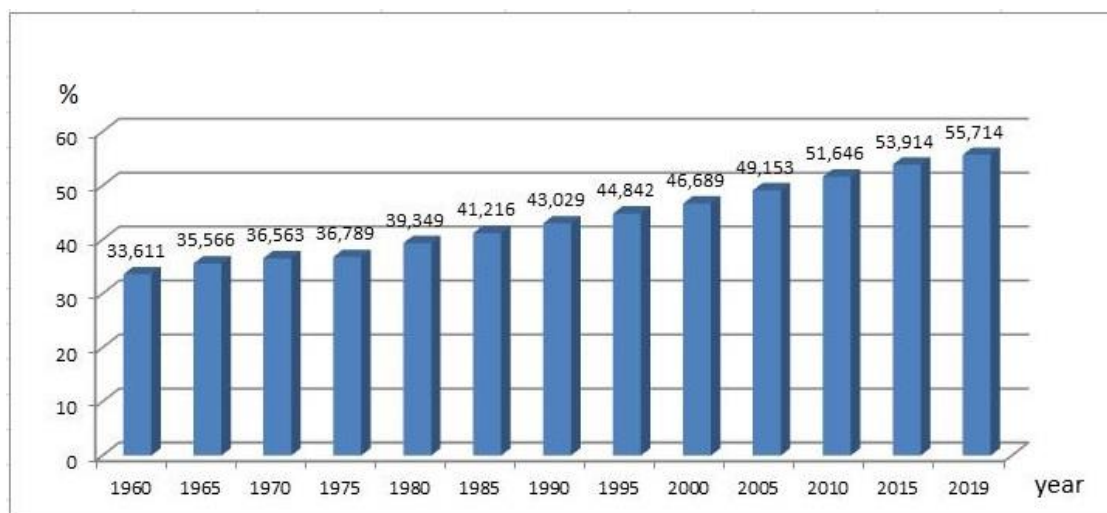


Figure 1. Urban population (distribution in %) during the period 1960 – 2019

In the 60's and 70's of the twentieth century, the lack of resources and the way of distribution of goods are one of the most current topics. They have led to a contradiction in the relationship between nature and society. The latter causes a change in the attitudes and patterns of behaviour of governments, organizations and consumers and unite their efforts. Proper management and conservation of biosphere resources are a top priority of humanity. The concept of "sustainable development" appeared in the late 80's of the twentieth century. By the mid-90's it became one of the most common terms in society and the professional space. In 1987 a report by the World Commission on Environment and Development, "Our Common Future" (WCED, 1987, pp. 43), known as the Brundtland Report, formulates the most famous definition of sustainable development. Sustainable development is one that "meets the needs of the present without compromising the ability of future generations to meet their own needs." The objectives of the concept of sustainable development and its practical dimensions are presented by the World Conference on Environment and Development (UNCED). The "Agenda 21" action program (Agenda 21) states that sustainable development is "a process of change through which the use of resources, investment orientation, technical and institutional changes reach levels of harmony and improve current and future potential for meeting people's needs."

Despite the extreme dissemination of the literature on sustainable development, cities seem to have been largely neglected in the literature on sustainable development (Mitlin & Bicknel, 1992: 2). It is therefore surprising that in the growing literature on environmental sustainability and environmental policy, the urban environment is often neglected or forgotten, as attention is focused on "global" issues such as climate change, deforestation, desertification and the like.

The city is "a large settlement, usually administrative, commercial, industrial and cultural center" (Dictionary of the Bulgarian language). This is the village where a large number of people live, work and have fun. Cities are centers of government, trade and transport. In recent years, one of the most relevant topics in our daily lives is the definition of geographical boundaries of settlements. There are still no standardized international criteria for the coverage of the settlement. In some cases, the city describes the administrative boundary, and in others - the "urban agglomeration", ie. the convergence of nearby urban-type settlements. Urbanization is both an opportunity and a threat to sustainable human

development. This is one of the reasons for introducing a significant change in the construction and management of urban spaces.

Sustainable urban development is emerging in research as a major problem in the development of society in the twentieth century. The role of cities in the pursuit of sustainable development changed sometime in the mid-1990s (Satterthwaite, 1999: 3; Weisz & Steinberger, 2010: 185). Long-term planning is by no means a new phenomenon: visiting the ruins of almost every city of ancient civilizations should illustrate this point. The new literature formulates and addresses new spatial and temporal realities. In particular, destructive urbanization and levels of anthropogenic planetary impact have given rise to this new literature and concepts.

Sustainability arises from the evolution of the relationship between man and nature. The concept of sustainable development in the urban environment provides an opportunity to improve the quality of the economic, social, natural and technological environment. In the long run, it has the opportunity to strengthen the foundations of the urban system. Sustainable cities are cities in which economic and social interests come together in harmony with environmental and energy issues in order to ensure continuity in evolution.

In September 2015, the 2030 Agenda for Sustainable Development was adopted by the world leaders at a UN summit. It is a "plan of action for people, the planet and prosperity." The focus of the program is to create strong links between goals and objectives, develop an integrated approach to implementation, achieve sustainability in all its forms and eradicate poverty. On January 1, 2016, the 17 Sustainable Development Goals, namely poverty, enter into force; hunger; healthcare; education; gender equality and supremacy over women; energy; economic growth; infrastructure and industrialization; inequality; cities; sustainable production and consumption; climate change; oceans; biodiversity, forests and desertification; peace, justice and strong institutions; connections between participants. Objective №11 is to make cities more attractive, safe and sustainable places. A major challenge of modern society is to maintain cities in a way that thrives without negatively affecting resources and the environment. The Operational Program "Growing Regions" (OPRD, 2017) 2014 - 2020 is an integrated operational program aimed at achieving sustainable development of Bulgarian cities. It is funded by the European Union. The set tasks are related to urban development; energy efficiency; educational, health, social and road infrastructure; tourism and technical assistance. The first priority in this strategy is "Sustainable and integrated urban development 2014 - 2020". It focuses on urban regeneration and development, the energy efficiency of different types of buildings (residential, administrative, student), the improvement of the urban environment, infrastructure (educational, social, cultural and sports) and urban transport. Beneficiaries under Priority Axis 1 "Sustainable and integrated urban development" are the municipalities: Sofia - city, Plovdiv, Varna, Burgas, Ruse, Stara Zagora, Pleven, Veliko Tarnovo, Blagoevgrad, Vidin, Montana, Vratsa, Lovech, Gabrovo, Targovishte, Razgrad, Shumen, Silistra, Dobrich, Sliven, Yambol, Haskovo, Kardzhali, Smolyan, Pazardzhik, Pernik, Kyustendil, Svishtov, Gorna Oryahovitsa, Kazanlak, Dimitrovgrad, Asenovgrad, Karlovo, Dupnitsa, Petrich, Lom, Gotse Delchev, Panagyurishte and Velingrad.

3. INDICATORS FOR SUSTAINABLE CITIES

At the beginning of the 21st century, sustainable development is becoming one of the fundamental issues for urban development by governments, organizations and local people. Principles for sustainable development have been developed and implemented in urban

strategies and plans. Creating a sustainable city is a basic requirement and challenge for urban planners.

In 1992, the United Nations Conference on Environment & Development (1992) focused on developing indicators that would serve to make an informed decision on sustainable development. Chapter 40 of Agenda 21 (Agenda 21, 1992) calls on states, together with governmental and non-governmental organizations, to develop indicators for sustainable development and harmonization of electronic standards in their preparation. Four years later, the Commission on Sustainable Development approves the indicators at international level.

In the period 1994-2001, two sets of indicators for sustainable development were developed, which were tested and used by many countries in order to achieve stable growth. An increasing number of organizations are turning their attention to sustainable development in urban areas by developing indicators in the short and long term. Some of them are working on issues related to the health of the population, others - on environmental protection, and others are trying to develop a full set of criteria. The Department for Policy Coordination and Sustainable Development of the Commission for Sustainable Development aims to achieve interaction between all participants. This determines the high importance and relevance of research and deepening of indicators for achieving sustainable urban development.

Indicators and research (models, case studies, etc.) have the task of informing policies aimed at achieving sustainable development in cities. Indicators are a key tool for stimulating urban governance. Their long-term implementation allows for the preparation of ongoing assessments related to the condition of urban areas. The main considerations when using the indicators for sustainable development are aimed at:

- Setting specific goals;
- Data collection through monitoring;
- Achieving efficiency;
- Reporting on global development;
- Improving the relationship between society and the environment;
- Taking into account the following factors - geographical location, people, culture and institutions.

Traditional indicators for sustainable development represent the relationship between the three different segments - economic, social and environmental. Economic indicators include GDP, investment, inflation, government loans and debt, productivity, competitiveness, trade (imports and exports), and more. However, they do not provide the integrity to achieve sustainable development in the economy. For this reason, additional indicators have been developed, namely social and environmental, which have been widely used throughout the world in recent years.

The object of the social indicators are the economic and natural living conditions of the population. They focus on human health, education, poverty, crime and more. Environmental indicators affect the state of natural balance, which include water quality, air, natural resources and more.

Figure 2 presents the main indicators for sustainable development. First, natural resources provide the materials of production on which shareholders' jobs and profits depend. Second, jobs affect the level of poverty, which in turn is linked to crime. Third, the quality of the air, water and materials used in production have an impact on both public health and shareholder profits. Fourth, health problems provoked by environmental pollution environment, have an impact on worker productivity and contribute to rising health insurance costs.

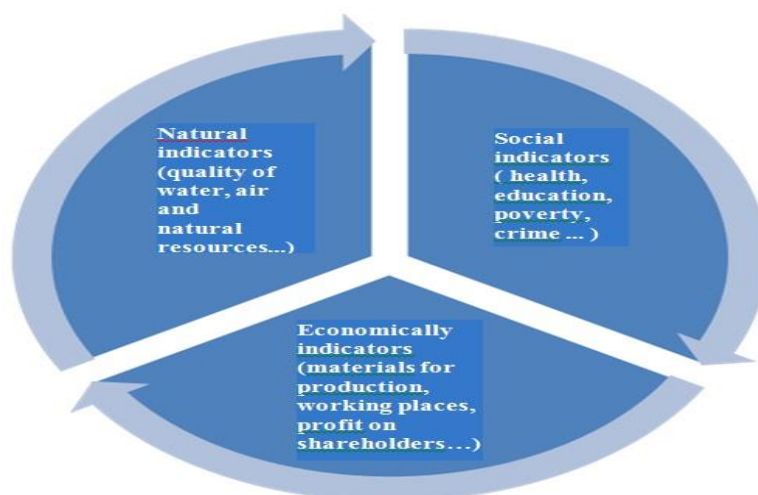


Figure 2. Indicators for sustainable development

In conclusion, there is a strong correlation between the economic, social and natural indicators. They cannot exist and be considered independently. The realization of the set goals is possible through the management of economic development, aimed at the limitations of the planet and social justice. The indicators for achieving sustainable development in cities can be summarized as follows:

- Indicator of urban population (sex, age, birth rate, mortality, migration);
- Indicator of employment on the labour market and unemployment;
- Indicator of income, expenditure, investment and consumption of households;
- Indicator for the right to housing.

4. NATIONAL AND INTERNATIONAL CITIES AIMED AT SUSTAINABLE DEVELOPMENT

In recent years, one of the largest design and consulting companies in the world associated with sustainable cities is ARCADIS. It compiles the Sustainable Cities Index 2016, 2018, which is a complex indicator of sustainable urban development. It uses data from reputable sources such as the United Nations, the World Bank, the World Health Organization and the International Labour Organization. According to ARCADIS, sustainability has three dimensions - people, planet and profit, which reflect the social, environmental and economic sustainability of cities. The index ranks 100 global cities. People are associated with a social factor, namely education (literacy rate and university availability), health (life expectancy, obesity), demographic characteristics, income inequality, opportunities, work-life balance, crime. These are the indicators that take into account the quality of life.

The planet, in turn, is an environmental factor that includes environmental risk, green spaces, energy, air pollution, greenhouse gas emissions, waste management, drinking water and sewerage, sanitation and natural disasters. These indicators are considered as "green factors". The profit is related to economic factors - economic development, GDP per capita, transport infrastructure (various modes of transport and the traffic generated by them), business opportunities, tourism, national and international relations, work, importance of the city.

The latest study, conducted in 2016, shows that cities around the world fail to successfully balance the three dimensions of sustainability. Some of the settlements play a leading role in certain areas, while in others - show low results. This has a negative impact on their overall performance. Table 2 presents the first 10 cities that have the highest indicators in terms of criteria - people, planet and profit. Cities can occupy different positions depending on the requirements, i.e. in terms of profit, Singapore is in first place, but in general terms - in second place. The Swiss city of Zurich is at the top of the rankings. According to the economic factor it is on the 5th position, according to the ecological one - 1st, and according to the social one - 27th. By all accounts, Singapore, the city-state, ranks second, while Stockholm, the capital of Sweden, ranks third. Singapore and Seoul are the only countries that are not part of the European Union and are in the top 10.

Table 2. Indicators of the index of sustainable

Sequence	General indicators	People	Planet	Profit
1	Zurich	Seoul	Zurich	Singapore
2	Singapore	Rotterdam	Stockholm	Hong Kong
3	Stockholm	Hamburg	Geneva	London
4	Vienna	Vienna	Vienna	Dubai
5	London	Berlin	Frankfurt	Zurich
6	Frankfurt	Prague	Wellington	Edinburgh
7	Seoul	Amsterdam	Rome	Prague
8	Hamburg	Munich	Sydney	New York
9	Prague	Muscat	London	Paris
10	Munich	Montreal	Hamburg	Stockholm

Source: ARCADIS

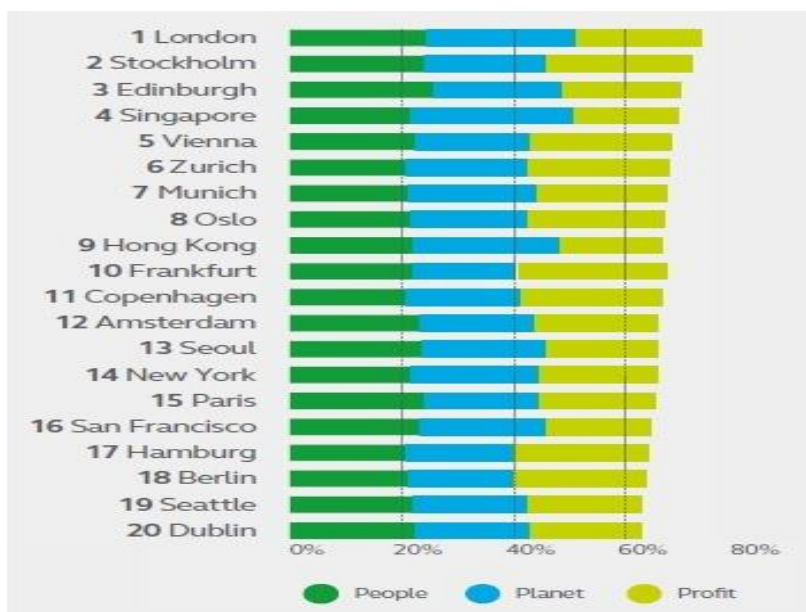
The Sustainable Cities Index ranks 100 global cities in three pillars of sustainability: People, Planet and Profit. The three pillars are closely linked to the UN Sustainable Development Goals (SDGs). They monitor progress on UN SDG commitments covering:

- Health and well-being;
- Water and sewerage;
- Industry, innovation and infrastructure
- Sustainable cities;
- Impact of climate change;
- Life on land;
- Partnership.

London tops the index, ranking second in terms of both people and profit, as well as 11th relative to the Planet sub-index. London is one of the few highly efficient balanced cities in the Index with similar results on the three pillars.

The highest ranked cities rank well in one or two pillars. This is illustrated by Singapore and Hong Kong. The two cities that are in the top 10 are led by a very high profit ranking and occupy a middle place in the People and Planet ranking. Most of the top 10 cities have very high results on the planet - these are cities in Northern Europe, namely Stockholm

and Frankfurt, which have achieved great success in combining economic prosperity and environmental management.



Source: ARCADIS

Figure 3. Overall Index Rankings, 2018

The concept of sustainable development affects citizens both internationally and nationally. Bulgaria is one of the countries striving to achieve sustainable and harmonious development of urban areas. It needs to focus on achieving economic growth, social responsibility and environmental protection. Since the beginning of the XXI century, many plans, programs and strategies related to a healthier lifestyle have been developed and implemented, namely: National Development Program "Bulgaria 2020"; National Strategy for Sustainable Development of Tourism in the Republic of Bulgaria; Operational Program "Growing Regions 2014-2020"; Operational Program "Environment 2014-2020"; National Strategy for Environment (2009-2018); Operational Program "Human Resources Development" 2014 - 2020, Operational Program "Science and Education for smart growth" - function "Education", etc. In the next few lines are considered plans and programs related to sustainable development of Sofia, Varna, Burgas, Veliko Tarnovo and Ruse. The program "Green Sofia" 2017 is related to motivation and participation of citizens in projects for improvement and improvement of green spaces on the territory of the city of Sofia. It is aimed at landscaping and construction of colourful spaces, design of recreation and communication areas in green areas, surrounding areas and gardens, and to provide appropriate equipment necessary for the implementation of the above activities and the subsequent maintenance of the sites. Opportunity for this is provided to registered condominium owners, non-governmental organizations and community centres. The Sustainable Urban Mobility Plan is a strategic document at a lower hierarchical level for the development of the transport sector with a long period of implementation.

The main goal is to optimize the transport system of Bulgarian cities. Some of them are Burgas with a period of action from 2014 to 2020, Veliko Tarnovo - from 2015 to 2020 and Ruse - from 2016 to 2026. Since 2012, the "Strategy for Sustainable Energy Development of the Municipality of Varna 2012-2020" has been applied. Its main goals are divided into four priorities, which are related to: 1) rehabilitation, modernization and construction of

infrastructure, which provides the conditions for sustainable growth and employment; 2) development of sustainable urban mobility systems; 3) increasing the share of energy produced and used from renewable energy sources; 4) increasing the management capacity of stakeholders and improving public awareness of energy efficiency programs.

5. CONCLUSION

In recent years, sustainable cities are widespread used a concept that has an increasingly strong influence on global policy planning and design. Nowadays, resilience is not limited to protection of the environment, and is aimed at achieving a stable and lasting relationship between economic, social, cultural, environmental and political factors.

There are many definitions in the modern literature related to the concept of a sustainable city. However, there is no generally accepted definition, which makes it difficult to understand, study and interpret this concept. Sustainable cities are in the stage of development, renewal and enrichment. In summary, a sustainable city should focus on better living, working, housing, health, energy and the environment for both current and future generations.

Building sustainable cities in the national and an international plan requires certain criteria. First, support from each country through additional investments in renewable energy sources. Second, achieving efficiency in the use of water and electricity. Third, design and build compact, sustainable cities. Fourth, achieving a balance between built-up area and green spaces. Fifth, fast, reliable and efficient transport. Sixth, improvement and management of waste and recycling systems. Cities in poor countries need resources to support economic, social and environmental development. This can be achieved by creating, implementing and managing plans and programs targeting cities around the world.

ACKNOWLEDGEMENT

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TECHNICAL COMMITTEES AS PART OF THE QUALITY INFRASTRUCTURE IN SERBIA

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Abstract: Quality infrastructure (QI) is composed of an institutional complex that encompasses services of metrology, standardization, certification, accreditations, and conformity assessment. When it comes to standardization, standards are adopted, prepared, and translated by technical committees. This paper strives to analyze the work of members of committees at the Institute for Standardization of Serbia to show the structure of QI experts considering their position, type, size, and innovativeness of their organizations and number and length of engagement in the committees including it's a category. The results showed that most members of the committees work in large organizations, in executive positions, and see their organizations as innovative. The dominant activity of the organizations in which the respondents work belongs to the electricity and mining industry. Most experts are engaged in only one commission for a period of up to 3 years or more than 10 years, respectively. When it comes to certain committees, one of the most numerous is CASCO (Conformity Assessment Committee).

Keywords: Quality Infrastructure, Technical Committees, Standards, Experts

1. INTRODUCTION

Recently, frequent and accelerating changes can be noticed in the field of standardization. Such changes are noticeable both at the international and at lower levels of standardization. There are many new areas of human activity that are covered by standards. Up to date, ISO has developed and published over 23,355 different standards that touch on almost all aspects of everyday life (ISO, 2015). According to (World Standards Cooperation, 2000), so far the focus has been on the benefits that standardization brings to an industry or the economy. In parallel, many standards have a direct approach and impact on the general public. This includes "traditional" standards for users and the workforce, such as standards for household appliances, for the safety of machinery or signs and symbols, as well as newer standards for sustainability, energy efficiency, social responsibility, or services (Blind, 2004). Thus, if interested parties representing these mentioned aspects participate, the standards will have an impact on the needs and expectations of the general public in terms of safety and security, labelling, accessibility, equity, and sustainability as social and environmental dimensions (Blind & Thumm, 2004). The bodies that work directly on the adoption of standards are the technical committees for standardization. The adoption of standards alone

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would be meaningless without a properly regulated quality infrastructure, which in addition to standardization includes other elements such as accreditation, metrology and certification. Therefore, the goal of this paper is to research the activities of technical committees at the Institute for Standardization of Serbia in order to closely present the structure of QI experts.

2. THEORETICAL FRAMEWORK

2.1. QUALITY INFRASTRUCTURE

In order to promote trade, break down technical barriers, and improve industry competitiveness, particularly in developing countries, quality infrastructure enters into force (Li et al., 2019). It is essential in pointing out factors in the greater integration of one country into the international trading system (Ruso et al., 2017). The quality infrastructure consists of an institutional complex, needed to overcome the relevant information asymmetries, which includes services in the field of metrology, standardization, conformity assessment, certification and accreditation (Peuckert, 2014). It is usually state concern, taking into account that all QI institutions and organizations are predominantly owned by the state except certification bodies (Ruso and Filipovic, 2020). Each component of the quality infrastructure individually and all together they are key to production and trade and are closely linked.

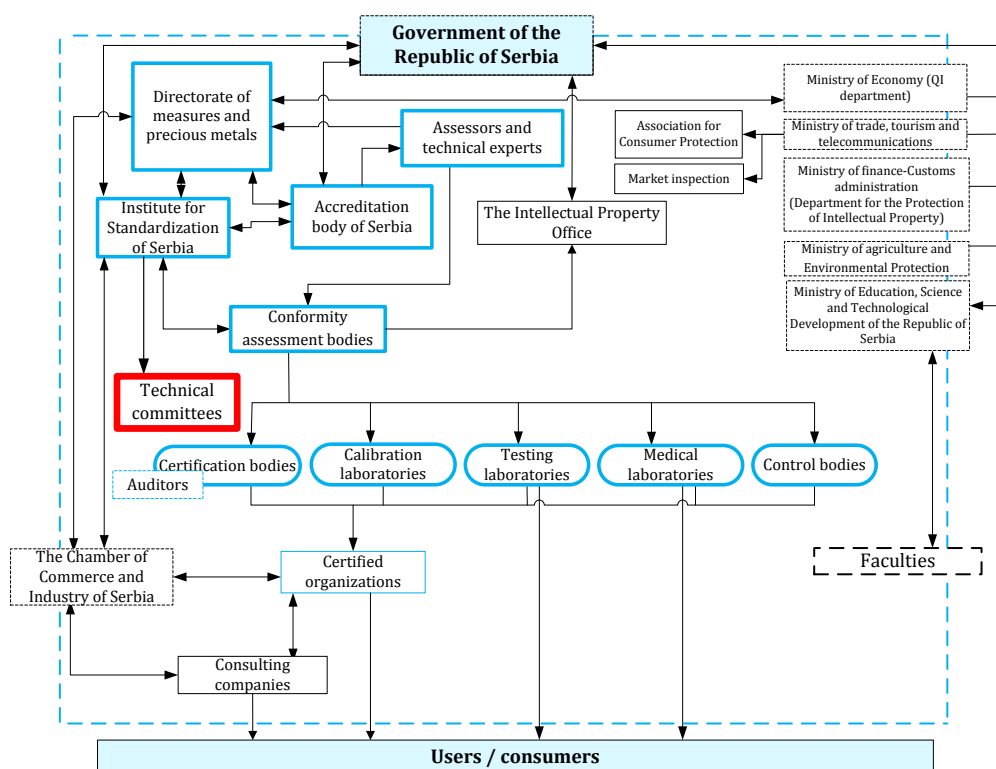


Figure 1. Quality infrastructure institutions (Ruso et al.,2017a - modified)

Metrology is the science about measurement and "provides the scientific and technical basis for standardization and conformity assessment" (Yoo, 2019). Standardization is a set of coordinated activities on the adoption of standards and related documents, while conformity assessment provides that the specified requirements relating to process, system, person or

body are met (ISO, 2004). Finally, accreditation is an accepted process by which a third party gives formal recognition that the organization is competent to perform certain tasks (Castanheira et al., 2007). The element that connects all these activities as a whole is the standard - publicly available document which sets out the rules, requirements, characteristics, instructions, recommendations or guidelines for activities or their results in order to achieve the optimal level of regulation in a particular area (ISO, 2004a).

Certain state institutions in the Republic of Serbia are responsible for the implementation of all these activities of the national quality infrastructure, such as the Accreditation Body of Serbia, the Directorate for Measures and Precious Metals and the Institute for Standardization of Serbia (technical committees) and others (Figure 1).

2.2. THE WORK OF TECHNICAL COMMITTEES

The activities on the adoption of Serbian standards takes place in national technical committees at Institute for Standardization of Serbia, which are formed according to international and European technical committees - one technical committee for each technical area (ISS Serbia, 2020). The technical committees are staffed by experts from various organizations interested in technological and other solutions in the field. These experts represent their organization. Technical committees develop a plan of priority issues which solutions should be standardized (Lisica, 1985; Blind & Mangelsdorf, 2012). Before the definitive solutions are adopted, the institution sends the proposed solutions to its members for consideration and voting, so that the adopted solutions reflect the interest of all members (ISS Serbia, 2020). Despite the openness of the standardization process, weaker interested parties such as users and SMEs are still struggling to participate adequately in these processes (Blind & Mangelsdorf, 2012). Also, according to the European Committee for Standardization and the European Committee for Standardization in Electrical Engineering (CEN-CENELEC, 2010), the concept of "regulatory closure" is a major obstacle for standardization bodies and refers to the ability of influential technology manufacturers to act towards standard development to ensure that their project "works" for their benefit.

3. METHODOLOGY

In cooperation with the Faculty of Organizational Sciences, the University of Belgrade and the Institute for Standardization of Serbia, a research was conducted among experts who actively participate in the development and adoption of national standards in Serbia. There are 163 technical committees that are actively working at the Institute. The key selection criterion was the activity and commitment of the respondents in the work on the adoption of national standards within their committees. A total of 300 questionnaires were sent by e-mail, of which 120 were filled in correctly, which represents 40% of the total number of distributed questionnaires. Thus, it can be considered that the sample of good response in accordance with other studies (Graca et al., 2015). For example, response in the US was 13.22%, while in Brazil it was 7.2% (Homburg et al., 2015). Out of 1000 sent questionnaires received 178 correctly filled in of which 12 out of 1000 questionnaires were not delivered. Thus, the overall response rate is 18.0% (Homburg et al., 2015). In addition to questions from the demographic block, the experts answered a set of questions about the quality of their work in the committees. The questions were concerned about the usage of modern technologies for the work of committees, participation in decision-making, in creating programs and work of the

committee, access to relevant documents, as well as a commitment to the work of the committee through serious preparation for each meeting. A five-point Likert scale was used for the answers.

4. RESULTS

4.1. DESCRIPTIVE STATISTICS

According to the obtained results, large and medium-sized organizations participate in the standardization processes in Serbia to the greatest extent (Table 1), which shows that they have the greatest awareness of the advantages of participating in the work of standards committees, but also the greatest influence in the work of technical committees. Therefore, special support is needed for SMEs to avoid developing standards based on the interests of powerful and influential interested parties.

Table 1. Demographic profiles and descriptive statistics of respondents (Trajković & Milošević, 2018 - modified)

Characteristics	Frequency	%	Cumulative %
Organization size			
Micro	18	15.7	15.7
Small	23	19.1	34.8
Medium	32	26.1	60.9
Big	47	39.1	100.0
Total	120	100.0	
Innovativeness			
No innovative organizations	15	12.2	12.2
Innovative organizations	105	87.8	100
Total	120	100.00	

According to the results of the research, the organizations whose representatives took part in the research belong, among other things, to the following activities: electricity, gas, steam and air conditioning supply; traffic and storage; mining; education; manufacturing industry; public administration and defense: compulsory social insurance; professional, scientific, innovative and technical activities; administrative and support service activities; agriculture, forestry, fishing; water supply, wastewater, control; wholesale and retail trade; information and communication; health and social protection.

Respondents also answered about what position they were engaged in their organizations, and the following data have been found (Figure 2).

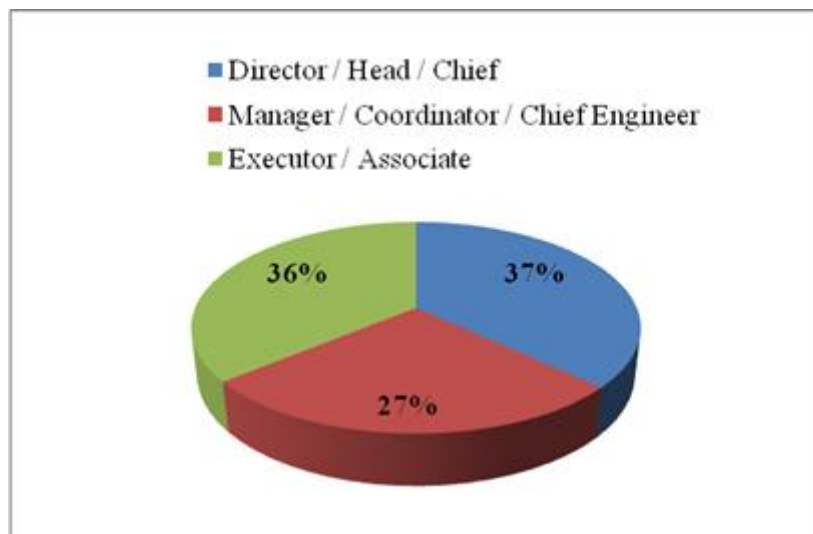


Figure 2. Workplaces of respondents

In order to see which respondents' positions are most often represented in certain committees, the data show that in the CASCO (Conformity assessment and quality management) committee 50% of members are in positions such as Director, Head or Chief, 25% of them have managerial positions and 25% of experts are in executive positions. On the other hand, in N020/81 (Electric cables) and Z226 (Road traffic lights) committees are more executive/associate positions.

Most experts are engaged in only one commission for a period of up to 3 years or more than 10 years, respectively. The results also show that respondents, regardless of their time/years spend in committees, are most often engaged in only one of them. However, those who are engaged in two or three committees are mainly professionals who have more work experience in this type of work (Table 2).

Table 2. Number of years of engagement in committees * Number of committees in which respondents are engaged

		Number of committees in which respondents are engaged		
		1	2	≥3
Number of years of engagement in committees	0-3	86,4%	11,4%	2,3%
	4-6	60,9%	30,4%	8,7%
	7-10	64,7%	23,5%	11,8%
	>10	48,3%	31,0%	20,7%

When it comes to organizations in which members of committees work, the most represented are from the mining and electricity industry, followed by public administration and public companies, while the least represented institutions are testing and calibration laboratories and organizations that distribute/produce consumer goods. Also, most respondents work in large and medium-sized enterprises (Figure 3).

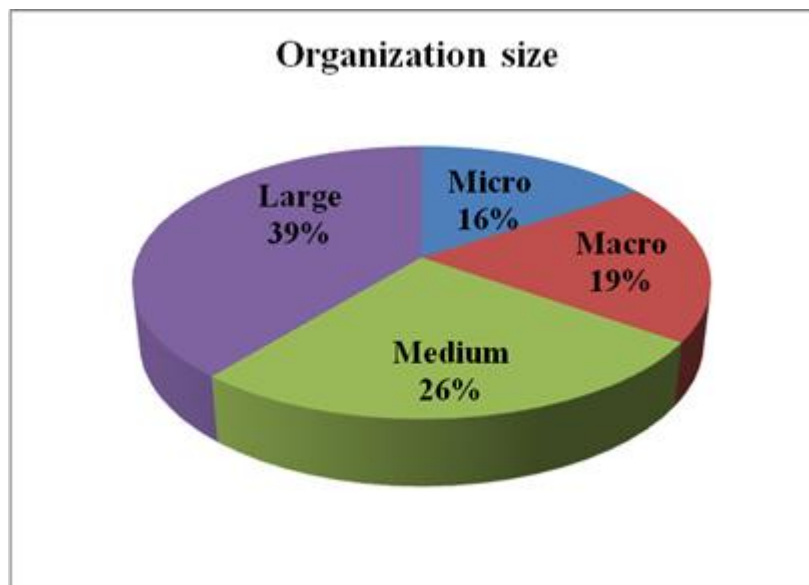


Figure 3. Organization size

Finally, the majority of respondents declared their organizations to be innovative (88%). Experts who stated that their organization is non-innovative are generally engaged in only one committee, while those who consider themselves to work in an innovative environment are deployed not only in one but in several committees (Table 3).

Table 3. The innovation of the organization * Number of committees in which the respondents are engaged

		Number of committees in which the respondents are engaged		
		1	2	≥3
The innovation of the organization	Innovative	66,0%	24,7%	9,3%
	Non-innovative	78,6%	7,1%	14,3%

5. DISCUSSION AND CONCLUSION REMARKS

The experts gave their opinion on the quality of work of the technical committees at the Institute for Standardization of Serbia. The members of the committees confirmed that their committee uses modern technologies to identify market trends in order to develop standards in their field of work and to use modern information and communication technologies in order to increase the effectiveness of meetings and discussions. Over 80% of experts confirmed that they are carefully preparing for each meeting of the committee, which is certainly a prerequisite for proper work on the development of our national standards.

Also, modern information and communication technology used to improve communication between geographically distant communication partners was confirmed. An important factor in the development of standards is to ensure the completeness of information on standards, and on this question from the questionnaire, experts had a positive attitude about it.

There is a positive attitude in the engagement and taking of active participation of the members of the committee in the development and determination of the work program and annual plans of its committee, as well as in the participation in decision-making. When it comes to joining the relevant funds of literature and information, the members of the committee expressed a positive attitude on this issue, a significant majority confirming such views. With the documents of international and European committees, the approach is relatively better than with the documentation funds of the information system of the Serbian Institute. Experts expressed a positive opinion on the impact they have in the field of standardization, as members of the committee of the Institute for Standardization of Serbia, with an extremely high percentage of agreement (72.4% agree).

Regarding the participation of members of the committees in the stages of development of international and European standards, the opinion of experts is divided, and there is a significant opportunity and chance for Serbia to take a more active part in regional and international standardization processes and enable its economy to develop better and follow trends in step with developed countries.

Namely, in real circumstances, in the process of development and adoption of standards, various experts are involved, and they are referred to each other, to permanent communication regarding common issues and problems that arise during the submitted documentation concerning the new standard. Therefore, it is not good to single out individuals, because that would reduce the quality of communication, set certain obstacles and create a climate for insufficient knowledge about what other members of the committee are doing. This would jeopardize the interest of the members of the committee and their motivation to work.

Due to all the above, it is necessary to make a balance in structuring the subjects of standardization, respecting the principle of involving all interested parties in order to adopt standards that will be suitable for everyone through standardization processes.

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GUIDELINES FOR TRANSITION FROM SURVIVING STRATEGIES TO SUSTAINABLE REGIONAL DEVELOPMENT OF BULGARIAN BLACK SEA CITIES

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Abstract: The report reviews the post-totalitarian development of the Bulgarian Black Sea cities. Special emphasis in the study is placed on the problems in the development, ecology and infrastructural improvement of the big cities on the Bulgarian Black Sea coast - Varna and Burgas. The problems - ecological, structural and socio-economical of the smaller Black Sea municipalities - Shabla, Obzor, Nessebar, Pomorie and others are partially considered in the summary. Based on the problems of urbanization in the conditions of the socialist totalitarian system in Bulgaria, conclusions and findings are made about the nature and peculiarities of the formed urban communities in the post-totalitarian period of the development of the Republic of Bulgaria. The thesis is defended that the future development of the Bulgarian Black Sea cities should be based on environmental friendliness and sustainability. They should strive for a coastal fluidity, with a transition from one urban environment to another, with a panorama of a cultural collage that combines the national aspects of urban environment and architecture with the challenges of technology and modern transport and communication infrastructure. An attempt has been made to highlight the positive and negative changes in the development of the Black Sea cities over the last three decades. The changes should create conditions for sustainable prosperity both in our large sea ports - Varna and Bourgas, and in the small Black Sea resort towns.

Keywords: sustainable development, transition from central to market economy, maritime economy, problems of urbanization, ecology

1. INTRODUCTION

In the conditions of established market relations in the Bulgarian national economy, the need for a comprehensive reassessment and reorientation of regional policy on a national scale comes to the fore. Such reorientation is especially necessary for the cities of the Black Sea region, due to their role in strategic for the development of the Bulgarian economy industries such as water transport, tourism, construction, trade, extraction of marine resources and in general due to their position as centers for development of modern Bulgarian maritime economy.

Both of the largest Black Sea cities of the Republic of Bulgaria - Varna and Burgas - grew significantly during the socialist period - after September 9th, 1944 Varna was the city

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with the largest mechanical growth in the Republic of Bulgaria. On September 9th, 1944 the population of the city of Varna was 45,000 people. In 2007, when the Republic of Bulgaria became a member of the EU, the city of Varna officially numbered 710,000 people. This is an increase in city residents more than 15 times. The growth rates of the city of Burgas are similar, which for the period from 1944 to the beginning of the Millennium became the fourth largest city in Bulgaria, after Sofia, Varna and Plovdiv.

The rapid and uncontrollable pace of urbanization under socialism was predetermined by the rapid growth of consumption under socialism. This consumption is essentially mass, uniform, standardized and therefore defective and of poor quality of goods and services. This gives rise to a specific Bulgarian socialist phenomenon - the DIY (do it yourself) movement. Bulgarian citizens try to provide themselves with consumer goods by making the necessary repairs, improvements and productions in the personal farm. Low incomes are complemented and compensated by the process of "naturalization of incomes". Almost every household has a small farm, which produces some of the products needed for consumption - fruits, vegetables, poultry, eggs, milk and more.

The logic of capitalism is the opposite: under capitalism, competition between producers requires an increase in the quality of products produced and services rendered. The increased quality of goods and services leads to higher prices. As a result, extras are constantly being created for all kinds of goods. New models of various goods are designed, fashion trends are set. This presupposes specialization of activities and continuous growth of the used services - communal, repair, construction, supply, information, administrative, etc. The market for services under capitalism is highly developed, while in the socialist system it is very limited and almost non-existent.

The Bulgarian socialist worker, on the other hand, cannot rely on the services market. Even if he pays for the service, he is not sure that it will satisfy him in terms of quantity and quality. That is why the socialist reality introduces something like an additional currency - the supplement under the table. These are barter services, or extra money over the price and other corrupt practices. It turns out that cheap mass consumption under socialism requires extra work - everyone has to build a kind of informal trade network to survive.

"The unexpected effect of these informal trade networks - according to Ivaylo Dichev - is the general stabilization of the system¹: people become much more dependent on each other. Any form of resistance marginalizes man, excluding him from the forms of gift exchange, just as unemployment marginalizes people in developed Western countries. In other words, "defective" consumption of low-quality and defective goods produces sociality. You have to constantly expand the perimeter of the alliances to multiply your resources - and although the basic building material of solidarity is traditional, the big city multiplies possible connections between people, combines kinship and politics, fellowship and generational fashions, etc." (Dichev Ivaylo, 2005)

This "socialization" of the big Bulgarian cities inherited from the recent totalitarian past (including in cities like Burgas and Varna) is preserved as a tradition (especially in terms of corruption) in the post-totalitarian period. Moreover, this socialization and resilience is reinforced by the increased opportunities for the inhabitants of large cities to join informal groups (which were banned by the authorities under socialism). These are such informal groups as hunting parties, professional guilds, elite clubs, private associations, etc. Another thing that strengthens the socialization and sustainability of life in big cities are the

¹ This refers to the urban system in the big Bulgarian cities in the conditions of totalitarian socialism in Bulgaria.

opportunities for larger sales and distribution projects for more enterprising urban residents, mainly in the field of direct marketing and social entrepreneurship.

2. MACROECONOMIC MANAGEMENT OF THE BULGARIAN BLACK SEA COAST

The past period of over three decades since the beginning of the democratic changes in Bulgaria has radically changed the realities in the Bulgarian Black Sea cities. Historically, they were formed under different conditions and have different natural and demographic features. The common thing that unites them is their location in the coastal strip of the Bulgarian Black Sea coast and their connection with the sea and the Black Sea ecosystem.

The changes that have taken place in the context of the transition to a market economy have both positive and negative dimensions.

2.1. POSITIVE CHANGES IN THE BLACK SEA CITIES DURING THE TRANSITION TO A MARKET ECONOMY

At the present stage, the positive changes are relatively small and have little effect in the direction of improving the environmental situation. Rather, they are reflected in certain negative processes such as redevelopment of resort areas, pollution and destruction of unique ecosystems in the few remaining pristine beaches such as Irakli, Ropotamo, Perla and others.

2.1.1. Shrinkage of industrial production in the Black Sea region of the Republic of Bulgaria

The most significant positive change in the ecological situation on the Bulgarian Black Sea coast is the drastic reduction of industrial production, mainly in the northern Black Sea cities and mainly in the Varna-Devnya industrial agglomeration. The liquidation of entire structurally defining industries for the region, such as shipbuilding, production of internal combustion engines, radio electronics, heavy chemicals, as well as limiting electricity production to a minimum volume needed to cover the peak moments in the load of the country's energy system, lead to natural results: reduction of pollution of river and sea waters; to less harmful emissions into the air and to reduction of soil pollution.

The largest shipyard in the Republic of Bulgaria - the Varna Shipyard - has not been operating for almost two decades. The last buyers - Bulyard Shipbuilding Industry AD still cannot reach even half of the operational capacity of the former shipyard. Today the capacities of Bulyard Shipbuilding Industry AD are used only for ship repairs. The last ship to come down from the berths of the Varna Shipyard was the ship Persenk in 1998.

The largest Thermal power plant (TPP) on the Balkan Peninsula - TPP - Varna has long been operating at reduced capacity. Of the six generators of 200 megawatts of power, only one operates in minimum power mode only to cover the load at peak hours. The power plant, adapted to work with coal from the Donbas coal mining region, turned out to be unprofitable in the new conditions of market reorientation and economic restructuring.

Coal supply itself is irregular, given the complex situation in Ukraine. It relies on stocks from past periods and on occasional deliveries from different countries. For the time being, the plant's capacities are included in the so-called "Cold Reserve", as an opportunity to

meet crisis moments in electricity generation and electricity supply. The latest instructions of the Prime Minister of the Republic of Bulgaria are to disconnect TPP Varna from the Cold Reserve and to use Cold Reserve only from the state power plant - Maritza-East-2 if necessary. The decision was prompted by the fact that the government has been accused by the opposition of diverting funds from the budget to the owner of Varna TPP - former politician and current businessman Ahmed Dogan. The contract for maintenance of "Cold Reserve" from TPP "Varna" is for BGN 54 million per year (about 27 million euros).

2.1.2. Ecomanagement in Varna region

In Varna region, which is controlled by the Regional Inspectorate for Environmental Protection and Water (RIEW) - Varna, 464 sites have been built and are functioning, which are potential and active sources of air pollution. Atmospheric air treatment facilities operate in only 163 of the above-mentioned sites. 329 autonomously operating facilities purifying the differentiated gas streams have been installed in these sites. Of these 329 facilities, only 304 operate effectively. The remaining facilities are characterized by an unsatisfactory cleaning effect. Reconstruction and modernization, as well as complete replacement are needed for the air purification facilities in TPP Varna, a large part of the electrostatic precipitators of the enterprise "Deven" AD, the facilities of the production association "Agropolichim" AD in the town of Devnya, the furnaces for incineration of hospital waste of the university hospital. "St. Anna", the hospital "St. Marina" and the hospital in Dobrich, the treatment facilities of the plant for microproducts "Kaolin" AD in the village of Ignatievo and the asphalt bases of the enterprises: "Road Construction" AD Dobrich; Roads and Bridges AD Varna and Roads and Bridges AD Provadia.

The fact that the Republic of Bulgaria finds itself outside the network of gas highways has a positive side in environmental terms. In practice, Bulgaria is not on the gas map of Europe. This is not good for the national economy and for the economic development of the country, but it definitely has positive effects on the protection of the environment and ecosystems. The implementation of the South Stream project would lead to large-scale construction in the Varna Black Sea region, which would inevitably have a negative impact on the adjacent resort areas south of Varna.

2.1.3. Ecomanagement in Dobrich region

In Dobrich region, which is represented by several small towns and villages on the Black Sea coast, one of the last eco-projects is the one launched on November 19th, 2019. project for closure and reclamation of the landfill for municipal waste in the municipality of Shabla. The investment amounts to BGN 2,284,235, incl. BGN 2,192,211 for technical reclamation, which are provided by the Enterprise for Management of Environmental Protection Activities (EMEPA), and BGN 92,024 for biological reclamation, which are at the expense of the Municipality of Shabla (<http://ecology-bulgaria.com/article/2697-startirizipalnenieto-na-proekta-za-zakrivane-na-depoto-za-otpadaci-v-shabla>).

As a positive fact for the Bulgarian economy can be assessed the fact that cities such as Burgas and Pomorie retain to some extent the industrial production, incl. and the production related to the extraction of marine resources (the Black Sea salt pans in Pomorie and Burgas). In Burgas, oil refining, machine building, metallurgy, ore mining and

shipbuilding are the main pollutants of the ecosystem, including the waters of the Burgas Bay, as well as the lakes: Atanasovsko Lake, Mandre Lake and Lake Vaya.

2.1.4. Ecomanagement in Burgas region

"One of the industrial giants of heavy chemistry in the Republic of Bulgaria - Lukoil Neftochim" - Burgas has invested over \$ 35 million in treatment plants since 2014, which reduce harmful emissions into the air. Reconstruction and modernization of an existing boiler have been carried out in the plant, and a filtering system has been installed. The technology is of a new generation in the field of oil refining and this is one of its first applications within the EU. It reduces emissions from catalyst dust several times compared to the equipment used so far." (investbg.government.bg/bg/sectors/news-n21-934.html)

For a short time in small southern towns such as Tsarevo (formerly Michurin), part of the industrial production was preserved by producing coupes for the licensed production of Renault cars in the neighbouring Republic of Turkey. To date, this production has been terminated.

One of the last investments in improving the ecological environment in the Burgas region is from March 19th, 2020. When a project for reclamation of a landfill for solid waste in the town of Obzor, Nessebar municipality in the Burgas region started. The project has a total value of BGN 1,254,410.89, of which BGN 1,066,249.26 is a grant from the European Regional Development Fund (ERDF) and BGN 188,161.63 is national co-financing.

The purpose of this eco-investment is to carry out technical reclamation of the decommissioned landfill for solid waste in the land of Obzor. The implementation of the project will provide an opportunity for the subsequent improvement of the landscape and for the restoration of the suitability of the terrains for agricultural or forest use (<http://ecology-bulgaria.com/article/2717-startira-rekultivaciia-na-depo-za-tvardi-bitovi-otpadaci-v-obzor>).

2.2. NEGATIVE CHANGES IN THE BLACK SEA CITIES DURING THE TRANSITION TO A MARKET ECONOMY

Unfortunately, the negative effects of the transition from a centrally managed economy to a market economy are much greater.

The accelerated development of industry in the 70s and 80s of the last century in the Black Sea cities of Bulgaria and especially in the region of Varna and Burgas (electrical production, heavy chemical industry, petrochemical engineering, shipbuilding, electrical industry, cement industry, locomotive production and wagons, etc.), has led to a sharp rise in water consumption and the formation, as a logical consequence, of huge volumes of polluted water. In this regard, the complex and rational use of groundwater and surface resources, as well as the fight against pollution of water bodies and marine waters, is becoming important. One specific danger of pollution of the largest water basin touched by the Republic of Bulgaria - the Black Sea - is oil. The research of the Specialized Laboratory of the Oceanological Institute of the Bulgarian Academy of Sciences found that only 30 grams of gas oil are completely sufficient to destroy 300 units of plankton per 1 cubic meter of water. Statistics show that 10% of the oil that is extracted from the water and 1% of the oil and petroleum products that are transported by sea fall into sea and river waters. In this way, these pollutants degrade water quality, pollute a huge area of the sea area and the coastline and at the same time cause irreparable damage to marine and river flora and fauna.

2.3. ACTIVITIES ENSURING THE SUSTAINABLE DEVELOPMENT OF THE COASTAL REGION

All these data show the need for an integrated approach to protect and maintain the purity of sea and river water. Here are some activities that can ensure the sustainable development of the coastal region in the direction of purification and decontamination of sea and river waters from the Black Sea region:

- the creation of new high-efficiency treatment facilities and modernization of existing ones;
- reduction of the norms of industrial water use, liquidation of the water losses during the production processes and the introduction of a closed cycle of water use;
- strengthening the control and self-control of the maintenance of the water quality in the points of water use and water discharge;
- the discovery of own water sources in the economic structures and their rational use;
- prevention, non-admission and timely elimination of pollution on the Black Sea coast by ships and coastal pollutants.

Particularly sensitive to industrial expansion is another very important ecosystem - forests, along with the surrounding terrain, natural landscape, flora and fauna. The main principle in the creation, growth and use of forests should be the strengthening of their protective, recreational, water regulatory and other environmental functions. This means that forests should not be seen only as a source of wood. It is good to remember that they are a major source of oxygen enrichment. They are also a protector of mountainous and steep plots and areas of erosion, and are also an important nature-forming and conservation factor of wild flora and fauna. The forests are also the most majestic and beautiful ornament of nature and an indispensable place for rest and relaxation. It is necessary to start from these positions when planning and implementing measures for forest protection and enrichment of the forest fund.

3. SOCIO-ECONOMIC CONSEQUENCES OF THE DEINDUSTRIALIZATION AND DEPOPULATION OF THE BLACK SEA REGION IN THE REPUBLIC OF BULGARIA

The deindustrialization of the northern Black Sea region frees large masses of people from the industrial sector. The service sector and the tourism business are unable to compensate for rising unemployment. People are looking for an opportunity to get their land back and work that land as small farmers and tenants. Lack of experience in agricultural production makes their efforts ineffective. For the first two years of the SAPARD program, for example for the agricultural sector, only 6% of the funds have been used and only 29 projects have been launched. With the accumulation of experience in design, the situation in the agricultural sector tends to improve, but the industry is still far from optimal in the absorption of EU funds.

High unemployment creates demographic and social problems, especially in small northern Black Sea towns such as Shabla, Kavarna and Balchik.

3.1. ASYMMETRY IN THE DEVELOPMENT OF LARGE AND SMALL BLACK SEA MUNICIPALITIES

Since totalitarian times, the practice of large municipalities, which already have higher revenues from local taxes and fees, to receive a larger state subsidy than the small Black Sea municipalities has been preserved. The end result is an ongoing and growing asymmetry in development and in the ability of municipalities to solve important and priority problems.

The result of the limited financial possibilities is the impossibility to keep the coastal zone in the small municipalities clean and ennobled. Due to lack of funds, the coastal protection measures have been suspended for years, as a result of which the sea erosion annually takes away part of the land in the northern regions of the Bulgarian Black Sea coast (around the Yaylata wildlife sanctuary near the village of Kamen Bryag, Dobrich region). The coastal fortifications in front of the park-museum of the summer residence of Maria Theresa in the town of Balchik are relatively recent.

As the famous architect Jan Geel notes, “there are differences between the needs and opportunities of rich and poor cities. It is important for developed countries to pay more attention to social sustainability as a key element of a well-functioning and attractive city.

In low-income societies (such as Bulgarian society - MT) the problems are much more urgent, as the gap between rich and poor is huge, and widespread poverty limits the opportunities of marginalized groups. Solving the problems in these societies requires a reallocation of resources, visionary urban policies and capable leadership” (Geel Jan, 2016).

Specifically for Bulgaria, this thesis is on the one hand extremely valid and on the other hand it is practically inapplicable. It is valid because the difference between rich and poor cities in our country has been replaced by the difference between small and large cities, but they are relatively equally poor and equally rich, given the strong centralization of public finances in the Republic of Bulgaria. The centralization of public finances is equally damaging to large and small cities in the Black Sea region. It is the reason why neither the necessary redistribution of resources nor visionary urban policies can be realized. Cities such as Varna and Burgas have long needed the metro as a solution to transport problems in both cities. At the same time, in both large Black Sea cities the infrastructural changes are few in number, not very good as urban planning solutions and often imitation. The same applies to the sea and port infrastructure, despite the fact that both Bourgas and Varna as ports are defined as the “sea gate of Bulgaria”.

Some of the Black Sea municipalities in Dobrudja and in the region of Black Sea Thrace specialize in agricultural production. There is an increasing emphasis on organic farming, the creation of organic farms, as well as wild farms, where cattle breeding is traditional for the region. As Professor Stella Todorova notes in one of her articles: „The stage of organic farming in Bulgaria offers numerous possibilities for people to participate in the daily routine on a farm. A potential for development of social farming in the country exists due to the suitable natural climatic conditions and the existing traditions in the agricultural output. Social farming helps people with specific needs solve their problems and start developing this kind of activities. The realization of this potential requires coordinated and purposeful work from the representatives of the state authority, scientists and specialists, who have to popularize the idea, reveal its perspectives and turn the public interest to the desired direction“ (Stela Todorova & Jordanka Ikova, 2014).

The existing asymmetry between the development of industry and agriculture has now been overcome. Moreover, today the regions of a number of Black Sea municipalities such as Shabla, Kavarna, Balchik, Pomorie and Tsarevo are mainly agricultural rather than industrial zones.

3.2. PROBLEMS IN THE MAINTENANCE OF WATERWAYS IN THE REGION

The lack of financial resources also limits the activity of the dredging fleet in cleaning the canal connecting Varna Lake with the Black Sea, as well as the access roads in the water area of the Varna port. The result of insufficient dredging is that with a design capacity of 23,500 tons, no more than 19,000 tons can pass through the canal today. This practically eliminates the possibility to operate the ferry ships from the former ferry connection "Varna-Ilichovsk" (Tonev Mladen, 1998). They are designed for the maximum capacity of the canal and have a displacement of 23,000 tons. The two Bulgarian ships from the ferry complex are unable to operate, regardless of the idea of developing a ferry connection with the port of Poti, the Republic of Georgia or with some of the Turkish Black Sea ports.

3.3. SMALL BLACK SEA MUNICIPALITIES IN TRANSITION

In a very difficult situation are the small Black Sea towns such as Byala, Obzor and others. Their remoteness from large urban centers and their underdeveloped urban and resort infrastructure limits their ability to compete successfully with established resorts such as Balchik, Nessebar, Pomorie and Sozopol. The lack of developed transport infrastructure is the main obstacle to the lack of promising investments in this region, regardless of its potential for combining sea and mountain tourism and for year-round use of the tourist base. Despite the obstacles and problems of infrastructural and administrative nature, giant hotel complexes have been built in these areas as well, trying to offer competitive tourist services, despite the underdeveloped infrastructure and the lack of sufficient treatment facilities on the Black Sea coast. As Ivaylo Dichev notes, "the Bulgarian city is again in a 'transition' - from a static place of privileges and national pedagogy to fluidity, cultural collage, multiple scenographies of desire." (Dichev Ivaylo, 2005) Palaces, towers, barn castles, amusement centers, water parks and other highlights of this "scenography of desire" have sprung up along our Black Sea coast in recent decades.

4. COMPREHENSIVE ASSESSMENT OF THE DEVELOPMENT STRATEGIES OF THE BULGARIAN BLACK SEA CITIES

In general, the current development strategies implemented by the Bulgarian Black Sea cities can be assessed as survival strategies. It relies mainly on the inherited and modernized tourist base. Unfortunately, it is oriented towards a predominantly communal tourism and manages to attract mainly insolvent tourists from the upper age groups, who do not go beyond the tourist package agreed with the tour operators. The small number of companies (52 companies working with the resources of the region) from the Bulgarian maritime economy, which are trying to extract marine biological and mineral resources. They have modest capital opportunities and do not receive serious support from local authorities. There is also a lack of synergies between entrepreneurs in the maritime economy system.

4.1. ASSESSMENT OF THE LANDSCAPE WORKS IN THE BLACK SEA CITIES

For example, for the city of Varna for decades no lasting solution has been found for the improvement of the coastal street from the central beach to the second coastal protection

riot. The undertaken public works are temporary - season for season and are implemented by companies that are close to the local government. The result is that every spring the coastal street becomes a construction site and the beach area repels rather than attracts tourists. Moreover, as a result of the started reconstruction of the coastal street, the first alley of Varna Sea Garden was destroyed - one of the most beautiful alleys in the garden with a wonderful panoramic view of the sea and the city beaches. This definite vandal reconstruction of the Sea Garden takes away a significant part of its charm of a cultural and tourist center and a zone for rest and relaxation of Varna residents and guests of the city of Varna.

Private initiative is relatively better in cities such as Nessebar, Sozopol, Kiten and Primorsko. The freedom of private initiative over the past decade has greatly changed the face of these towns, but it is not able to develop their full potential and this is where there is room for development not only of local municipality initiatives, but also of national initiatives.

The establishment and development of a system of reserves along the coast (Yailata, Rusalka, Kaliakra, Albena, Longoza, Kamchiyskoe Ustie, Perla, etc.) should continue. Together with the forestry farms in the Strandzha region and the hunting farms in the area of Shabla Lake, they can become a base for the development of year-round hunting and research tourism.

4.2. TOURIST AND TRANSPORT POTENTIAL OF THE CITIES IN THE BLACK SEA REGION IN THE REPUBLIC OF BULGARIA

Archaeological tourism and especially underwater archeology also have significant potential in the Black Sea region. As a zone of lively trade and economic contacts from the deepest antiquity, the Bulgarian Black Sea coast is rich in underwater archaeological finds, but underwater archaeological research is hampered by hydrogen sulfide gases at greater depths.

Of great importance for the development of the large Black Sea cities is their inclusion in the various transport schemes of the transport corridors passing through the country. The port of Varna and the ferry system (with maintained dredging fleet and maintaining the capacity of the Varna-Devnya canal) are able to maintain connection with other Black Sea ports and offer a variant of the ancient "Silk Road" that connects Western and Central Europe with The Middle East and Central and East Asia.

The construction of a modern highway along the Bulgarian Black Sea coast is important for the sustainable regional development. The active landslide processes in the coastal zone, caused by the uncontrolled construction and the lack of drainage channels, complicate such a construction, but such construction would allow the implementation of parallel coastal protection and landslide measures, although the cost of road construction itself.

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To some extent, coastal navigation is an alternative to coastal transport. The transportation of people and goods by sea is considered more profitable globally, but not for the Bulgarian conditions, due to the outdated fleet of the country. Provided that newer generation vessels are used, at some point it may be more profitable to travel by sea than by

land. Recently, the Russian Federation has resumed the production of “Comet”-type hydrofoils, which in the past served passenger navigation between the major Bulgarian Black Sea ports. Opportunities can be sought for contracts for the supply of this type of vessels, for which there are historically proven opportunities for operation in the Bulgarian Black Sea ports.

As an anti-landslide and anti-erosion measure in the area can be applied more massive afforestation, especially in the northern regions. Afforestation has a polyeffective result. The newly created forests protect against erosion, serve as an air filter, create wood for construction and industry, can serve as snow retention, etc.

5. CONCLUSION

Within one article, it is difficult to reveal the guidelines for sustainable development of an entire geographical region, such as the Bulgarian Black Sea coast. It is important to emphasize, above all, that this region has great potential, especially when the sustainable development of cities is combined with the necessary environmental activities to protect the air, water and soil. More than half a century of research into public space and urban life since Jane Jacobs's 1961 book, *Death and Life in Major American Cities*, "has made people who use cities visible to politicians and designers. It is now possible to plan for an active increase in urban activities or, at a minimum, to ensure that public space is usable and pleasant for urban dwellers. Once neglected, urban life is already an established and recognized field, which has a great influence on the attractiveness of cities." (Geel Jan, Birgit Sware 2014) This statement of Jan Geel and Brigitte Sware has its full force for the Bulgarian Black Sea cities.

In the transition from surviving strategies to sustainable regional development of the Bulgarian Black Sea cities, the necessary conclusion is that the reasonable exploitation of the potential and resources of the Bulgarian Black Sea coast can serve as a basis for a dynamic regional development of the coastal region in economic, social and environmental terms. and architecturally-urbanistically.

The Black Sea is the cradle of many human civilizations. With its resources it ensured the prosperity and development of Scythians, Thracians, Sarmatians, Alans, Greeks, Macedonians, Romans, Russians, Tatars, Georgians, Abkhazians, Turks and Bulgarians. The reasonable exploitation of its potential and resources can serve as a basis for a dynamic regional development, provided that work is done in this direction and that the parameters, criteria and conditions for this sustainable regional development are revealed.

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GUIDELINES FOR IMPROVING EDUCATIONAL MANAGEMENT IN THE REPUBLIC OF BULGARIA

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Abstract: The report examines the main problems of educational management in the Republic of Bulgaria in the context of the country's membership in the EU. The main landmarks in the educational management in the conditions of market economy in the Republic of Bulgaria are highlighted. The exhibition focuses on the principles of school management in market conditions. The main functions in the system of educational management are also interpreted. Special attention is paid to cultural aspects of educational management. It is argued that modern information and communication tools provide many opportunities that, multiplied by the infinite amount of information shared in the "world wide web", are a powerful tool for tackling the challenges of modern education. A justification has been made for the fact that the application of modern information and communication technologies also supports the development of two other key competencies in students - digital competence and the ability to learn independently. Having them is a good basis in the personal development of students and provides new opportunities for professional realization in the future.

Keywords: educational management, key competencies, principles of school management, cultural aspects of educational management

1. INTRODUCTION

In recent years, education has been repeatedly highlighted as a state priority by the governing administration in the Republic of Bulgaria. Almost every day we are flooded with information about the efforts of the government in this direction. Every autumn the number of renovated and newly built schools and gardens is reported. Various ideas for reforms in education are launched and tested. One generation of students has not yet been studied and the curricula are already changing. Learning material from the upper courses is "downloaded" in the smaller classes in order to unload the upper course for various forms of "vocational training". Vocational classes are being introduced in all secondary schools. Hundreds of articles, reports and reviews are written about the "delegated budgets" of the schools. Internet forums are flooded with comments about educational platforms Geo Gebra, Symbaloo, Red Paper Plane, G-Suite and others.

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The fact is that modern children have an interest in computer technology and love to spend time on social networks. This circumstance requires that part of the training to be transferred to where the students are, namely to the global network.

Modern students are "armed" with a bunch of mobile gadgets, which are already becoming an integral part of our daily lives. It is logical to take advantage of them in the learning process. In addition to the small size, the interest they arouse in adolescents, an important factor is the huge collection of mobile applications on leading platforms, which makes these devices a very suitable learning tool.

Modern information and communication tools provide many opportunities that, multiplied by the infinite amount of information shared on the World Wide Web, are a powerful tool for tackling the challenges of modern education. The application of modern information and communication technologies also supports the development of two other key competencies in students - digital competence and the ability to learn independently. Having them is a good basis for personal development and provides opportunities for future realization.

At the same time, the current and constantly updated Law on preschool and school education in its Article 5 "Objectives of preschool and school education", nowhere mentions this type of competence. The goals are the establishment of national identity (against the background of a multi-ethnic national community), early detection of talents and abilities and creating conditions for their development, knowledge of European and world cultural values and traditions, understanding and application of the principles of democracy and others similar. Neither creativity, nor information and communication competence, nor the modern aspects of socialization through global networks are among the goals of native education. Moreover, as a second main goal in Art. 5, second paragraph is fixed "The state pursues policies to improve the quality of education and prevent early school leaving." (PRESCHOOL AND SCHOOL EDUCATION ACT. -Effective from 01.08.2016, Prom. DV. issue 79 of October 13, 2015)

The current state of emergency regarding the pandemic of COVID-19 once again confirmed the fact that the education system in the Republic of Bulgaria needs serious changes in pedagogical practice and in the management of education, both in secondary and higher education.

The problem of improving, developing and perfecting educational management in the Republic of Bulgaria not only remains relevant for the entire period of existence and development of Bulgarian educational practice, but also acquires new dimensions and nuances now in the first decades of the XXI century. This circumstance requires a continuous study of foreign educational and managerial experience and permanent work on the implementation of this experience in management practice in the system of Bulgarian secondary, lower secondary and primary education. At the same time, it is logical to work on understanding and summarizing the national experience in the management of Bulgarian schools. Based on these summaries and analyses, a basic system for educational management can be formed, which as a conceptual basis can serve for further concretization of the various management methods and approaches for solving the problems arising from the development of educational management practice.

2. MAIN PROBLEMS OF EDUCATIONAL MANAGEMENT IN THE REPUBLIC OF BULGARIA

One of the current problems of the process of integration of the Republic of Bulgaria into the European Union is that of unification and harmonization of educational standards, including the standards in the system of secondary education. The topic of "education" is in the top three of the priority areas in which the Republic of Bulgaria begins negotiations for accession to the European Union. The European partners in the negotiations on Bulgaria's accession to the EU undoubtedly realize that without an education system adequate to European standards, Bulgaria would not be able to fit into modern European realities and be a worthy business, trade and cultural partner.

The reform of the Bulgarian education system reflects the changes in the legal framework imposed by our country's membership in the EU. It is also subordinated to the idea of borrowing the European and world experience in the national educational system, as an upgrade of the positive traditions developed in our national school and educational network. In world practice there are no precise standards and criteria for the development of a national network of educational institutions. This is a problem that each country solves for itself, according to the historical realities, traditions, demographic conditions, general cultural and technical level.² We can refer only to common framework standards, which automatically reveal the difference and irrationality of the Bulgarian education system. These structural and material features of Western European education are complemented by the traditionally strong and numerous links of education with private business and charitable foundations. This institutional, sponsorship, personnel and even political connection of the theory with the practice supports the realization of a highly profiled and narrowly specialized training, which will have to be achieved in Bulgaria as well.

Another result in the reform of Bulgarian education in recent decades is the change in the position of the state regarding the monitoring of educational and pedagogical activities at the national level. Under market conditions, the state is gradually disengaging in relation to this side of financial management, which is related to the budget financing of educational activities. Many educational institutions are transferred to local budgets, which are almost always in deficit. Budget funding at the expense of the national budget covers the most urgent needs of schools and regional inspectorates of education. Within a misunderstood autonomy,

² In the Report of the European Round Table of Industrialists of February 1995 entitled "Education for Europeans - Aiming for a Lifelong Learning Society", published in the magazine *Strategies of Educational and Scientific Policy*, Vol. 1/1996, p. 4 has a paragraph "What industrialists consider inadequate in education". That paragraph states that:

- “- Education is a complex process, deeply intertwined with the national system, where priorities are largely determined by political reasons and the need to balance the national budget;
- Educational institutions spend a lot of energy and time in organizing the ways of teaching, rather than learning how to teach differently, which is why their connection with the real world is very weak and in some places does not exist at all.
- In many European countries, schools are part of a centralized state system with a large bureaucratic machine, which predetermines the slow response and the difficult perception of the need for change.
- Too often, schools encourage the early specialization of young people, from which they find it difficult to break away later. The level of equipment in schools is low or even inadequate, which is largely due to insufficient funding.
- Educational standards vary considerably between different European countries and within the country itself. The structural discrepancy in the obtained final educational qualification raises questions about the different degrees of achievement in the different educational systems. this discrepancy can lead to discrimination against people in Europe ”

greater financial freedom has been given to attract funds from various sources, including by renting out facilities and equipment, in order to ensure the financial and operational activities of the training units and institutions. The role of the state in market conditions is reduced to the framework conditions that it forms with regard to the spending of funds for a school through the so-called "delegated budgets".

3. GUIDELINES IN EDUCATIONAL MANAGEMENT IN THE CONDITIONS OF MARKET ECONOMY

In the context of the transition to a market economy and in the context of the evolving process of democratization of the country and the formation of civil society as the most important guidelines for the management of an educational institution are the following:

3.1. THE IMAGE OF EDUCATIONAL INSTITUTIONS AS A COMPETITIVE ADVANTAGE

The image of an educational institution depends on its competitiveness. It is expressed in the ability of the educational institution to attract both quality pedagogical staff and quality students. The good image of a school or institution in education allows to increase the requirements for the entrance of the system (school), and from there to increase the internal requirements for teachers and the quality of the learning process. The image also implies fame and representation, as well as international recognition and partnership with renowned and established foreign educational units. The maintenance of a good image is realized mainly through the preparation of good and competitive students from different levels of lower secondary and secondary education. The criterion for the quality of the preparation is the further development of the graduates of a junior high school or high school. "Image management" is realized mainly through a system for linking training with practice as a first stage and by building a system for feedback and "monitoring" the development of graduates as a second stage. The purpose of such a post-school partnership with the graduates of an educational institution is to impose a system of training throughout the work and life cycle. The creation and maintenance of such a system is necessitated by the fact that in the conditions of dynamic development of social and business practice it is not possible for a specialist with a given secondary vocational education to go through his entire career only with the diploma obtained at 18-19 years.

3.2. OPENNESS OF THE EDUCATIONAL UNITS IN NATIONAL AND INTERNATIONAL PLAN

In the situation of ever-increasing integration processes, more and more prominent globalization of business and socially significant activities, it is absolutely necessary to develop inter-school integration nationally and internationally. Each educational institution has specific advantages, manifested through the development of Training material base (TMB), through the creation of specific pedagogical and educational schools, through the intellectual products created by the academic staff. The different strengths of schools can be combined in order to better prepare professionals for different professions and in different specialties. To the greatest extent, inter-school integration can contribute to the training of

hybrid / integrative / specialists to develop on the border of two or more traditional specialties. In this way, the openness of the schools allows them to be more flexible to the needs of the modern labour market and to offer the necessary specialists who, through combined training, have the opportunity to adapt to changing market and business realities.

3.3. ESTABLISHMENT AND DEVELOPMENT OF RELATIONS WITH THE BUSINESS SECTOR

This guideline is extremely important for an educational institution operating in market conditions. The business sector is a source of "social procurement" in terms of training and staff development. It is the consumer of educational "production" in two aspects:

- first, the business sector consumes a large part of the staff trained by a school, even after they upgrade some level of education in the higher education system, and
- secondly, the business sector is the main sponsor for some of the educational institutions, especially for the professional ones.

At the same time, the business sector is a partner in terms of practical training of students, as well as the field of parallel implementation of some of the teaching staff, which traditionally maintain the relationship with practice. An important point that is well worked out in European educational practice is the involvement of specialists, managers, experts and entrepreneurs from the business sector as expert consultants in specific educational courses. In this way a continuity between theory and practice is created. There is an opportunity for meetings and contacts of students with potential future employers from the student rank. Supporters from the business community for the educational cause are won and the creation of various foundations is provoked, which finance and sponsor various educational initiatives, scholarships are awarded for training of students and specialists. The business sector itself is also a good sponsorship environment that a school can rely on in situations where it has to face non-traditional costs related to representation and socially significant events.

3.4. FLEXIBILITY, ADAPTABILITY AND MOBILITY OF THE EDUCATIONAL UNIT

In market conditions, conservatism and stereotypes in educational management are transformed in a short time into anti-management, which results in the lack of good name of a school and may lead to the closure of some educational institutions.

Flexibility in educational management is expressed in finding various legal forms to legitimize a new type of educational units and centres that will solve school-specific tasks. Another aspect of flexibility is the quick response to the market needs of a given type of specialists. A very strong point in educational management is finding "market niches" in staff training - the ability to assess what type of specialists are needed and at the same time not offered by other schools at the regional and national level. The adaptation of the programs in a given school according to the available "market niches" provides potentially high interest on the part of the students in the offered educational services.

An important aspect of flexibility is the combinability and manoeuvrability in staffing the educational process. Combining full-time and part-time teachers, attracting teachers from other schools, inviting experts from the business sector who are also involved in educational projects and tasks provide an opportunity to combine quality, traditions, schools, and also involves meetings, contacts and interactions between teachers of different

age groups, with different experience, with different specialization and expertise, which forms a dynamic environment, develops an educational continuity not only regionally but also nationally, allows for a clash of opinions, positions and methodological approaches, which collision usually provokes fruitful pedagogical experiments and forms non-standard and attractive pedagogical practices.

The adaptability of a school or educational institution is expressed in their ability to fit into the system of educational services, offering not only the traditional range of educational levels and specialties, but also all modern forms of postgraduate education, as well as courses for preparing entrance exams for renowned high schools and vocational schools. Adaptability is also manifested in the context of the full and complex use of Training material base.

Manoeuvrability in addition to adaptability is expressed in the development of various forms of learning - distance learning, online learning / for example, online learning on the Internet /. It can be said that with great success the educational managers in the country managed to bring education in the country on "virtual rails" to the state of emergency on the occasion of the COVID-19 epidemic through the "resource of manoeuvrability" in Bulgarian education. Through the realization of such manoeuvrability, schools can realize a presence not only on the regional, but also on the national and international market of educational services.

3.5. DEVELOPMENT OF SCHOOL LIBRARIES AND SCHOOL TRAINING AND INFORMATION NETWORKS

Most often, library services are commercialized in order to provide sufficient funds for libraries to update and increase the fund. An important moment in the modernization of the library services is the digitalization of the library fund, through which you can make a reference and request for a book or document. Video libraries with educational and popular science films are also supported, as well as CD and DVD boxes for information based on CDs.

Libraries are usually the main link in the school information network. The latter is included in the so-called. intranet - the internal network with its inherent software and staffing and with the respective administration of the process. The school intranet is usually a mini-system or subsystem within the school's Internet connections. It is natural for the ever-growing computer network to be complemented by a system of faxes, telephones, information boards and shop windows as additional carriers of information for educational and managerial purposes.

4. PRINCIPLES OF SCHOOL MANAGEMENT IN MARKET CONDITIONS

It is logical for a modern system of educational management to be based on sound and logically precise principles. Adherence to these principles is a key guarantee for the effectiveness and efficiency of educational management. In this case, we can refer to at least some of the most important principles, which, in the author's opinion, it is advisable to follow in educational management practice:

- *Legality* - its meaning lies in the need for all management decisions and the resulting documents - ordinances, regulations, orders, instructions, recommendations, information and more of a given institutional management - to be formulated and verified on the basis of the national legislation with precise reference to the legal norms on which the respective

management document is based. Observance of this principle guarantees the executors and addressees of the orders and decisions against, managerial arbitrariness, as well as creates the necessary order and order in the internal-institutional plan. Observance of the law in the educational management practice is a guarantee for solid positions of a school and pedagogical management in litigation and inter-institutional arbitration.

- *Contract* - this is a basic principle in market management. Adherence to this principle presupposes the wide application of contractual relations in educational management practice. In this case we are talking about contracts, both with external institutions and partners, and contractual relations within the structure of the Ministry of Education and Science. Mission target and project groups should also be formed on a contractual basis, specifying the time parameters of the contract.

- *Profitability* - a principle that is still difficult to accept by the management of the so-called. "Public schools". Under market conditions, any non-income institution belongs to the non-profit sector. In this context, both approaches are implemented in world practice. Then, when a school is established as a unit by virtue of commercial interests, as in Bulgaria are many private schools (First Private Mathematical High School in Sofia; American College "Arcus" in Velico Tarnovo, etc.), profitability is a basic principle and guideline for management. In situations where we have "public schools" that receive a subsidy from the state, profitability may remain in the background, but with the reduction of the state subsidy it gradually becomes a priority principle.

- *Publicity of the activity* - it is still just a wish in the Bulgarian educational management practice, but it will gradually start to make its way. The best practice in this regard is the increased media presence and publicity of all initiatives and especially of the financial plans and balances of schools and innovative pedagogical practices.

- *Public control* - it is also a guarantee against managerial arbitrariness, as well as against the discrepancy between educational mission and teaching practice. Public control should not be understood as control exercised by deliberate institutions. It is above all self-control through a greater openness, through the incorporation of an intra-school system for evaluation and quality control of education and through an internal audit of the use of delegated financial resources.

- *State regulation* - it already presupposes the functioning of special "supervising" bodies at the highest state level - the Council of Ministers, the Ministry of Education, Bulgarian Academy of Sciences, National Statistical Institute, the National Library, various committees and departments related to education and teaching. It should set the framework for a diverse and adaptive to market realities educational practice. Any attempt to firmly position criteria and standards will inevitably reflect in stagnation, conservatism, and hence in the backwardness and inefficiency of the educational process in the Bulgarian education system.

5. MAIN FUNCTIONS IN THE EDUCATIONAL MANAGEMENT SYSTEM

The multiplicity of the main functions of management in general, including educational management, makes it difficult to define and analyze them in detail within a project model. What needs to be present in such a model are the ideas and principles for the improvement of these functions in the context of the country's membership in the EU. In a meaningful context, the following management activities can be referred to the system of functions of educational management:

- planning;

- educational activity;
- structuring - channel nesting structure - combined structure;
- organization - of flexible type with all kinds of elements and substructures .;
- intra-school networks and communications;
- Financial Management;
- human resource Management
- marketing;
- advertising;
- control and monitoring;
- information provision;
- Public Relations;
- international cooperation;
- environmental management.

It is difficult to come up with ideas in any of these areas. In this statement, I will limit myself to this simple enumeration.

5.1. CULTURAL ASPECTS OF EDUCATIONAL MANAGEMENT

They are also difficult to cover in full, but an attempt will be made to focus on the more important ones, which can help to improve university management in general.

5.1.1. Creating, developing and maintaining school traditions

School traditions play a very important role in the system of educational management. Unfortunately, in Bulgarian conditions, educational traditions "are not what they were in the recent and distant past."

The lack of traditions in the Bulgarian educational sphere largely determines the lack of outstanding and internationally recognized pedagogical schools in Bulgaria. Suggestopedic pedagogy, which was created by Bulgarian scientists and is used very actively all over the world (in the EU mostly in Austria and Finland), is not popularized and is not even officially recognized in the Republic of Bulgaria. The school of physics of the teacher Teodosi Teodosiev from the Mathematical High School in Kazanlak is also not popularized, except for the incidental bursts of media attention caused by the success of his students.

5.1.2. Development of the educational culture

The concept of culture is not unambiguous. The interpretation of the term "educational culture" is also too broad. Here, the reference to definitions would be difficult to guide us in the issue. Here is an author's view of the characteristics and practices that fill the concept of educational culture with content:

The information system and information resources of a school can also be related to the cultural aspects of educational management. They characterize what is commonly called the "technological culture of education." At the same time, they are not fixed in specific requirements, but the more developed and larger they are, the more competitive a school is.

Probably in the western educational practice there are other informal indicators of the quality of education in a given school. For example, *the image of the graduates of the school*

themselves; the aspiration of the companies to engage the alumni of a given educational institution from the school benches; the international recognition of some diplomas, etc. similar.

It seems that the formalizable management approaches in the field of the assessment of the quality of the teaching work in the field of education are easier for practical modification and incorporation.

The requirement for a "good image" also applies to teachers. Deciphering this requirement can be decomposed into a whole set of qualities that are difficult not only to measure but also to test, such as *intellectual integrity; pedagogical tolerance*³, *correctness and responsibility*. A very important criterion for the quality of teaching work is the *leadership attitude and the ability of a teacher to take a leadership position in the pedagogical process*. Here, the concept of leadership is interpreted in a broad context and includes organizational skills as integral concepts; activity and initiative; professional forecasting skills, managerial skills and known entrepreneurial abilities and qualities. Approbation for the presence or absence of leadership qualities in a teacher can not be done in any other way, but only through practice. Attempts to identify or rule out such qualities through tests, case studies, and other types of exams have often been misleading.

An important requirement for modern teachers is *contact*. The ability to work in a team is largely due to it and pedagogical tolerance. Without such a skill, the professional development and career of a teacher is impossible.

Contact as a quality of a pedagogical worker is directly related to the ability to conduct a constructive dialogue, with the ability to conduct a reasoned discussion that leads to a specific scientific result. The importance of face-to-face communication, interpersonal communication and cooperation between teachers is increasingly recognized (Mulkay, M., and Gilbert, N. 1982).

Pedagogical popularity is another such symptom that is difficult to register and formalize. One but limited option for researching a teacher's popularity is either direct interviews with students or questionnaires for feedback. On these maps, the respondents can not give comparative opinions and assessments about the pedagogical and professional presence of a teacher.

Maintaining a professional relationship with former students - this is something that seems to be missing in the Bulgarian educational practice and as far as there are such relationships in our country they are incidental and are dictated more than informal relationships between teachers and students.

One very important criterion for recognition and fame in the West is the *social and institutional commitment of the particular teacher*. It also implies a better media presence of the respective teacher - contacts with the media, media appearances, media promotion of successes and pedagogical experiments.

In summary, there are many informal aspects of teaching quality assessment. It will be difficult to prepare mechanisms for all the desired characteristics. The point is to highlight those whose mechanism is known, easy to constitute and can be effectively incorporated into

³ It is worth noting that two German chemists, Otto Hahn and Fritz Strassmann, discovered the fission of the atom, but the Americans were the first to make an atomic bomb. One of the main reasons for the failure of the Germans is that in the course of working on the German bomb, scientists split into two camps - theorists and experimenters, who compete with each other. In contrast, in the United States, the two groups work together. For example, D. Robert Oppenheimer - director of the program in Los Alamos has worked in both experimental and theoretical physics – (Bundy, Mc George, 1988).

a better balanced in terms of quantitative and qualitative aspects, as well as in terms of formalized and informal criteria and standards, educational management system.

5.2. ETHICAL ASPECTS OF EDUCATIONAL MANAGEMENT

Ethics imposes on educational practice a system of restrictions, which in themselves represent a sum of moral and ethical rules and traditions that have developed in a given educational system.

In essence, pedagogical ethics is a type of business ethics based on honesty, openness, respect for the word between individuals and groups in the educational community and expressing the ability for effective functioning of educational institutions in sync and compliance with established rules and traditions in these countries. .

American theorists in the field of business ethics formulate the following principles of business ethics, which principles can also be addressed to academic ethics, insofar as in market conditions, it is also a type of business ethics (Selivanov, A.I., 1995)

- principle of justice;
- principle of law;
- principle of utilitarianism / practicality /.

As a very comprehensive concept, educational ethics acquires its completed form in the form of "business school etiquette". In general, it can be characterized as the basis of the code of conduct adopted in a school community.

All the above testifies to the fact that ethics is a moral category, encompassing a variety of forms of activity of academic units and scientific and educational institutions. It is difficult to expose with the help of a certain set of rules of conduct and communication. In the specialized literature, attempts are made for typologies, but at this stage they present mainly principles that are supported by the positive precedents of educational practice.

6. CONCLUSION

Improving educational management is a permanent process. It is constantly looking for answers to thousands of questions:

- How to make the school attractive, despite the difficult lessons and the ever-increasing flow of educational, cognitive information?
- How to motivate students to show a desire to learn, to be better at what they do?
- How to create a positive educational environment in the classroom, whether it is real or virtual?

And many other similar questions. It is constantly experimenting with new information and communication technologies and virtual realities, which are a successful substitute for the real learning environment in critical situations. Life and practice constantly create challenges for educational management and it must accept and "play" them in an adequate way. The complex problem is that this play must be realized in synchrony on many levels simultaneously - ministerial, regional, school, etc. This is the great difficulty in the complex set of managerial decisions and actions included in the broad concept of "educational management".

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ONLINE TEACHING, LEARNING AND EVALUATION DURING THE CORONAVIRUS CRISIS. A ROMANIAN PERSPECTIVE

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Abstract. In the context of the changes caused by the COVID-19 pandemic, the whole society had to adapt its operating principles. The academic environment had to adapt quickly to the new situation. Starting from the analysis of available resources and from the experience of working in the online environment, Romanian universities have switched to the E-learning system since March 16, 2020. This paper describes the particularities of the way of working in higher education institutions in Romania. The case study is conducted at Transilvania University of Brasov. The different academic profile of the authors allows the description of the academic activities both for the technical and humanities fields. The paper analyzes the efficiency of the activity carried out in the second semester of the academic year 2019-2020 and presents the perspectives for the first semester of the academic year 2020-2021.

Keywords: academic activities, online learning, blended learning

1. INTRODUCTION

The beginning of 2020 meant also changing the way of life of mankind, because of the COVID-19 pandemic (Bao, 2020; Sahu, 2020). In particular, in Romania, the appearance of the first case on February 26 determined changes in all fields of activity. Education had to adapt to the new conditions. Thus, from March 16, 2020, the government decided to switch to the online learning system. Starting from the available resources, both the pre-university education institutions and the universities tried to respond to this challenge (Purcell et al, 2020). This paper begins with a description of the particularities of online activities in Higher Education Institutions, under the circumstances of the 2020 pandemic. Transilvania University of Brasov, the seventh largest university in Romania, is a representative example for all HEIs in Romania. The second section describes the particularities of E-learning for both technical and non-technical faculties. The last chapter presents the conclusions drawn from the experience of the first semester of the academic year 2019-2020 and the perspectives for the next academic year, respectively.

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2. ROMANIAN HIGHER EDUCATION INSTITUTIONS DURING THE PANDEMIC

Since 2016, the Romanian Government, through UEFISCDI (Executive Financing Unit in Higher Education) has launched annually a call for application for FDI (Institutional Development Funds) projects, through which the applicant universities could obtain funds for certain strategic areas. The six areas refer to:

- increasing social equity, in order to ensure social inclusion and increasing access to higher education, linking the educational offer with the demand of the labor market (including those related to career counseling and guidance);
- internationalization of Higher Education in Romania;
- ensuring the proper functioning of university botanical gardens, didactic stations, practical training bases and other infrastructure that supports teaching activities within universities;
- supporting the activities of student entrepreneurial societies (SAS) within universities;
- improving the quality of teaching activities, including the respect for academic ethics;
- supporting research excellence in universities.

In this specific way, the basic funding of universities has been supplemented. At Transilvania University of Brasov (UNITBV), the funds attracted by applying for FDI projects allowed the development of both the infrastructure (FDI on the research also aimed at investing in the university's IT infrastructure) and the Learning Management System to enable education in a blended system. In parallel, the Man and the Computer project, developed from the university's own funds, ensured that all teachers have laptops provided by the university.

UNITBV is a comprehensive university, the seventh largest institution in Romania and the largest in the Central Region and consists of 9 technical faculties and 9 non-technical faculties.

Projects implemented in recent years, both for IT equipment for the university and for teachers, and for software resources have been used in previous years for E-learning for study programs that are developed in the form of Low Frequency Learning or Distance Learning.

Also, the teachers who carried out teaching activities within these programs were trained to use online resources.

Another source of information and funding was the Erasmus +, Capacity Building and Strategic Partnerships projects. These allowed the sharing of good practices from countries with a high degree of computerization to low income countries. This type of project has improved the skills of working with E-learning platforms.

All these resources attracted over time have created the premises for the transition to the online teaching-learning-evaluation system.

2.1. E-LEARNING IN THE TECHNICAL FIELD - PARTICULARITIES

In accordance with the regulations of the Romanian Agency for Quality Assurance in Higher Education (ARACIS), the disciplines in the technical field have provided both theoretical courses and hours of practical activities (De Brouwer, 2020). Online, the courses were held in videoconferencing, using the Big Blue Button facilities of the Moodle resource.

Online learning - BigBlueButton extends these core features to enable a teacher to engage students for learning. For example, a tutor can use BigBlueButton's multi-user whiteboard to help a student with solving a difficult math problem. BigBlueButton has built-in integrations with all the major learning management systems (LMS), including Canvas,

Jenzabar, Moodle, Sakai, and Schoology. It also supports Learning Tools Interoperability (LTI) 1.0 for integration with other LMS systems (such as Blackboard and D2L).

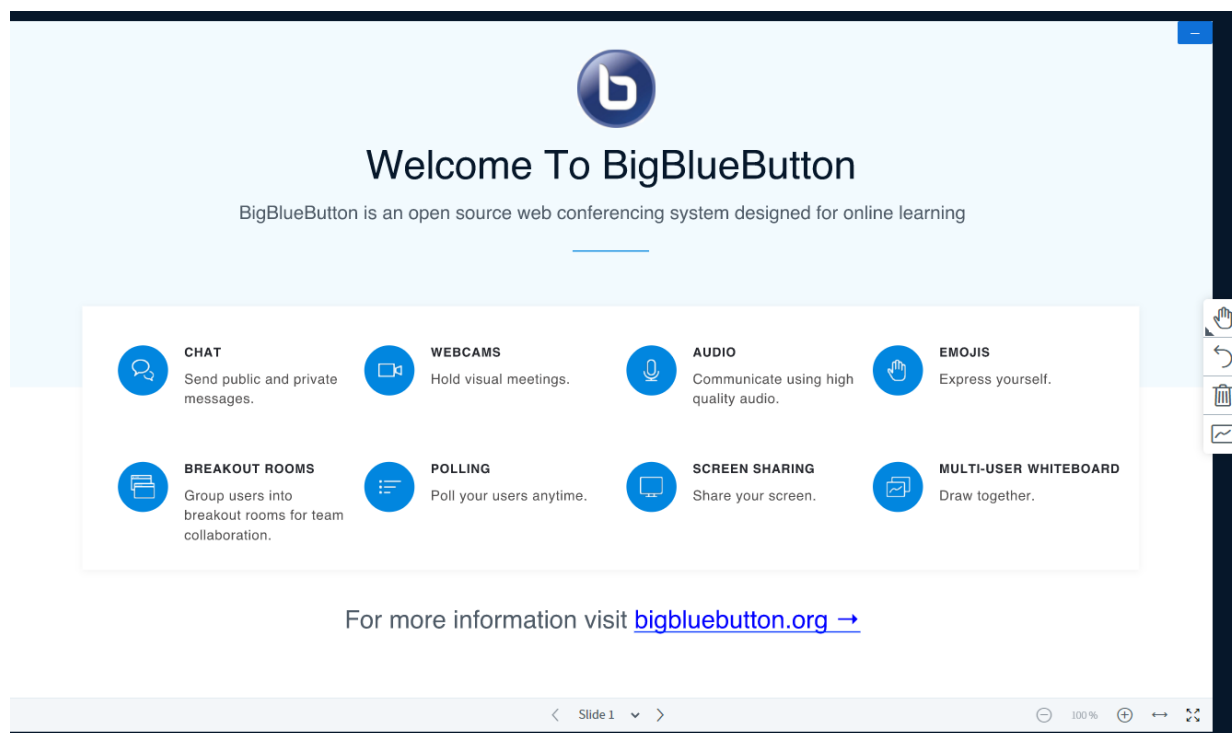


Figure 1. Videocference facilities

The bbb facilities proved to be very useful for the teaching activities of the course (Figure 1).

Another particularity of teaching technical disciplines is the organization of laboratories. A laboratory is a facility that offers controlled conditions, in which experiments, measurements and scientific research can be performed. The organization of a laboratory activity can be done by several methods: traditionally, by face-to-face meetings; at a distance; blended.

Carrying out remote laboratory activities is conducted:

a) by using information and communication technologies:

- local or server simulation;
- interactive command;
- visualization of experiments.

b) through practical remote experiments (virtual laboratory).

Considering these particularities, the laboratory works are currently done, practically, only in electronic format. In the preamble of the paper itself, the teacher makes a brief presentation of the objectives in the bbb system. The electronic format of the paper is available to students on Intranet or Internet servers. Some experiments can be followed remotely by students through the use of simulations.

Pedagogical practice has demonstrated the ease with which students can learn the basics of a user-friendly software application and the fact that they are taking a relative distance from traditional teaching tools and equipment. The accessibility of computer

technology and simulation software has led a number of teachers to gradually replace practical experiments with simulations.

However, the simulation used exclusively in the educational process produces a series of negative effects, the students being deprived of the full understanding of the phenomena.

The screenshot shows a Moodle course page for 'Managementul productiei'. The breadcrumb trail is: Dashboard / Cursurile mele / Zi / Facultatea de Inginerie Tehnologică si Management ... / Departamentul de Ingineria Fabricatiei / Aurica Luminita PARV / MP_IMC4. The left sidebar contains a 'Meniu principal' with a tree structure: Dashboard, Pagina principală, Pagini site, Cursurile mele, ID-IFR, Zi, Facultatea de Inginerie Tehnologică si Management ..., Departamentul de Ingineria Fabricatiei (with sub-items: Camil Traian Sorin LANCEA, Milena Flavia FOLEA), Aurica Luminita PARV (with sub-items: RS 2020, Ex_PCLP_TCM1, Ex_PCLP_TCM2, Ex_PCLP_CA, Ex_PCLP, LD, SIAD). The main content area has three activity icons: 'Forum știri', 'Prezență', and 'Tema de sinteza'. Below these, text states: 'Evaluarea la disciplina MP va consta in realizarea unei teme de sinteza ce va include: - descrierea unui instrument/ principiu LEAN - determinarea KPI pentru un proces LEAN <https://www.adaptivebms.com/tools/> Tema va avea aproximativ 3 pagini si va include si bibliografie. Evaluarea va avea loc in 11 mai, incepand cu ora 11.' Below this is a date range '16 martie - 20 martie' and a course icon 'MP' labeled 'Curs 4' with the title 'Lean Manufacturing - Introducere'.

Figure 2. Course interface

Another component of the teaching process is evaluation. Moodle allows the implementation of Quiz tests that allow multiple settings. This type of assessment can be used with excellent results for online teaching activities.

Test - grila

Attempts: 20

▼ What to include in the report

Attempts from

enrolled users who have attempted the quiz

Attempts that are

In progress Overdue Finished Never submitted

Show at most one finished attempt per user (Highest grade)

Show only attempts

that have been regraded / are marked as needing regrading

▼ Display options

Page size

30

Marks for each question

Yes

Show report

Regrade all

Dry run a full regrade

Figure 3. Quiz options

Questions are created and stored separately in a Questions Bank and can be reused in different quizzes. When creating a Quiz one can either make the questions first and add them to the Quiz, or add a Quiz activity (as below) and create the questions as you go along. In a Quiz with random questions not all students have received the same set of questions, as the application allows the shuffle of both the questions and possible solutions, which means that every student will receive actually a completely different test each time. To account for this, the analysis below distinguishes between positions in the test, and test items.

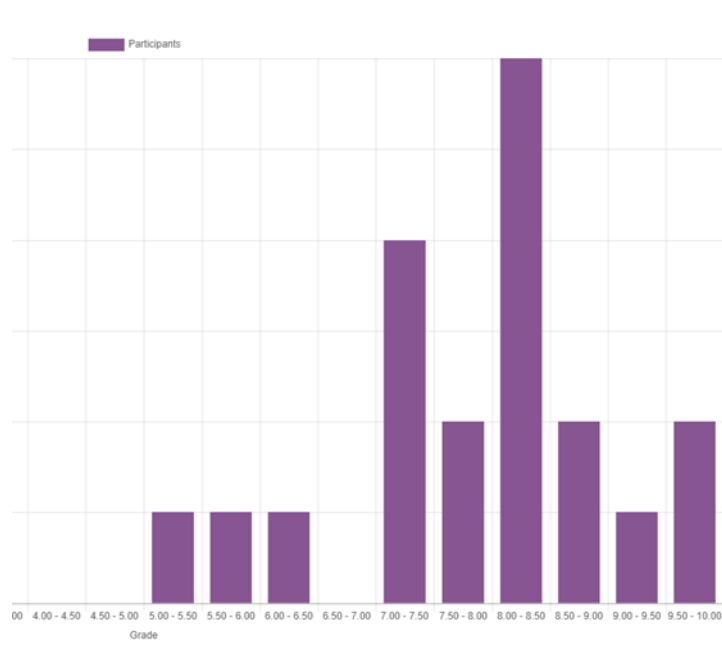


Figure 4. Marks statistics (Moodle interface)

We have a lot of students $s \in S$ who have completed at least one attempt on the quiz. The test has a number of positions $p \in P$. The test is assembled from a number of items $i \in I$. Because of random questions, different students may have received different items in different positions, so $i(p,s)$ is the item student s received in position p .

2.2. PARTICULARITIES OF ONLINE LEARNING IN THE PHILOLOGICAL FIELD

Having online academic activities is maybe an easier task in what the Philological field is concerned than in technical field, as, in general, practical activities do not necessarily require special equipment, and the difference between courses and practice actually gets down to switching from a more passive role of the students during courses (where the active role belongs more or exclusively to the teacher), to a much more active one during the practical activities (Cojocariu et al, 2014).

Thus, the bbb application's facilities (Figure 1) are extremely useful, as they are perfectly integrated within the overall teaching-learning process. We present below (Figure 5) an example of the teaching activities (Name of the course: Théories du discours argumentatif (Theories of the Argumentative Discourse) – in French, for students in Applied Modern Languages BA study program) planned for:

1. practical activity (PA): (week March 16 – 22, 2020)
2. course activity (CA): (week March 23 – 29, 2020)
3. practical activity (PA): (week March 30 – April 22, 2020)

We refer to the activities carried out during the second semester of the 2019 – 2020 academic year, which meant the switch to a 100% online teaching at UNITBV, due to the global sanitary conditions generated by the spreading of COVID-19.

16 martie - 22 martie: Argumentation et débat

 2 Argumentation et debat PPT

 Amosy Ruth Les dessous de l'argumentation dans le débat politique télévisé.

 Elements d analyse du debat televise

23 martie - 29 martie

 3 Argumentation commerciale PPT

 Travail individuel 2 - Argumentation commerciale

 Cours

30 martie - 5 aprilie



Figure 5. Course interface

As the PA continues the CA from the week before, we can notice that for the PA (1.) we have a practical activity on Argumentation and Debate, which is configured as follows:

- a) PPT presentation containing the main features and characteristics of the debate as a particular case of argumentation (reminder from the previous CA on the same subject).
- b) Study case (Debate on television – an article by Ruth Amossy)
- c) Elements used for the analysis of a debate on television – which consists actually in the practical activity students need to carry out in writing within the following two weeks and upload on the E-learning platform for the teacher to review. At the beginning of the next PA, the teacher will present the conclusions and discuss them with the students using bbb app.

The CA (2.) activity consist in:

a) PPT presentation about commercial argumentation – delivered through bbb app (see bbb icon labelled Curs) that also allows screen sharing, so actually the students will follow the presentation in real time, just like during a face-to-face academic activity;

b) A short practical activity in order to check that the students have understood the concepts presented and they are capable of applying them in practice. This also prepares them for the PA from the following week (March 30 – April 22, 2020) - PA on TV commercials for different products, produced and aired in France in 2018, 2019 and 2020 (source: Youtube).

As the platform allows to upload videos or place links to sites that teachers and students can use as materials, most of the PA related to the Theories of the Argumentative Discourse course are based on relevant videos found online in open access.

The platform also allows the participants to generate different types of relevant reports and statistics. For instance, the teacher can follow the frequency in which any given student did or did not access the platform, as well as if the students have accessed the materials uploaded for the CA or PA.

We can see below a chart for all the roles (mainly Teacher and Student) for all the activities, from March 31, 2020, to August 31, 2020 (Figure 6).

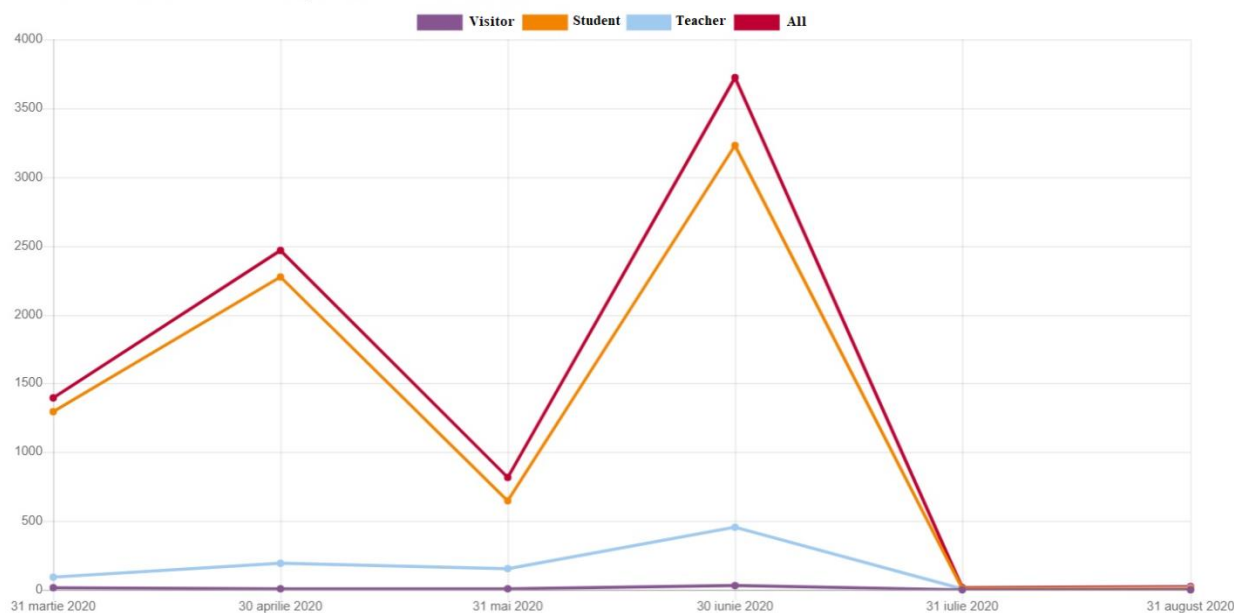


Figure 6.

3. CONCLUSIONS AND FUTURE DIRECTIONS

The analysis of the didactic experience (Artemi et al., 2009; Cojocariu, 2014) lived by the academic community allows the authors to present a SWOT analysis, as follows:

a) Strengths

- Students can access resources from anywhere
- The available resources can be more diversified
- The costs of the teaching process are lower
- The online system is much better adapted to nowadays' students

b) Weaknesses

- There are also students without hardware resources
- Not all teachers have ITC skills
- The number of students accessing learning resources simultaneously is higher for the online learning situation than for the face-to-face learning situation

c) Opportunities

- Online resources can be much better adapted to the teaching process
- Students in master's programs can more easily access learning resources, given that most of them are already employed

d) Threats

- The direct communication between the teacher and the student disappears
- The danger of dropping out in the first year of studies increases

Given the learning experience of the academic year that has ended (Remuzzi et al, 2020), higher education institutions are much better prepared to deal with the blended learning system, that is expected to be applied next academic year.

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ROLE OF RFID IN DATA EXCHANGE FOR EFFICIENT CONTAINER LOGISTICS

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Abstract: Information systems play a critical role in the inland container movement which can support in various cost control methods such as optimizing transportation, reducing inventory, managing future orders through data exchange applications. A significant part of the total cost in container movement is due to the inland transportation of containers. In this paper, a solution based on RFID (Radio frequency identification) technology is proposed in one of the large inland geographical economy with higher container delivery distance from sea port to inland depot. This application will be reliable and efficient for the port processes and contribute in reducing the dwell time of shipping container by providing near real time visibility of containers. Tagging each container with a passive RFID tag will support in near real time identification and tracking of container by fixed readers installed at strategic locations such as container freight station, toll plaza's, empty yards and inland container depots. Such a system will enable near real time data exchange between different entities of container supply chain and increase the productivity by reducing dwell time and congestion time.

Keywords: Container logistics, RFID, Port, Productivity, tracking, smart container

1. INTRODUCTION

1.1. OVERVIEW OF CONTAINER LOGISTICS

With the globalization and open economy system, logistics and transportation play an important role in cross border transportation. For such a transportation, international world trade heavily relies on marine mode of transportation, approximately 80% of the volume of international trade, and 70% of the value, is moved by vessel and operated through the maritime ports distributed throughout the planet (Muñuzuri et al., 2020; UNCTAD, 2018a) and the percentage is even higher for most developing countries. With expanding economies and advancing globalization, containerization is further staged to grow and remain as a preferable mode of cross border cargo movement (Fruth & Teuteberg, 2017).

With compounded growth of container volume, maritime sector is one of the key sectors for digital transformation. With high degree of information interface and transactions, this sector offers a scope for large range of tracking technologies and applications for

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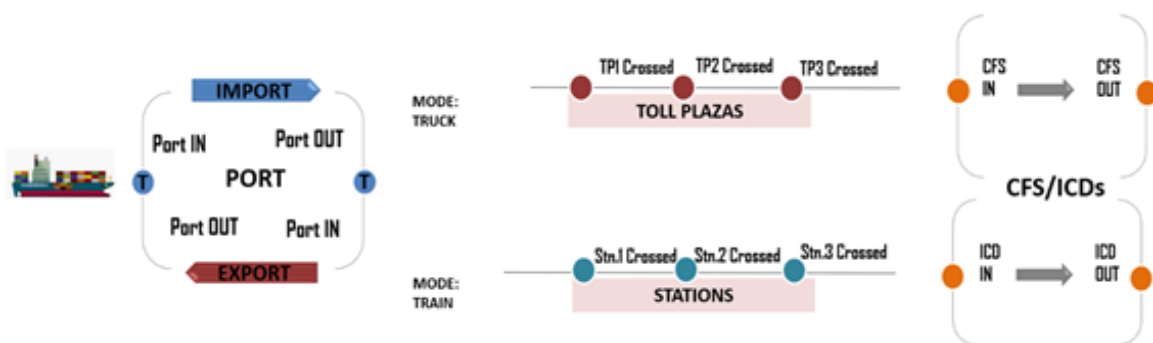
digitization. Container logistics operations comprises of data exchange between various stakeholders such as shippers, importers, vessel operators, NVOCC, freight forwarders, custom house agents, container freight stations. These custodians of container transaction owners need to exchange information in a more collaborative manner for timely information flow on container movement and achieving strategic operational efficiencies.

Thus, two important parameters for the evaluation of such a data exchange is tracking and tracing along with synchronization for container management operational efficiencies. World Bank publishes a comprehensive set of national-level performance indicators Logistics Performance Index (LPI) which ranks economies on the basis of their logistics performance. LPI is calculated across six parameters to rank an economy on logistics competitive management. The aggregate index is calculated by evaluating six main components, which are Customs, Infrastructure, International shipments, Logistics Competence, Tracking and Tracing and Timeliness (World Bank, 2018).

A container movement cycle is as shown below in Figure 1. This research s study discusses about a cost-effective RFID proposed solution to be implemented in a large hinterland geography for the inland container transportation. Within a port environment and port to hinterland transportation uncertainty is becoming an important factor that is driving ports to become more competitive in nature (Narsoo et al., 2009).

Container Terminal Operator - In general terms, container terminals can be described as open systems of material flow with two external interfaces. These interfaces are the quayside with loading and unloading of ships, and the landside where containers are loaded and unloaded on/off trucks and trains. Containers are stored in stacks thus facilitating the decoupling of quayside and landside operation (Steenken et al., 2004).

Container Freight Station/Inland Container Depot – Container Freight Station (CFS) / Inland Container Depot (ICD) is a common user facility with public authority status equipped with fixed installations and offering services for handling and temporary storage of import/export laden and empty containers carried under customs control and with Customs and other agencies competent to clear goods for home use, warehousing, temporary admissions, re-export, temporary storage for onward transit and outright export. Transshipment of cargo can also take place from such stations. CFS is a place where containers are stuffed, de-stuffed and aggregation/ segregation of export/import cargo take place. This is more so when the ports are facing congestion at their premises (Abirami & Gayathri, 2016).



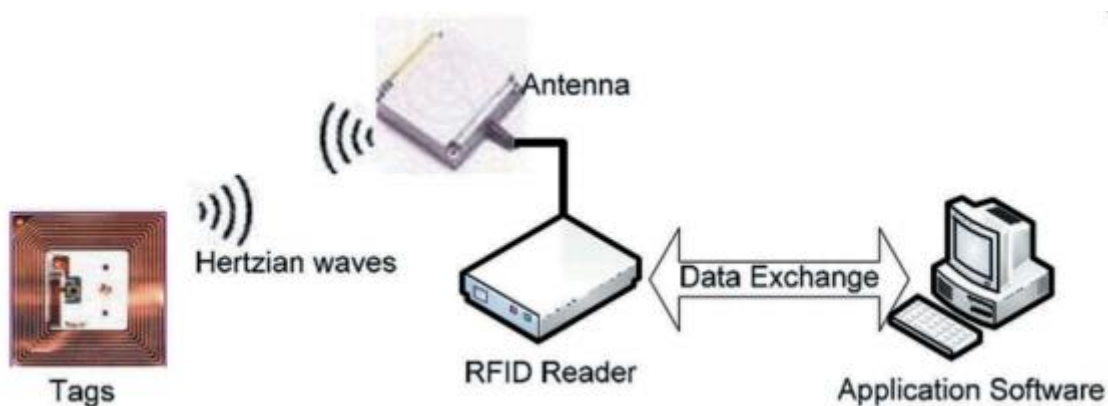
Source: Author

Figure 1. Container movement from Port to Container freight station

1.2. OVERVIEW OF RFID

Radio frequency identification technology (RFID) is defined as a wireless identification and data capture technology (Wamba et al., 2008). This technology is a very effective tool in the process of monitoring and digital processing of data in a controlled manner. There are four basic functions of any data exchange process: tracking, optimize operational efficiency productivity, asset management and integration between supply chain (Wamba, 2012). RFID system is utilized for data acquisition based on attaching a passive RFID to items or containers.

RFID technology is growing to be used worldwide in the field of tracking and identification of assets (Fanget al., 2016). As shown in Figure 2, RFID technology works on three components RFID Tag, RFID Reader and application software.



Source: Adame et al., 2018

Figure 2. Components of RFID system

Many researches have been performed on the usage of technology for port inland hinterland, however there are few studies focussing on analysis of integrated multiple-mode inland transportation systems. (Hu et al, 2019).

The paper is structured as per the following details: Section 2 illustrates on the problem statement along with the methodology and objective of the study. Section 3 reviews the theoretical background for RFID in the research studies along with container tracking. Section 4 described the proposed solution as a system for smart container management tracking and data exchange. Section 5 shared about the detailed analysis of RFID application and proposed architecture. Lastly concluding remarks are presented.

2. PROBLEM STATEMENT

Container management is essentially becoming an important and strategic process for shipping liners and container terminal operators. The timely exchange of information for the efficiency, productivity and managing terminal operations is of utmost important to all the stakeholders in container supply chain. This process is still conducted manually to a large extent in the several ports. With the advent of technological advancement in ecommerce and road transportation, there is a major thrust towards automation and digitizing platforms in container logistics management (Becha et al., 2020).

With stiff competition from International, national and regional ports, many ports are adapting latest technologies for container tracking and management. These technologies are adopted for creating a near real time tracking system for container management (Wang & Fan, 2009a). Although many ports globally, have many terminals operating and information systems such as NAVIS, ACTOS, TOS, still many operations process are conducted manually. Such manual intervention leads to delay in process of container transactions and leads to unwanted delay and inefficiencies.

2.1. METHODOLOGY AND OBJECTIVE OF THE STUDY

The proposed solution method was discussed with practitioner and experts in the shipping and port industry. Concern and challenges for the daily operations from data information exchange perspective was discussed in detail along with the proposed solution. The research study proposes a centralized solution implemented in RFID system for container tracking from a sea port till hinterland depots. The main aim and objective for proposing this solution is to identify a system with RFID technology for seamless data exchange between various container stakeholders. This will enable terminal authorities, container freight stations, transporters, ship liners, customers in identifying the near real time location and respond quickly for any critical situation. Additional benefits of this solution can be realized for the following activities:

- a) Information exchange between multiple container stakeholders for operational efficiency and productivity.
- b) Congestion and delivery times of container.
- c) Managing and reducing dwell time of container.

Thus, this paper proposes a solution for tracking containers with a centralized solution for data exchange from various stakeholders in smart container supply chain and RFID for in transit data.

3. THEORETICAL BACKGROUND

Marine shipping is the most significant mode of transport for international containerized transportation. Ocean shipping is the fastest growing transportation industry which has grown increasingly from about 224 million TEUs (Twenty-foot equivalent units) to 792 million TEUs in 2020. A large number of containers are handled by vessels and terminal operators. Every year since 2012, more than 600 million TEUs flows in and out ports around the world (UNCTAD, 2018b).

In 2009b, Wang and Fan. researched about the information exchange of container transportation and its management. As per the research, information exchange has become a necessary development in the field of container transportation management. Radio Frequency Identification (RFID) is a useful technology to improve container transportation efficiency, safety, productivity and visibility.

RFID is one of the cost-effective solution available which can be integrated with any other technology for developing a tracking application. Ramanathan et al. (2020), proposed the characteristics of Green Characteristics of RFID using Innovation Diffusion Theory. Development of technology and security standards related to data exchange through the

shipping industry is based upon a model to redefine the definition of track and trace between different partners in container supply chain (Transmetrics,a).

Various models of RFID have been studied for the outdoor or indoor tracking purpose. Kunhoth et. al (2020) studied the combinational effect of RFID with sensors and computer vision and sensors on the tracking during indoor movements. Various navigational tools such as RFID, Blue tooth ultra-light, and Ultra-wide band were evaluated for indoor positioning and navigation systems. Fazzinga et al. (2020) also researched on the multiple scenarios of RFID tagged objects in the indoor movement.

Choi et al. (2017), developed a framework for IOT (internet of things) container tracking system enabling users to track containers during transit and facilitate the cross-border transactions. Williams and Cunningham (2017), researched on the usage of RFID by various organization for computerised tracking. Multiple aspects have been studied for the tracking of smart container utilizing various technologies such as freight visibility, security, equipment monitoring utilizing optical character recognition for gate processes (Scholliers et al., 2016). Brkić et al. (2015) researched on different tracking systems with real time object detection for various industrial and commercial applications.

Data has become the cornerstone of any modern logistics operation. Improved operational efficiency, last-mile and real-time route optimization, strategic network and capacity planning, customer service improvement and more product innovation are just a few of the major benefits now easily produced by a data-driven business. Across the industry, logistics data standards have yet to become a common practice. The lack of industry data standards complicates the exchange of information, which in turn limits innovation by providing an incomplete picture of issues that may be affecting logistics companies (Transmetricsb).

Role and advantages of RFID system:

Scanning range and reading ability – RFID Technology can scan without having a line-of-sight limitation within a frequency range

Speed and Convenience – RFID system can scan tags in milliseconds in comparison to other scanning systems such as optical character recognition which requires semi-manual operation and slow response time

RFID Cost – RFID is comparatively less costly compared to other technologies such as GPS, OCR.

RFID tags can be accessed and utilized during every instance of weather or times as compared to other technologies such as GPS (Requires constant power supply) or OCR (which requires constant maintenance during extreme weather conditions). There have been multiple research studies focussing on the discussion and the implementation of RFID at container terminal operations, however there have been rarely any study discussing the RFID based tracking system in a large inland geography (Park et al., 2006; Shi et al., 2011).

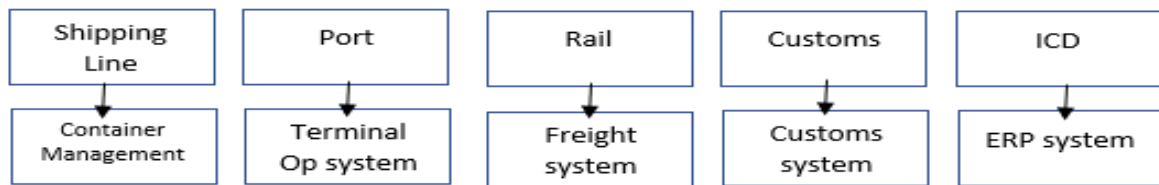
4. PROPOSED SOLUTION

In this paper, we propose a solution to enhance container tracking management system. Such a container will work on RFID tracking technology for smart container movement for data exchange. The proposed solution utilizes RFID technology along with developing an application system for data sharing between multiple stakeholders in container logistics management. The solution discusses about tagging a RFID container during

unloading at vessel berth. Information such as container number and mapping are performed while tagging at berth. Other information such as container type, specification, next destination can be linked through back end using terminal operating system. The common reference number for tracking would be the container number. Information such as In and Out can be fetched from the fixed RF (radio frequency) readers at the In and Out dates of the expected container operator locations.

4.1. CURRENT SET UP AND PROPOSED SET UP

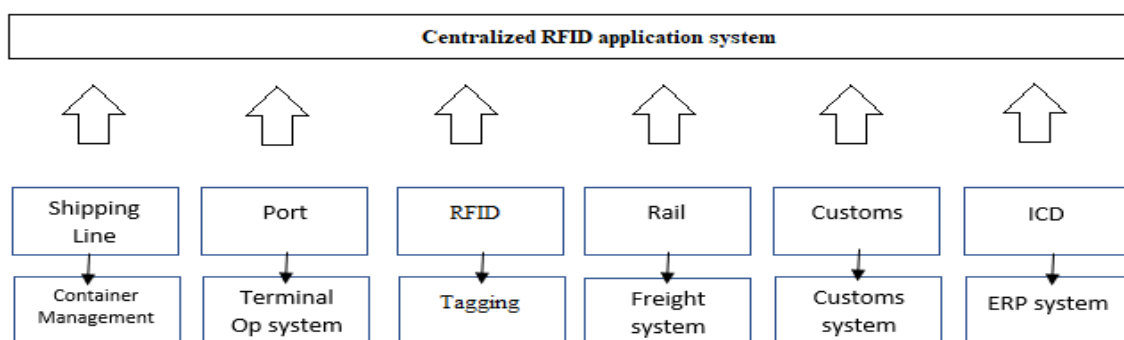
Presently, all stakeholders in container logistics management, operate and transact as per their individual customized ERP solutions in silo for container management (Figure 3). Due to the limitation and complexity of the container logistics, it is imperative to have a solution devised and connecting amongst them for near real time information and data exchange flow.



Source: Author

Figure 3. Current set up of information exchange

Figure 4 proposes a setup of data exchange interface along with RFID tagging data which can be processed in a centralized processor for data management and recording tracking events. Centralized processor will include transacting data exchange through SFTP in the form of csv files or data exchange through API services.

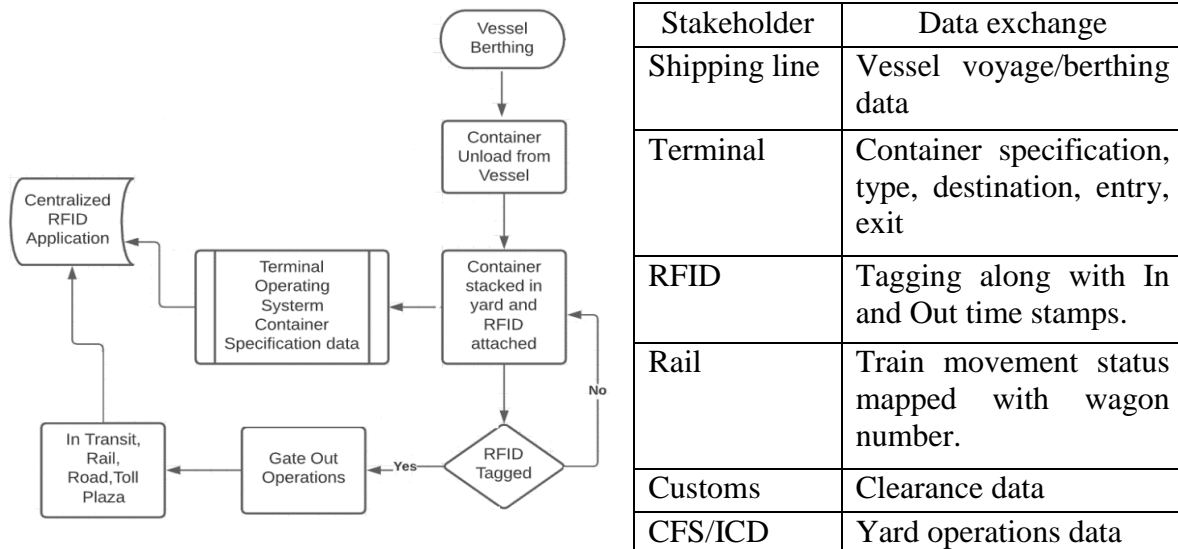


Source: Author

Figure 4. Proposed RFID application set up

In Figure 5, we propose a smart container tagging system after container arrival at the port along with data exchange responsibilities. The import container will be tagged during the outward journey from the gate operations. Data from multiple system can be incorporated and fetched utilizing csv files (comma separated values) or through at API (application

programming interface). Data exchange as shown in Fig. 4 can be fetched from multiple agencies such as terminal operating system, rail movement, customs and physical movement for In and Out stamps can be fetched using RFID tag. The data can be synchronized using TOS (Terminal operating system) data and physical tagging only needs to map container number with tag EPC (Electronic product code) identification.



Source: Author

Figure 5. Container tagging process and data exchange

5. ARCHITECTURE OF PROPOSED RFID SYSTEM

This section will describe the application of proposed RFID system in the context of one of the ports with large hinterland area. Firstly, we estimate the transit route and days from one of the ports of Europe to ICD in Northern India along with readers requirement per gate. Secondly, we present a brief analysis of architecture of the solution for the implementation of solution.

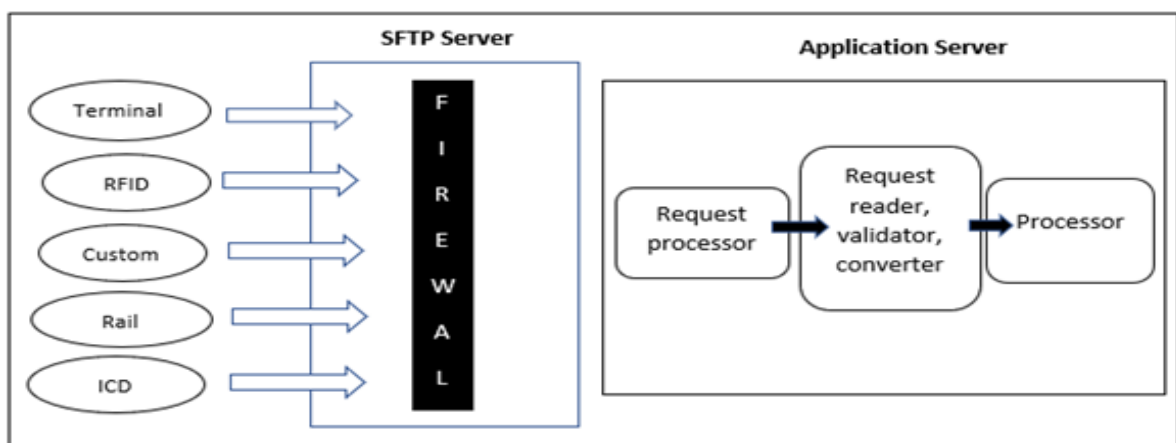
To estimate the application requirement set up, it is important to understand the setup of a large hinterland geography and the expected ICD served by them. Figure 6 represents the major Indian ports and ICD's served by them.



Mundra port comprises of four container terminals. The total approximate volume handled presently is 4 million TEUs. There are two major ICD's catering to the import volume from Mundra port. ICD Tughlakabad and ICD Dadri. Each have on average 8 gates for the estimation of RFID fixed readers. For a container from Hamburg, Europe to Inland depot in Delhi, India it approximately takes 43-45 days with scattered tracking.
 34(Voyage) + 2(Port) + 7 (Port to

Figure 6. Port to Hinterland route

The proposed RFID system is a setup of RFID tags and RFID fixed readers. The tags and readers will be operating at the permissible limit generating a read range of up to 12-20 meters. We are assuming that read range of two readers will not intersect provided they are placed at the appropriate distance and height. Each tag will have its own unique EPC code which will be mapped by scanning and entering container number data in back end application. All readers and handheld are networked with GPRS to communicate with backend server hosting data base application. Proposed architecture of RFID system is shown in Figure 7.



Source: Author

Figure 7. Proposed architecture

This application can support in numerous benefits such as coordinate operational planning between multiple container management stakeholders, reduction in dwell time and congestion time, smart container security.

6. CONCLUSION

Container logistics management is one of the key fields for cargo movement. It caters to 80 % of the world container volume. This sector employs many technologies to improve operations and bring efficiency and productivity to the complex container management. In order to bring efficiency, still there are many processes that are managed manually. Near real time tracking of containers is imperative to locate container and plan operations efficiently. This research study proposes an RFID bases container tracking system for the geography with large hinterland area. This implementation can provide several benefits such as effective monitoring, based on the requirement, we proposed a system for data exchange between multiple container logistics stakeholders along with RFID tagging for each container. The system will be more effective, one data exchange mechanism can be developed for coordinated operational and container management planning. Further scale for operations to cost reduction and data exchange can be facilitated through coordinated scalable efforts of stakeholders in container supply chain.

Limitation of this study includes the application for this system in only large hinterland geographies and may not be suitable for investment in smaller distance from port to inland depots. One of the limitations is also about the data sharing policy of all the included stakeholders. Future research will include application of this system in multiple ports along with a pilot study and evaluating results for sample containers for holistic purpose.

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PREDICTION OF THE COPPER PRODUCTION IN THE FRAMEWORK OF ELECTRICAL ENERGY CONSUMPTION USING ARTIFICIAL NEURAL NETWORK

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Abstract: The metallurgical process of the copper production is a very complex process and requires the consumption of electrical energy in large quantities. One of the challenges of today is to reduce the use of electrical energy by increasing the energy efficiency of the system. This challenge can be solved by developing energy management in mining companies. In order to approach the development of energy management, it is necessary to create models for predicting the volume of copper production by investigating electricity consumption in the main production stages. In this paper, the consumption of electricity required in the process of copper production is analyzed on the example of a local mining company. Data on electricity consumption were collected for a period longer than one year and the parameters were divided according to the main phases of the metallurgical process. Two models for predicting copper production using artificial neural network were created and the most influential parameters were identified. The significance of the models is reflected in the efficient forecasting of the copper production and therefore the demand for electrical energy. Another advantage of the models is the increased possibility for rationalization of electricity consumption on the basis of the influential parameters. The models are recognized as flexible and can find their application in related companies.

Keywords: Electricity consumption, copper production, prediction model, artificial neural network

1. INTRODUCTION

With the accelerated economic development of countries and organizations, a new challenge has emerged in the form of forecasting resources. Predicting all kind of resources either for countries or for individual companies is a vital task for planning. Forecasting resources has become complex and demanding job since the environment is constantly changing causing the modification in production processes. This problem leads to incomplete prediction models and lowers their prediction potential. Prediction models have been used for solving different energy related problems and some of them are described as follows. Kavakliouglu et al. (2009) highlights the importance of using prediction models in planning

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electrical energy resources because it allows big systems to foresee the future demand and provide secure electricity supply. Moreover, Günay (2016) reports that electricity planning is essential for achieving electricity balance, because neither lower electricity production than demand nor higher electricity production is good. Prediction models are seen as necessary in forecasting future electricity consumption in all systems because they allow faster economic development (Wang et al., 2018). Improving stability and accuracy of prediction models is a challenge faced by today's researchers. Researchers are constantly developing models by adding different variables in the model structures.

Predicting electricity consumption in metallurgical industrial activities is an interesting research topic since it is known that metallurgy is recognized as a high energy intensive industry (Vidal, 2017). The electrical energy demand of copper production is affected by the following factors: (a) mineral processing routes (hydrometallurgical or pyrometallurgical), (b) the ore grade, (c) mineral hardness, (d) mine age and type (surface or underground), (e) location of the mine and water access, (f) process design and technology selection (Moreno-Leiva et al., 2020). The artificial neural network methodology for creating prediction models has been applied in this study to investigate the future copper production. The prediction model was constructed taking into account electricity consumption in the production process, so it considers process design and technology selection factors. Accordingly, the copper production in this research was forecasted in the light of electricity consumption in the main production stages. The study is applied on an organizational level.

Experts employed on developing the copper production process are coping with emerging challenges of using environmental-friendly technology (Schlesinger et al., 2011). This is not an easy task since the copper production is not a clean process. Continuous reduction of energy demand is among the primary goals of the future technology of copper production (Schlesinger et al., 2011).

2. METHODOLOGY

The initial dataset that was used in the research was collected in a copper mining company. The period that was observed includes data from January 2018 to May 2019. More accurately, the values of the parameters have been recorded for 511 days. The study included seven parameters that concern consumption of electrical energy for the main phases of the copper production process, sulfuric acid production and the volume of the copper production. The main phases in the copper production are described as: flotation → drying concentrates → flash smelting → converting → anode refining and casting → electro refining (Schlesinger et al., 2011). All of these phases use energy resources to ensure continuous copper production. The variable named sulfuric acid production is used because it represents an integral by-product in the production process. Some of the phases in the copper production process require the use of Fe and S oxidation for heating and melting, which causes the production of sulfur dioxide (SO₂) (Schlesinger et al., 2011). Therefore, sulfuric acid is produced as a result of production operations that create high values of SO₂. SO₂ gases are transformed into sulfuric acid in a specialized plant that operates within the copper company. The main aim of this study was to investigate the demand for electrical energy in a copper production system. To fulfill this goal, it was necessary to differentiate the phases of the copper production process with the major electrical energy demand. The demand for electrical energy and the production of sulfuric acid were observed in relation to the results of the copper production. Furthermore, the parameters for electrical energy consumption and the volume of the sulfuric acid production were used to construct two prediction models for the copper

production. First model is constructed using the parameters for the electricity consumption to predict the volume of the copper production. The second model included additional parameter named the volume of the sulfuric acid production.

Figure 1 illustrates trends of electrical energy demand in the observed period. It can be concluded from the figure that most of the electrical energy is used for in the phase of converting and refining, followed by the phase slag flotation. Phase of batch preparation records the lowest electrical energy demand.

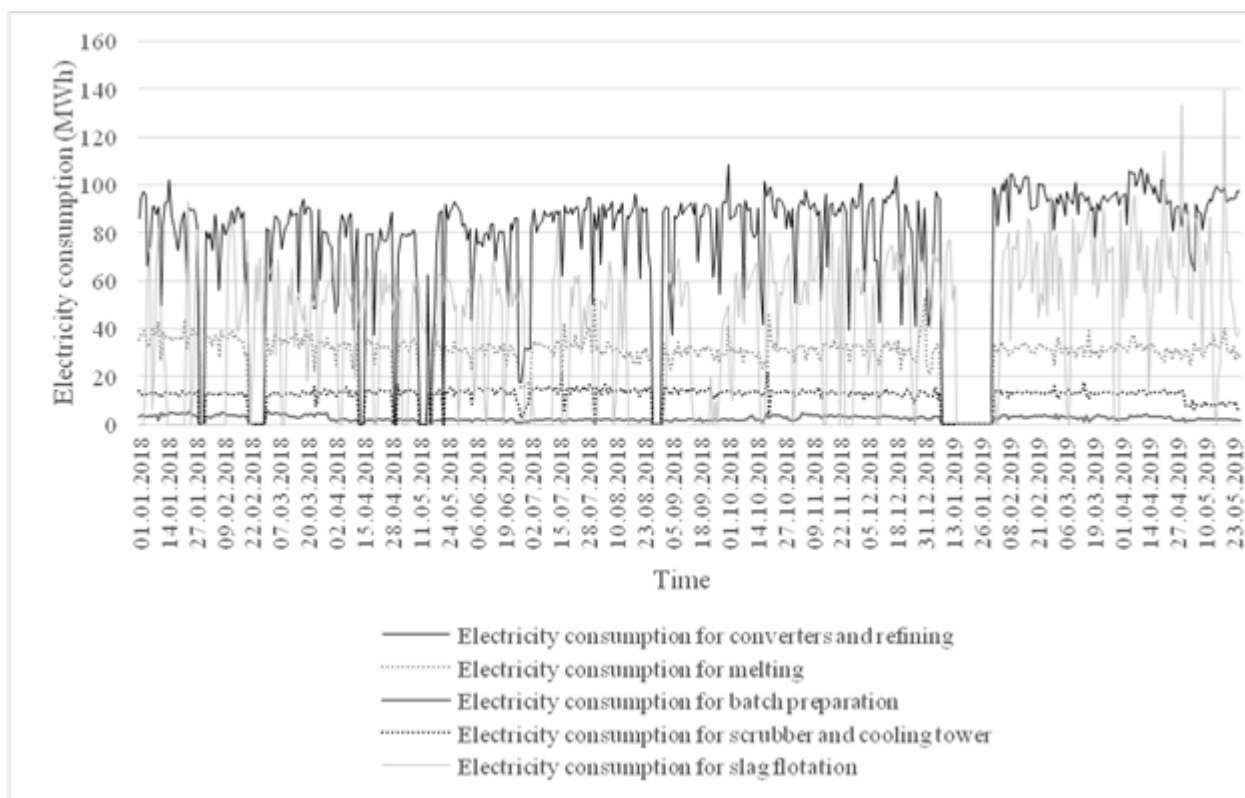


Figure 1. Trend of consumed electricity in the copper production process for the period January 2018 to May 2019

The presented data related to the electrical energy consumption were used to create prediction models for the copper production volume. Software program SPSS v.17.0 was employed to perform the analysis that included descriptive statistics and Pearson's correlation coefficients. The collected data regarding copper production volume were combined with the data about electricity consumption in different production phases and sulfuric acid production to develop prediction models for copper production. The prediction models were generated using the methodology of artificial neural network (ANN).

So far, ANN prediction models have been widely used in solving energy problems (Singhal and Swarup, 2011; Günay, 2016; Guijo-Rubio et al., 2020; Nolting et al., 2020; Piazza et al., 2020). The main reason for choosing this methodology is found in the fact that ANN has great capabilities for predicting behavior of non-linear systems and can accept variation in the data and introducing disturbance variables (Kavaklioglu et al., 2009; Shin et al., 2020). ANN models are also known as simple, easy to use, with good performances (Đozić & Urošević, 2019). The basic ANN model is multilayer perceptron (MLP) that consists of one input layer, more than one hidden layers and one output layer (Behm et al.,

2020). The ANN algorithm for predicting values is based on the transmission of the information from input to output layers, passing through the hidden layers (Lopez-Garcia et al., 2020). This algorithm is simulating the function of human brain and is deciding to whom the neuron in the layer should pass the information that possess (Sharma & Garg, 2020).

The computational equation for the simple three-layer ANN model is the following (Li et al., 2015):

$$Y = f(b_0 + \sum_{j=1}^k h(\psi_j + \sum_{i=1}^m p_i w_{ij}) b_j) \quad (1)$$

where the following labels can be described as:

- Y – predicted values,
- $f(.)$ – nonlinear transfer function,
- b_0 – output bias,
- $h(.)$ – activation function of the hidden layer,
- ψ_j – hidden layer bias,
- p_i – input values,
- w_{ij} – weights from input layer to the hidden layer and
- b_j – weights from hidden layer to the output layer.

By learning the patterns obtained from the past data, ANN models modify and calculate the future data values. When comparing ANN and multiple linear regression (MLP) analysis that is also used for creating prediction models, ANN is recognized as more sophisticated methodology that can solve different non-linear problems, which differentiates it from MLP methodology (Nolting et al., 2020).

General structural model that was used to construct prediction models using artificial neural network is presented in the Figure 2. It consists of input variable that is consumed electrical energy (X_1 - X_5), one disturbance size sulfuric acid production (Z), transformation process that is copper production and output variable that is the amount of the produced copper (Y). The parameters for electrical energy consumption in the copper production process were recorded separately, for each copper production phase and are reported in the Figure 2 as variables that range from X_1 to X_5 .

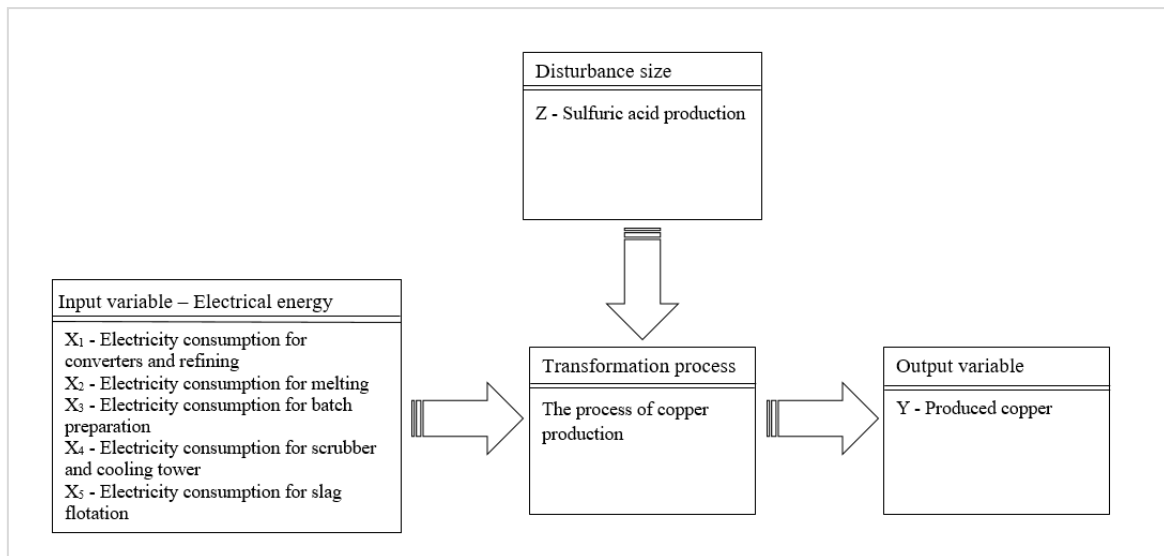


Figure 2. General structural model – systematic approach

The integral variables of the structural model presented in the Figure 2 were used to constitute two different prediction models. Their structures are illustrated in the following Figure 3.

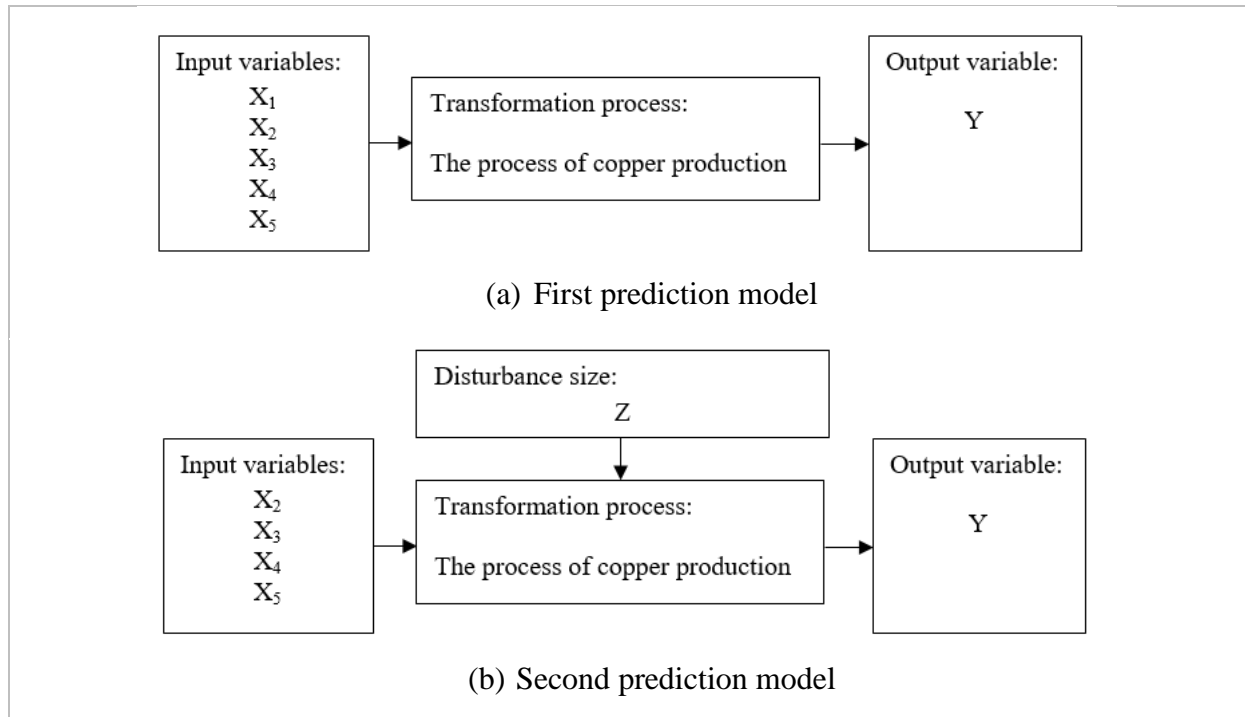


Figure 3. Structure of the (a) first and (b) second prediction model

3. RESULTS AND DISCUSSION

The process of constructing prediction models for the volume of copper production took several stages and various analysis. First among them was the descriptive statistics analysis and Pearson's correlation. Interpretation of the results of descriptive statistics and correlation are reported in the following part of the study.

Table 1 contains data about several statistical parameters for the considered variables that include range, minimum and maximum values, mean, standard deviation and variance. In addition, Table 2 reports the results of the Pearson's correlation coefficients that reveal the relationships between the variables. The outcome of the correlation analysis showed strong positive correlations among majority of the independent variables that are statistically significant ($p < 0.05$). The highest positive correlation is recorded between the independent variables X_1 - electricity consumption for converters and refining and X_2 - electricity consumption for melting where $r = 0.902$ and $p = 0.000$. Detected correlation suggest that these two phases in the copper production process are highly correlated and increase in electricity consumption in the phase of melting will induce the escalation of electricity consumption for converters and refining. Furthermore, independent variable X_4 - electricity consumption for scrubber and cooling tower achieved high positive relationship with variables X_1 and X_2 , where correlation coefficient equals to 0.830 for variable X_1 and 0.824 for variable X_2 and both are statistically significant ($p = 0.000$). These results are expected since all individual phases in the copper production process are interdependent. Lower correlation coefficients are perceived in relation between variable X_5 - electricity consumption for slag flotation and other

independent variables (X_1 - X_4). When referring to the relationship between dependent variable Y- copper production and other observed independent variables (X_1 - X_5), variable X_1 is achieving slightly higher positive correlation with the output variable than other input variables. This relationship is characterized by the Pearson's correlation coefficient that equals to 0.499 and the level of statistical significance of 0.000. Further analysis identifies strong positive Pearson's correlation that is statistically significant between disturbance variable sulfuric acid production (Z) and copper production that equals to 0.721. Identified positive Pearson's correlation among all variables showed that copper production process is dependent on electricity consumption and higher production volume follows higher electricity demand. The same relationship can be identified between sulfuric acid production and copper production.

Table 1. Descriptive statistics

	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
X_1	108.62	.00	108.62	75.644	1.284	29.034	842.991
X_2	53.40	.00	53.40	28.723	.461	10.426	108.721
X_3	5.75	.00	5.75	2.464	.055	1.244	1.548
X_4	22.29	.00	22.29	11.792	.194	4.388	19.255
X_5	139.81	.00	139.81	41.893	1.313	29.685	881.221
Z	1393.00	.00	1393.00	860.754	13.502	305.216	93156.596
Y	450.00	.00	450.00	230.064	4.232	95.684	9155.461

Table 2. Correlations

		Y	X_1	X_2	X_3	X_4	X_5	Z
Pearson Correlation	Y	1.000						
	X_1	.499	1.000					
	X_2	.350	.902	1.000				
	X_3	.205	.678	.714	1.000			
	X_4	.300	.830	.824	.629	1.000		
	X_5	.332	.268	.197	.204	.150	1.000	
	Z	.721	.642	.455	.332	.366	.304	1.000

Correlation is significant at the 0.05 level (2-tailed)

Moreover, a multi-collinearity test was performed in order to test the relationship between the variable data. The obtained collinearity statistics reports variance inflation factor (VIF) is less than 10 for all observed variables. The outcome of the test is acceptable and allows further analysis using ANN methodology. The significance of the prediction models is evaluated by calculating coefficient of determination. Results of the multiple linear regression analysis showed acceptable outcome since Pearson's correlation for the first model equals to $r=0.603$ and coefficient of determination is $R^2=0.364$. Provided results are statistically significant ($p=0.000$). In addition, Pearson's correlation for the second model equals to $r=0.737$, coefficient of determination is $R^2=0.543$ and the model is statistically significant ($p=0.000$).

The next step was to generate ANN prediction models for the copper production in relation to the electricity consumption. The structure of the ANN prediction models was previously presented in the Figure 3.

The first model sample was divided into two groups, first group was training sample that included 66.9% of the total sample and second group was testing sample with 33.1% of the total sample. Figure 4(a) provides graphical representation of the artificial neural network result for the relationship among independent and dependent variables. The first constructed ANN prediction model consists of five input layers, five hidden layers and one output layer.

The second model sample was divided into training sample that included 66.9% of the total sample and testing sample that included 31.1% of the total sample. The structure of the second ANN prediction model is illustrated in the Figure 4(b) and consists of five input layers, two hidden layers and one output layer.

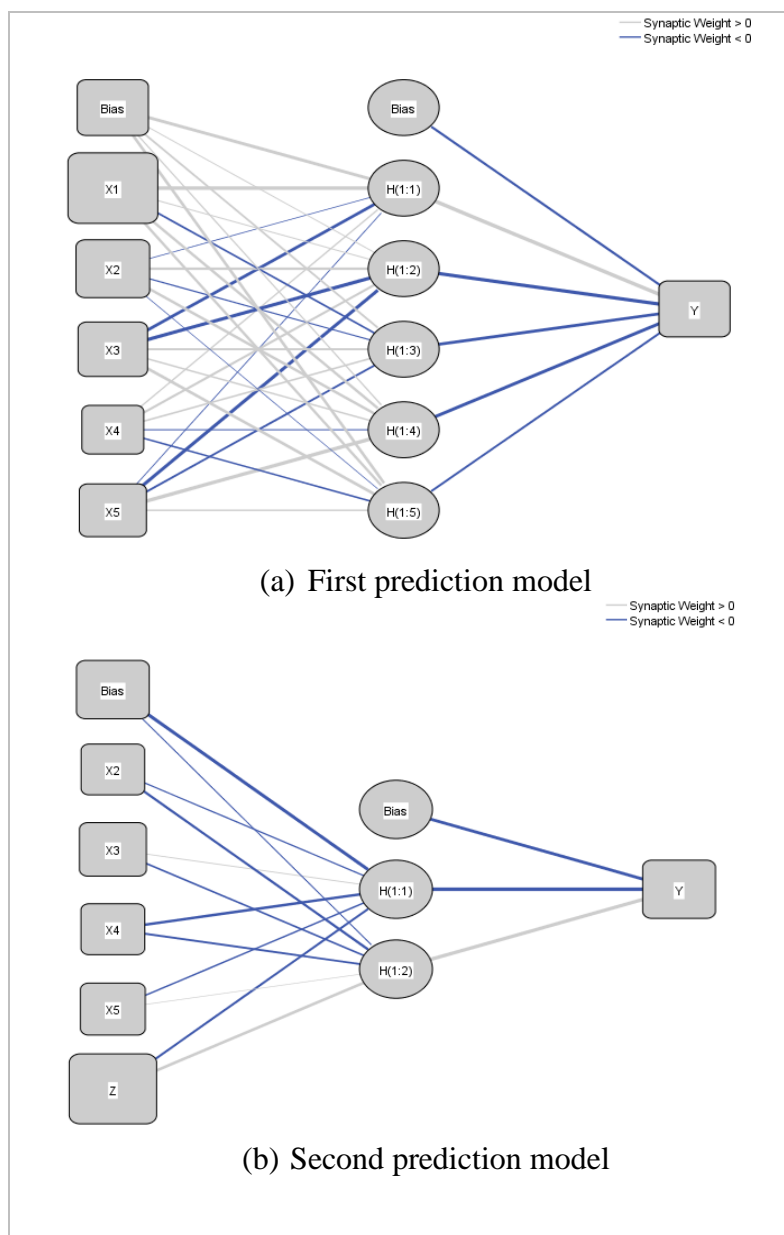
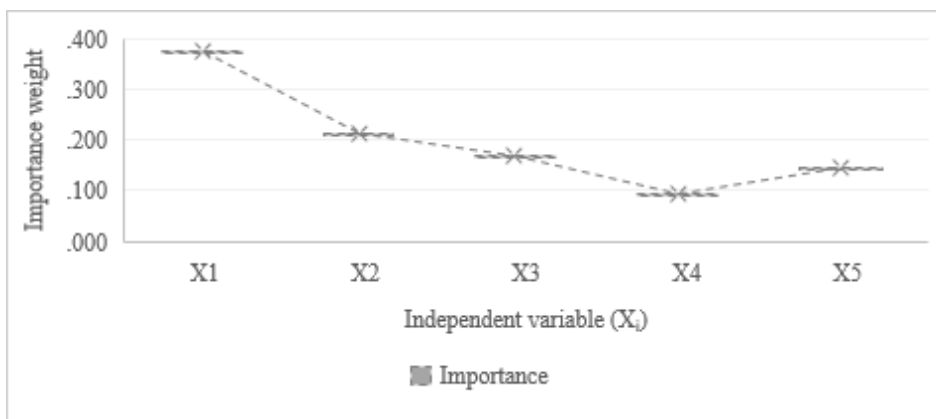
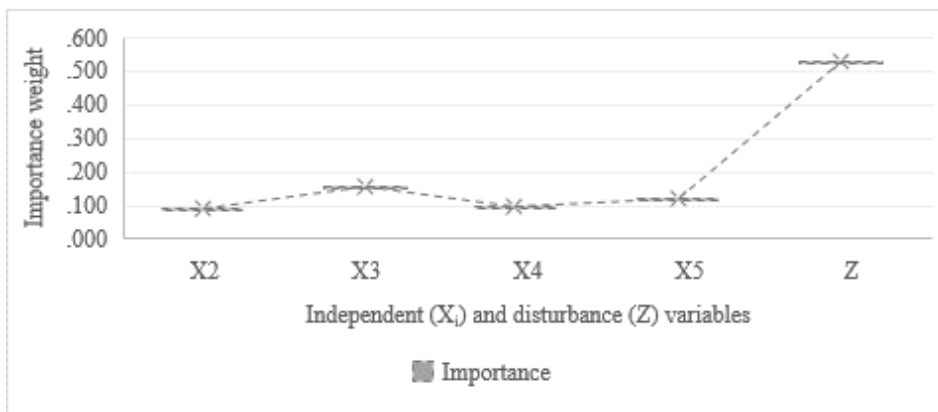


Figure 4. Artificial neural network for (a) first and (b) second prediction model

As an integral part of the ANN analysis, the importance of each input variable was calculated and the outcome of the calculation is presented in the Figure 5. Independent variable electricity consumption for converters and refining (X_1) is evaluated as the most important variable in the first ANN prediction model with its importance weight of 0.374, followed by electricity consumption for melting (X_2) with importance weight of 0.213. Third ranked variable is X_3 -electricity consumption for batch preparation (0.170), fourth ranked is X_5 - electricity consumption for slag flotation (0.147) and fifth ranked is X_4 - electricity consumption for scrubber and cooling tower (0.095). The outcome for the second prediction model illustrated in the Figure 5(b) showed the high importance of the disturbance size Z- sulfuric acid production with importance weight of 0.530 while the rest of the independent variables importance weights range from 0.094 to 0.158.



(a) First prediction model



(b) Second prediction model

Figure 5. Importance of independent variables in (a) first and (b) second prediction model using ANN

Furthermore, constructed ANN prediction models provided prediction values for the copper production and those values have been compared with the realized values of the copper production. The comparison results are illustrated in the Figure 6. The peak of the copper production is recorded in May 2019. However, detected discontinuities in production were explained as maintenance of production technology. Predicted values in the graph show slight deviations from the realized values. Both realized and predicted values show the trend of growth for copper production. Comprehensive analysis of predicted values for both (a) first

and (b) second prediction model suggest that better results were achieved by the second prediction model.

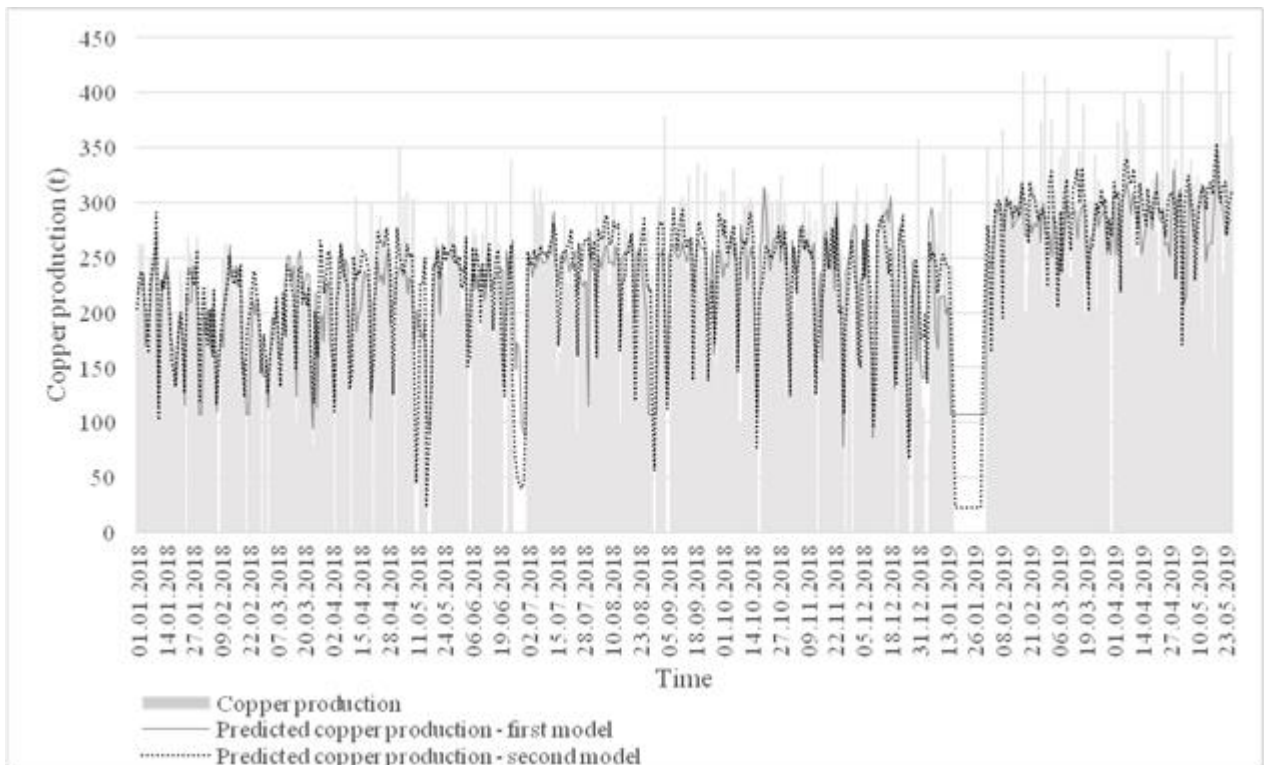
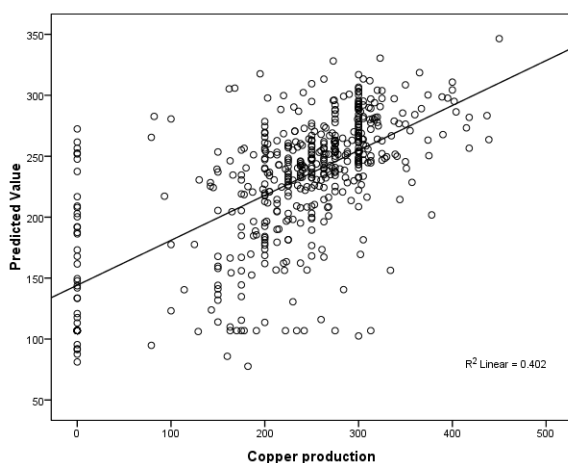
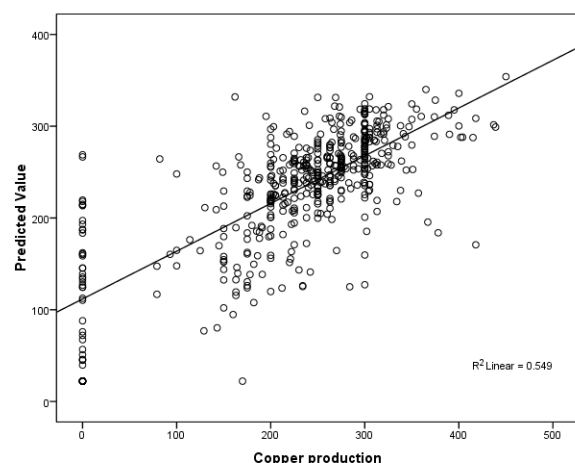


Figure 6. Predicted amount of copper production using ANN

Next Figure 7 (a) and (b) illustrates the relationship between realized and predicted values of the copper production. The linear trend confirms the growth tendency of the produced copper but also highlights the major deviations from the average values. Figure 7(b) reports less deviation values than Figure 7(b).



(a) First prediction model



(b) Second prediction model

Figure 7. Realized and predicted amount of copper production in (a) first and (b) second prediction model using ANN

As it can be concluded from the outcome of this study, the process of copper production is considered for a large electrical energy consumer. Phases that are fundamental parts of the production process are highly energy dependent. Among them is highlighted the phase of converters and refining as the leader in electricity consumption. In addition, the phase of scrubber and cooling tower achieves the lowest electrical energy consumption. The results of the Pearson's correlation imply on positive, statistically significant, relationship between electricity consumption in all individual phases of copper production with the volume of the production. The identified correlation is confirming the dependence among electricity consumption and copper production where any increase in copper production is leading to the increase in electricity consumption. The disturbance size that measures the volume of the sulfuric acid production reports high Pearson's correlation with the volume of copper production. Moreover, the empirical evidence from the descriptive statistics showed the increasing trend in the volume of copper production. This increasing tendency is connected with the total electrical energy demand. It leads to the conclusion that higher volume of copper production is demanding higher electrical energy consumption and reverse. This conclusion is logic and expected and it is interesting for further analysis of the observed variables.

Further analysis is considering construction of prediction models for the volume of copper production in the function of electricity consumption. The first constructed prediction model is illustrating the share of electricity consumption of each production phase. The prediction model is underlying the importance of converting and refining operation on the volume of copper production. More specifically, almost 37% of the total share of electricity consumption is referred to the phase of converting and refining and is mostly shaping the results of the prediction model. This outcome is consistent with the previous results of the descriptive statistics that characterize the same production phase as the largest electricity consumer. The second important phase is the phase melting that participates with approximately 21% in the total share of electricity consumption. The third phase by its importance is the phase of batch preparation (17%), followed by the phase slag flotation ($\approx 15\%$). The least effect is achieving the phase scrubber and cooling tower ($\approx 10\%$). The model provided interesting results referring to the importance of the lowest electricity consumption phase that is the phase of batch preparing, reporting that even though is the lowest electricity consumer it is more important than higher electricity consumption phases like slag flotation and scrubber and cooling tower. Ranking by importance weights follows different path in the second prediction model. In the second prediction model, the most important independent variable is sulfuric acid production with $\approx 53\%$ share of the importance in comparison to the importance of the rest independent variables. The empirical evidence suggest that the volume of the copper production is more efficiently predicted using more production parameters.

The predicted values of the copper production using artificial neural network are following the realized values and manifest some deviations in certain production periods. Predicted values are following the rising trend of the volume of copper production. This means further growth of electrical energy demand and emerged need to efficiently plan the production volume. With the help of the prediction models, it is possible to plan all sorts of resources, including electrical energy demand. The use of prediction models is recognized as essential for smart energy management. Constant monitoring of the production results and electrical energy resources could bring to the use of more efficient technological solutions in those production phases that are considered as high electrical energy consumers. Energy efficient solutions would have as a result low electrical energy demand.

4. CONCLUSION

The main contributions of this paper are following:

- Electrical energy demand for the process of copper production has been observed for the period longer than one year. The most important phases in the copper production have been identified and electrical energy consumption for those phases has been recorded on a daily basis. The observed parameters have been divided into input, disturbance and output groups of variables.

- The gathered data have been used to conduct further analysis of the electricity consumption using SPSS software package. Empirical evidence obtained from the SPSS showed the descriptive statistics of the dependent and independent variables and Pearson's correlation matrix. The highest positive correlation has been recorded among variables X_1 - electricity consumption for converters and refining and X_2 - electricity consumption for melting where $r=0.902$ and has achieved acceptable level of statistical significance ($p<0.05$). The outcome of the multiple linear regression analysis for the first prediction model showed statistically significant value of Pearson's correlation that equals to $r=0.603$ and coefficient of determination is $R^2=0.364$. Obtained values provided acceptable results and approved the construction of this prediction model. Results for the second prediction model that are statistically significant, indicate on high value of the Pearson's correlation coefficient that equals to 0.737 and coefficient of determination is $R^2=0.543$. The obtained performances of the second prediction model showed better outcomes than first prediction model.

- Five input variables and one output variable have been employed to construct the first artificial neural network prediction model. Input variables included parameters concerning electricity consumption in five phases of copper production and output variable included the volume of copper production. ANN results revealed five hidden layers in the prediction model. The most important independent variable in the prediction model was X_1 - electricity consumption for converting and refining with the importance weight of 0.374 . This highlights the variable X_1 as the most influencing variable in the prediction model. The second prediction model included five input variables; among them is one disturbance size, two hidden and one output layer. The most important independent variable is Z - sulfuric acid production with its weight of 0.530 . The high importance of this variable allows it to shape the results of the output values in major share.

- The outcome of the prediction models was used to calculate prediction values for the volume of the copper production and was compared to the realized volume of the copper production in the observed period. The comparison results showed occasional variation in the prediction values. The results indicate that second model provides higher-quality predictions values than first prediction model.

- The major advantage of the constructed prediction model is identified in the possibility to adapt it to different situations and add other variables. The same concept can be used in other industries that are marked as high electrical energy consumers. The results of the study can be useful in further investigation of the electrical energy consumption in copper production process and influence of copper production volume on electrical energy demand.

- Further analysis of the relationship between electrical energy demand and the volume of the copper production can be done using more variables that are recorded in the production process. It is evident from the study that adding different input and disturbance sizes can cause changes in the predicted output values. Supplementary variables could explain the relation between copper production process and production parameters in more details. This is also considered as the main limitation of the study.

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PERSPECTIVES ON MULTICRITERIA CLASSIFICATION METHODS

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Abstract: Various methods and algorithms have been developed in order to address multicriteria classification issues. In last two decades, in the field of the multicriteria decision making (MCMD) considerable attention has been paid to supervised classification problems, so called multicriteria sorting problems. However, recently some novel approaches have been proposed also for non-supervised classifications, known as multicriteria clustering procedures. Therefore, this paper aims to introduce some of the prominent multicriteria classification methods. Illustrative example has been employed to enlighten properties of the used MCDM methods. Moreover, this study discusses the similarities between obtained results of each methodology and evaluates their validity and robustness.

Keywords: Multicriteria decision making (MCDM), Multicriteria classification, MCDM sorting techniques, FlowSort, ELECTRE Tri, TOPSIS-Sort

1. INTRODUCTION

Multicriteria decision analysis (MCDA), as an advanced field of operations research, encompasses wide range of methodologies that are well suited to address the complex decision making issues in various research fields (Zopounidis & Doumpos, 2002a, 2002b, Andreopoulou et al., 2017). Namely, according to the Doumpos et al. (2019), MCDA deals with decision-making/aiding problems involving the consideration of multiple (conflicting) criteria, attributes, points of view, goals, and objectives. Recently, the group of well-known MCDA researchers have given monumental contribution by providing a collection of quality chapters that are highlighting how the MCDA is currently forming and how it can be shaped in the future (Doumpos et al., 2019).

Multicriteria Decision Making (MCDM) problems that can be modelled as a set of alternatives evaluated based on the several conflicting criteria, according to the Roys' classification (1981) usually consider the four main types of decision: 1) the choice problem; 2) the ranking problem; 3) the sorting problem; and 4) the description problem. Additionally, Ishizaka and associates completed this list with two more types that occur in MCDA community: elimination and design problems (Ishizaka et al., 2012; Lopez & Ishizaka, 2017; Ishizaka & Pereira, 2020).

Based on the different scientific literature reviews it can be stated that MCDA methods generally have been developed and utilized for the choice and ranking problems

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(Behzadian et al., 2010; Behzadian et al., 2012; Ishizaka & Labib, 2012; Subramanian & Ramanathan, 2012; Ishizaka & Nemery, 2013; Mardani et al., 2015; Doumpos et al. 2019). Both choice and ranking approaches in order to do derive special evaluation outcomes rely on relative judgments, which consequently yield results depended on the considered set of options. However, the classification decision making problems impose the absolute judgments that decision makers need to perform.

One may consider term “classification” as organizing data into groups that have common characteristics (Zopounidis & Doumpos, 2002a, 2002b, Cailloux et al., 2007). Classification technics can be divided in the two major families (De Smet & Guzman, 2004, Nemery, 2008): 1) the supervised grouping problem; 2) the unsupervised grouping problem. Doumpos and Zopounidis (2002) defined supervised classification as assignment of finite set of alternatives into predefined groups, where formulation of these groups has been done according to the ordinal rather than nominal approach. On the other hand, unsupervised grouping problems consider situation where potential groups in given data set have to be defined, in a manner that elements, which are in the same cluster express more similarities between each other in comparison to the elements in the other clusters (Doumpos & Zopounidis, 1999).

In order to address the classification problems various methodological frameworks have been developed (Andreopoulo et al., 2017). Traditionally, application of statistical and econometric methods have been present in scientific literature such as discriminant analysis, K-means clustering, hierarchical cluster analysis etc. (Doreian et al., 2005; Nemery, 2006). However, the recent research developments in the field of the classification models are directed to the usage of operations research tools and artificial intelligence technics. Several approaches emerge, such as: artificial neural networks, Naive Bayes networks/classifiers, mathematical programming, fuzzy and rough sets, and last but not least, MCDA methods. These methodological frameworks have been validated in wide range of real-world applications: medical diagnosis, human resource management, risk management failures, financial and economic risks etc. While all methodologies have their advantages as well disadvantages, according to the Zopounidis & Doumpos (2002b) MCDA methods can be an adequate option in a situation when the focus is not only on the development of automated procedures for creating a classification. Therefore, MCDA classification models also aim to incorporate decision maker’s preferences, which sometimes could be defined even in qualitative form.

In this contribution, this paper analyze applicability of well-known multicriteria methods for addressing various business decision making issues that need classification support. To justify usefulness and accuracy of proposed methods illustrative example has been analyzed and solved, then derived results have been mutually compared in order to determine validity and robustness of proposed multicriteria sorting frameworks.

This paper is organized as follows: Section 2 gives brief literature review considering MCDA classification/sorting methodologies; Section 3 presents application of three well-known MCDM sorting techniques: PROMETHEE FlowSort, ELECTRE Tri and TOPSIS-Sort, which have been applied in business case example, Section 4 summaries the research findings and discusses further research directions.

2. LITERATURE REVIEW

Multicriteria decision making analysis (MCDA) strive to find optimal solution/s for the decision problems in the presence of multiple, usually conflicting criteria. Scientific

researches that employed multicriteria analysis have shown tremendous development potential during the past two decades, where numerous methods and techniques have been used to solve different management problems (Stevic et al., 2016). In the recent years many well-known researchers and practitioners from the field of MCDA and operations research have devoted their studies to address decision making situation where considered alternatives (options) need to be assigned (classified) into two or more predefined homogenous groups, where these groups can be nominal or ordinal, and also express preferential relations among each other (Doumpos et al., 2019). Moreover, assignment of the alternatives into the nominal groups refers to the classification problem, where there is no need for the preference order between predefined groups. On the other hand, when the alternatives are assigned to the groups that are completely ordered one can consider that situation as sorting.

Various MCDA based methods have been developed and introduced in the literature for classification issues in business organization. A comprehensive literature overview on this special topic and used MCDA classification methods can be found in several references (Zopounidis & Doumpos, 2002a, 2002b; Nemery, 2008; Doumpos et al., 2019 etc.). Also, deeper insight of the related literature indicates that some of the most popular multicriteria methods have been extended to the classification especially to the sorting problems. For example, some of the prominent MCDA methods such as the **Analytic Hierarchy Process-AHP** (Saaty, 1980; Bozanic et al., 2015), The **Preference Ranking Organization METHod for Enrichment of Evaluations- PROMETHEE** (Brans & Vincke, 1985), the **ELimination Et Choix Traduisant la REalité-ELECTRE** (Roy, 1978, 1981), the Measuring attractiveness through a categorical-based evaluation technique- **MACBETH** (Bana e Costa et al., 2012), the **Technique for Order of Preference by Similarity to Ideal Solution-TOPSIS** (Hwang & Yoon 1981; Yoon, 1987; Hwang et al., 1993), **VIseKriterijumska Optimizacija I Kompromisno Resenje-VIKOR** (Opricovic & Tzeng, 2004) have been adapted and applied to the sorting problem, such as the AHP variations: **AHP-Sort** (Ishizaka et al., 2012), **AHP-Sort II** (Miccoli & Ishizaka, 2017), **GAHP-Sort** (Lopez & Ishizaka, 2017), **AHP-K-GDSS** (Ishizaka et al., 2017), such as the PROMETHEE variations: **PROMETHEE TRI** (Figueira et al., 2004), **PROMSORT** (Araz & Ozkarahan, 2005), **FlowSort** (Nemery & Lamboray, 2007, 2008), such as ELECTRE variations: **ELECTRE-TRI** (Yu, 1992, Roy & Bouyssou, 1993), **ELECTRE Tri-C** (Almeida-Dias et al., 2010), **ELECTRE Tri-nC** (Almeida-Dias et al., 2012), **ELECTRE-Sort** (Ishizaka & Nemery, 2014), such as other modifications: **MACBETH-Sort** (Ishizaka & Gordon, 2016), **TOPSIS-Sort** (Sabokar et al., 2016; Salih et al., 2019; de Lima Silva & de Almeida Filhob, 2020) and **VIKORSORT** (Demir et al. 2018).

However, according to the Pamucar and his colleagues there is no doubt that decision makers are still facing with a paradox which MCDM method is most effective (Pamucar et al., 2017). Multicriteria decision making in the context of sorting is challenging and it requires the development and validation of models, which take in consideration all specific characteristics and the nature of each decision situation and also decision makers that are involved. Bearing this in mind, this paper has two-fold contribution regarding this topic. First, it introduce the application of three MCDA sorting methods in case of real business example. Second, obtained sorting results were compared in order to determine the robustness of used MCMD methods. Following MCDM sorting methods have been used in the rest of this paper: **FlowSort**, **ELECTRE Tri** and **TOPSIS-Sort**.

2.1. FLOWSORT METHOD

The FlowSort method was introduced by Philippe Nemery as a part of his Ph.D. thesis (Nemery, 2008), where detail methodological procedure of this MCDA sorting approach can be also found in his referent papers with colleague Claude Lamboray (Nemery & Lamboray, 2007, 2008). In what follows, short explanation of the FlowSort principle will be given.

The FlowSort procedure refers to the extension of classical PROMETHEE methods to the sorting decision making issues. This methodology enables allocation of alternatives $a_i \in A$ for every $i=1, \dots, m$, into a predefined categories $K=\{C_1, \dots, C_K\}$ based on their calculated PROMETHEE flows in relation to conflict criteria $F=\{g_1, \dots, g_q\}$, either positive and negative flows:

$$\Phi^+(a) = \frac{1}{m-1} \sum_{x \in A} \pi(a, x) \quad (1)$$

$$\Phi^-(a) = \frac{1}{m-1} \sum_{x \in A} \pi(x, a) \quad (2)$$

or net flows:

$$\Phi(a) = \Phi^+(a) - \Phi^-(a) \quad (3)$$

The predefined categories K are completely order, which means that there are order from the most preferred (C_1) to the least preferred (C_K) group. Additionally, this categories are defined either by limiting profiles $R=\{r_1, \dots, r_{K+1}\}$ or central profiles (Sarrazin et al., 2018). The next Figure 1. shows limit profiles in the FlowSort method for a sorting problem with g criteria and K categories.

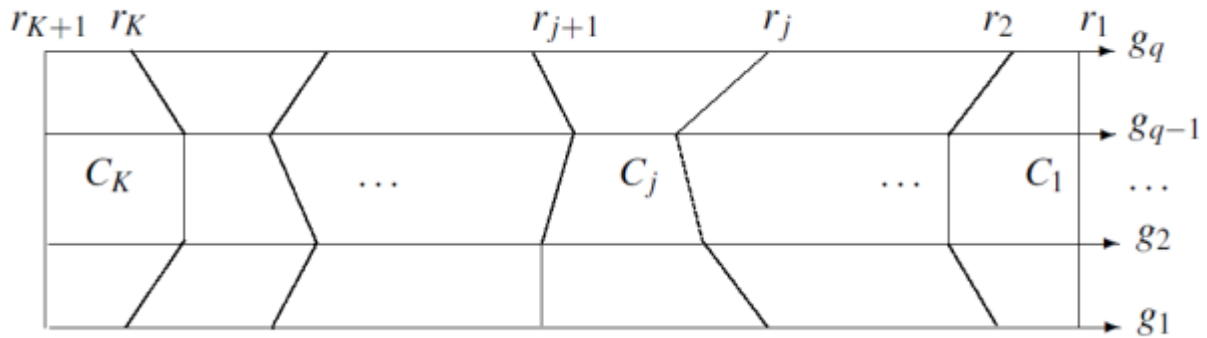


Figure 1. Illustration of limit profiles r_k in FlowSort (Adapted from Nemery, 2008)

In case that categories are characterized by limit profiles, than each category C_h is represented by two limit profiles: the upper limit profile r_h and the lower limit profile r_{h+1} . Furthermore, some conditions need to be assumed (Doumpos et al., 2019):

$$\text{Condition 1: } \forall a_i \in A : g_k(r_{h+1}) \leq g_k(a_i) \leq g_k(r_h) \quad \forall g_k \in \{1 \dots q\} \quad (4)$$

$$\text{Condition 2: } \forall r_h, r_l \in R \setminus h < l : g_k(r_h) \geq g_k(r_l) \quad \forall g_k \in \{1 \dots q\} \quad (5)$$

$$\text{Condition 3: } \forall r_h, r_l \in R \setminus h < l : \pi(r_h, r_l) > 0 \quad (6)$$

Finally, association of an alternative $a_i \in A$ to a given category is performed by comparing its PROMETHEE net flow scores to the limit profiles of given category, where if it is ranked between two successive limit profiles r_{h+1} and r_h then it will be assigned to the category C_h . Consequently, assignment rule can be defined as:

$$C(a_i) = C_h, \quad \text{if } \Phi^{R_i}(r_h) > \Phi^{R_i}(a_i) > \Phi^{R_i}(r_{h+1}) \quad (7)$$

where:

$$\Phi^{R_i}(a_i) = \sum_{k=1}^q w_k \Phi_k^{R_i}(a_i) = \sum_{k=1}^q w_k \cdot \left[\frac{1}{|R_i| - 1} \sum_{j=1}^{K+1} [P_k(a_i, r_j) - P_k(a_j, r_i)] \right] \quad (8)$$

$P_k(a_i, r_j)$ - unicriterion preference degree

$R_i = \{r_1, \dots, r_{k+1}\} \cup \{a_i\}$

2.2. ELECTRE TRI METHOD

The ELECTRE TRI method is one of the earliest MCDM sorting methods, developed by Yu (1992) based on the ELECTRE III methods. The basic sorting mechanism is similar to the previous one presented with FlowSort approach. Namely, Electre-Tri is a multicriteria sorting method used for the assignment of a set of actions $a_i \in A$ into K completely ordered categories C_1, \dots, C_K where category C_h is better than (or preferred to) category C_{h+1} . Also, the categories are defined by an upper and lower boundary or limiting profile (Nemery, 2008).

The association of an action $a_i \in A$ to one of categories is performed based on the outranking relations between that action and defined limit profiles according to the set of coherent criteria $F = \{g_1, \dots, g_q\}$.

The outranking degrees $S(a_i, r_h)$ and $S(r_h, a_i)$ (where $\forall h=1, \dots, K+1$ and $r_h > r_{h+1}$), measure the strength of outranking relation between considered elements a_i and r_h . Consequently, based on the results of these outranking degrees and so called cut-of level λ , four different situations can occur in practice (Ishizaka & Nemery, 2013):

- $a_i I r_h$, i.e. a_i and r_h are indifferent if and only if $S(a_i, r_h) \geq \lambda$ and $S(r_h, a_i) \geq \lambda$,
- $a_i R r_h$, i.e. a_i and r_h are incomparable if and only if $S(a_i, r_h) < \lambda$ and $S(r_h, a_i) < \lambda$,
- $a_i P r_h$, i.e. a_i is preferred to r_h if and only if $S(a_i, r_h) \geq \lambda$ and $S(r_h, a_i) < \lambda$,
- $r_h P a_i$, i.e. r_h is preferred a_i to if and only if $S(a_i, r_h) < \lambda$ and $S(r_h, a_i) \geq \lambda$.

Notes that outranking relation that is represented by $S(a, b)$ can be calculated by following formula, which summarizes the concordance and discordance degree as a measure how much a outranks b :

$$0 \leq S(a, b) = C(b, a) \cdot \prod_V \left[\frac{1 - d_k(b, a)}{1 - C(b, a)} \right] \leq 1 \quad (9)$$

where V is the set of criteria for which $d_j(b, a) > C(b, a)$ (Ishizaka & Nemery, 2013).

More, when comparing action $a_i \in A$ in regard to the reference profiles, three different scenarios may occur (Roy & Bouyssou, 1993):

- Alternative a_i is in between two successive limit profiles, i.e. $r_1 > a_i, r_2 > a_i, \dots, r_j > a_i, a_i > r_{j+1}, a_i > r_{j+2}, \dots, a_i > r_K, a_i > r_{K+1}$,
- Alternative a_i is indifferent with respect to one or several successive limit profiles, i.e. $r_1 > a_i, r_2 > a_i, \dots, r_{j-1} > a_i, a_i I r_j, a_i I r_{j+1}, \dots, a_i I r_{j+K}, a_i > r_{j+K+1}, \dots, a_i > r_K, a_i > r_{K+1}$,

- Alternative a_i is incomparable with respect to one or several successive limit profiles, i.e. $r_1 > a_i$, $r_2 > a_i$, ..., $r_{j-1} > a_i$, $a_i R r_j$, $a_i R r_{j+1}$, ..., $a_i R r_{j+k}$, $a_i > r_{j+k+1}$, ..., $a_i > r_k$, $a_i > r_{k+1}$,

ELECTRE TRI methods defines two different approaches to address these possible scenarios: the optimistic and pessimistic rule. In general, the pessimistic procedure can be applied when a policy of prudence is necessary or when the available means are very constraining. The optimistic procedure can be applied for problems where the DM desires to favor specific alternatives that present some particular interests or some exceptional qualities (Roy & Bouyssou, 1993). Formally, Nemery gave following explanation (Nemery, 2008):

- **Optimistic assignment rule:** An action a_i will be assigned to the category C_h , if the upper limiting profile r_h is the worst (lowest) profile which is preferred to considered action a_i ,
- **Pessimistic assignment rule:** An action a_i will be assigned to the category C_h if the lower limiting profile r_{h+1} is the best (highest) profile which is outranked by considered a_i or with which a_i is at least as good.

2.3. TOPSIS-SORT METHOD

The novel TOPSIS procedure, adapted for the sorting of alternatives, was introduced by Sabokbar and associates in 2016 (Sabokbar et al., 2016). The proposed TOPSIS-Sort methodology assigns the alternatives to categories based on their comparison to the reference profiles that defined predefined and completely ordered groups. Later on, authors de Lima Silva and de Almeida Filhob from Brazil in 2020 presented the improved version of TOPSIS-Sort method, named TOPSIS-Sort-C (de Lima Silva & de Almeida Filhob, 2020) that now propose one additional step for determining a domain for each criterion and an interval normalization option.

One may follow adapted steps from Sabokbar et al.. 2016 to conduct TOPSIS-Sort procedure (de Lima Silva & de Almeida Filhob, 2020):

- **Step 1:** Determine the Decision Matrix $X=[a_{i,j}]_{m \times n}$,
- **Step 2:** Establish a set of Profiles $P=\{(P^u_1, P^l_1), (P^u_2, P^l_2), \dots, (P^u_q, P^l_q)\}$, where P^u_k and P^l_k are respectively the upper and lower limits of class C_k ,
- **Step 3:** Establish a new Decision Matrix $M=[M_{i,j}]_{(m+q) \times n}$ formed by the set of alternatives and profiles.
- **Step 4:** Calculate the Normalized Decision Matrix $R = [r_{i,j}]_{(m+q) \times n}$ starting with the equations:

$$r_{i,j} = \frac{M_{i,j}}{\max_{1 \leq i \leq (m+q)} M_{i,j}}, i = 1, \dots, (m+q) \quad j = 1, \dots, n \quad \text{for benefit criteria} \quad (10)$$

or

$$r_{i,j} = 1 - \frac{M_{i,j}}{\max_{1 \leq i \leq (m+q)} M_{i,j}}, i = 1, \dots, (m+q) \quad j = 1, \dots, n \quad \text{for cost criteria} \quad (11)$$

- **Step 5:** Conduct steps 2 to 5 of traditional TOPSIS method, i.e. first determine ideal and anti-ideal solutions based on values from the weighted normalized matrix. Next, calculate the Euclidean distances of each alternative, the upper limit profile, and the lower limit profile in relation to the previous ideal and anti-ideal

results. Finally, determine the closeness coefficients C_i of each alternative (a_i), upper limit profile (P_k^u) and lower limit profile (P_k^l),

- **Step 6:** Classify the alternatives by making comparisons between their closeness coefficients $C_i(a_i)$ and those of the upper $C_i(P_k^u)$ and lower $C_i(P_k^l)$ limits of the profiles. Where following association rule can be applied:

$$a_i \in C_k \Leftrightarrow C_i(P_k^u) < C_i(a_i) < C_i(P_k^l), i = 1, \dots, m \quad k = 1, \dots, q \quad (12)$$

3. ILLUSTRATIVE EXAMPLE

In this section of the paper numerical example was analyzed and solved in order to show applicability and usefulness of previously discussed MCDA sorting techniques. The real case data from SMEs organizations have been used to test and validate the use of proposed sorting methodological frameworks.

In this example, MCDA sorting methods have been applied in real world classification problem concerning the evaluation of 10 SMEs initiatives. This problem was also studied by author of this paper in order to test traditional PROMETHEE I and II ranking approaches (Prvulovic et al., 2009). The aim is to classify 10 SMEs into the four predefined categories based on their business performance in respect to the 9 evaluation criteria. Following categories were defined:

- Category 1: SMEs with the high performance,
- Category 2: SMEs with the promising performance,
- Category 3: SMEs with the competitive performance,
- Category 4: SMEs with the weak performance.

The evaluation criteria consisted of 9 economic and financial indicators, where 8 were quantitative criteria and 1 was quality criterion.

By following methodological frameworks described in Sections 2.1., 2.2. and 2.3., in Table 1 limit profiles were defined for 4 predefined groups (open case with three limit profiles boundaries). These set parameters and limit profiles were the same for all three MCDA sorting procedures FlowSort, ELECTRE TRI (optimistic and pessimistic rules) and TOPSIS-Sort.

Table 1. Specification of limit profiles parameters for predefined categories

Code	Evaluation criteria	Max/min	Criteria weight	Limit profile boundary		
				R1	R2	R3
g1	Number of employees	min	0.05	1	3	5
g2	Revenues	max	0.2	120000	80000	50000
g3	Competitors	min	0.2	8000	12000	16000
g4	Material cost	min	0.08	10000	15000	20000
g5	Gross earnings	max	0.05	100000	80000	50000
g6	Nonmaterial costs	min	0.04	5000	7500	10000
g7	Income tax	min	0.04	1500	3000	4500
g8	Internal rate of return	max	0.14	1	0.6	0.1
g9	Investments	min	0.2	1	3	5

By using the proposed MCDA sorting procedure, assignment results were obtained and shown in Table 2. According to the results, it can be noted that results of ELECTRE Tri approaches, both optimistic and pessimistic, were consistent. Considering the fact that both

rules are based on the same ELECTRE III methodological framework, these results have been expected. Namely, firms F₃, F₆ and F₉ according to the ELECTRE III results have the highest ranking position based on their business performance, therefore, there were assigned into the category of high performance SMEs. On the other hand, firm F₂, had last ranking position in ELECTRE III ranking, so, accordingly it has been associated to category 3.

Table 2. MCDA sorting assignment results

Category	FlowSort	Electre Tri (optimistic)	Electre Tri (pessimistic)	TOPSIS-Sort
Category 1 (High performance)	-	F ₃ , F ₆ , F ₉	F ₃ , F ₆ , F ₉	-
Category 2 (Promising performance)	F ₁ , F ₃ , F ₄ , F ₆ , F ₇ , F ₈ , F ₉ , F ₁₀	F ₁ , F ₄ , F ₅ , F ₇ , F ₈ , F ₁₀	F ₁ , F ₄ , F ₅ , F ₇ , F ₈ , F ₁₀	F ₂ , F ₃ , F ₄ , F ₆ , F ₉
Category 3 (Competitive performance)	F ₂ , F ₅	F ₂	F ₂	F ₁ , F ₅ , F ₇ , F ₈ , F ₁₀
Category 4 (Weak performance)	-	-	-	-

Further, FlowSort procedure assigned 80 % of firms in category 2. Only, firms F₂ and F₅ based on their business performance were identified that they belong to category 3. Additionally, FlowSort procedure enables the deeper analysis of single criterion net flows scores, hence, one can consider the advantages of firms with good performance, and opposite, weakness of firms that were assigned to low-order categories can be analysed. In Figure 2. comparison of single criterion net flows are shown for firms F₆ (promising performer) and F₂ (competitive performer). According to the results shown in Figure 2, it can be concluded that Firm 6, which was assigned to category 2 as the best PROMETHEE II ranked alternative, has stable good performance for almost all considered criteria in model, except for the weak performance it has in regard to the criteria Competitors and Gross earnings.

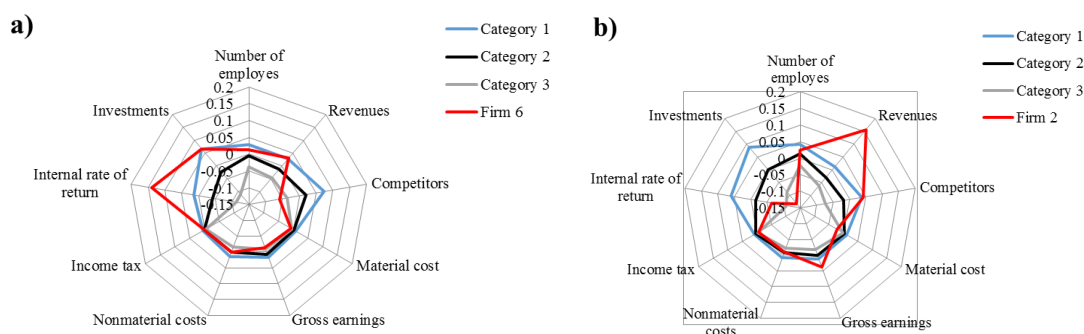


Figure 2. Comparison of the single criterion net flows for assigned alternative firms and respective categories: a) Firm 3; b) Firm 2

On analysing the TOPSIS-Sort results, it can be notice that the half of firms were associated to category 2, and the other half to the category 3. Surprisingly, alternative F₂ in this sorting procedure has belonged to the group of firms with promising performance. This fact can be explained by the fact that this firm performed relatively well regarding 3 criteria (Figure 2b) Revenues, Competitors and Gross earnings, which encompass total weight influences of 45% in model.

Last but not least, neither of applied sorting procedure associated alternatives to the “worst” (the least preferred group) category 4, where SMEs with weak performance were expected to occur.

4. CONCLUSION AND FURTHER RESEARCH

In this paper perspectives of using some of the prominent MCDA techniques have been considered for the sorting alternatives into the predefined and ordered groups. A numerical calculations were made to validate the usage and robustness of considered methods, where the same input data and setting parameters were used for this purpose. The obtained results showed potential of each individual MCDA sorting method and confirmed that a quality decision can be achieved. Moreover, the results confirmed coherence and consistency among used methodologies with what was expected considering the characteristics and nature of each MCDA method.

Further research on this topic can be directed in several directions:

- Most of the MCDA sorting procedures consider usage from single decision maker usage or a group of decision maker acting as one. Therefore, tendency can be to adapt current sorting procedures to support the group decision making,
- Hybridization of sorting procedures, i.e. combining several sorting procedures in one can additionally strength the applicability and effectiveness of MCDA sorting models,
- Uncertainty and vagueness of input data and decision makers' judgements in MCDA sorting procedures can be addressed by integrating approaches such fuzzy logic and/or rough sets.

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THE ENTERPRISE SIZE AND AGE AS DETERMINANTS OF SMEs FAILURE

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Abstract: This paper presents an analysis of the failure determinants of small and medium enterprises in Serbia. The aim is to examine the relationship between size and age, and the failure of small and medium-sized enterprises. The analysis was performed on data from a survey conducted in Serbia in small and medium-sized enterprises during 2018 and 2019, which had financial difficulties and at some point ceased or dramatically changed the business operations. Separate statistical analyzes were conducted for the size of small and medium enterprises and the factors of failure, and for the age of enterprises, in order to determine the categories that are more sensitive to financial distress than others. The results indicate that enterprises in Serbia are differently affected by the financial crisis when looking at the size of companies, while attitudes about certain factors of failure do not differ. Further, in the case of the age of the enterprise, the results show that younger enterprises are more prone to financial crises and bankruptcy than more mature enterprises.

Keywords: enterprise size, enterprise age, small and medium enterprises, failure

1. INTRODUCTION

Small and medium enterprises (SMEs) are the backbone of the progress of any economy, given that they are the bearers of development, employment and innovation. The SME sector is particularly important in countries that have gone through a transition and a period of disintegration of large state-owned companies. The interest in SMEs failure is increased after the financial crisis in 2008 when a large number of SMEs closed, provoking an increase of unemployment. Monitoring and understanding the reasons for the SME's failure is of great significance for policymakers, enterprises, the financial institutions, in order to propose adequate measures to help preserve and develop this vital economic sector. The main problem SMEs face is very limited resources and significant financial difficulties if unexpected disturbances occur (Jung et al., 2018). In order to overcome financial difficulties, SMEs reduce investments in research and development, reduce the number of employees, change the scope or type of products and services they offer, which leads to further degradation of business performance or complete cessation of business activities.

To this day, the classification of enterprises by size has remained a topic of discussion. Most often, each country defines its own criteria for classification. The criteria for classification are the number of employees, legal status, industrial sector, size of assets, and

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capital investments (El Kalak & Hudson, 2016). The classification of SMEs in Serbia was performed according to the number of employees, where micro-enterprises are defined as those with up to 9 employees, small enterprises with 10 to 49 employees and medium-sized enterprises are those with 50-249 employees. Entrepreneurs are persons who independently perform activities and are classified as micro-enterprises (Ministry of Economy, 2018).

In the Republic of Serbia, according to the report of the Ministry of Economy, the SME sector accounts for 99.9% of total active enterprises and employs 44% of registered employment (Ministry of Economy, 2018). The largest percentages of SMEs are entrepreneurs 71.9%, followed by micro-enterprises 24.36%, 2.96% small and 0.7% medium-sized enterprises. Statistics show that on average, in Europe, 39% of established SMEs fail in the first 3 years of operation, while only 48.38% survive after the 5th year (Mihajlović & Stojanović, 2019). Such a high failure rate of SMEs deserves additional attention from researchers in this field.

This paper examines the responses of SMEs in Serbia to financial distresses depending on the size of the enterprise and the age of the enterprise at the moment the financial crisis. The study is based on data collected during a survey conducted in 2018-2019, which aimed to examine entrepreneurs who had financial difficulties and determine which factors significantly influenced the failure of their enterprise (Mihajlović & Stojanović, 2019; Milošević et al., 2019).

2. LITERATURE REVIEW

The failure of SMEs is a topic that researchers often address from various aspects, trying to develop models that would identify risks and predict methods for their reduction (Gupta et al., 2018). Monitoring the failure and identifying the characteristic reasons why SMEs fail is not an easy task given that respondents are difficult to find and persuade them to participate in the research since the failure can be very stressful and personal, and that can lead to biased answers (Altman et al., 2010). Also, when studying failure, different variations of the definition of failure occur. Some authors see the failure as bankruptcy and the cessation of the business entity, while others define it as a change in the company's activities from production to services, voluntary closure, or a merger with a larger company (Esteve-Pérez et al., 2008; Pretorius, 2009; Tobbäck et al., 2017), etc.

Many authors suggest that financial problems are the main reason for the failure of SMEs while others point to a lack of managerial skills and planning (Hutchinson & Xavier, 2006); Altman et al., 2010). Lukason and Laitinen, (2019), examining the risks and stages of the enterprise failure process, have concluded that annual and accumulated profitability are the most important contributors to company failure. Franco and Haase (2010) in their study marked off two groups of influencing factors that classify the challenges faced by SMEs that lead to poor performance and failure. The first group includes external factors that encompass limited access to finance, poor market conditions, competition, unsatisfactory staff and lack of institutional support, while the second group includes internal factors such as lack of cooperation and networking, outdated technology, lack of entrepreneurial competencies and weak strategy and vision.

In a previous study, Milošević et al. (2019) proposed three factors that affect the failure of SMEs: personal - related to the personal characteristics of entrepreneurs and motivation to start the business; internal - representing the organizational and financial components that affect the failure; and external - where the most significant elements of political, economic and social influence are taken into account. This research confirmed the

significant influence of the personal factor on the deterioration of SMEs. On the other hand, Nikolić et al. (2018) concluded that external influences, such as political, economic and social, can significantly affect the failure of SMEs and their ability to recover.

A small number of researchers in their research make a difference between enterprises by size, because micro, small and medium-sized enterprises are most often treated as a homogeneous group (Gupta et al., 2018). However, size has a significant impact on the financial results of enterprise and the difficulties that SMEs meet in doing business do not affect enterprises of all sizes equally. Arguments in support of this are the fact that larger firms have more financial and personal resources with which can absorb increased operating costs (Williams & Uwi, 2014). Also, access to external sources of funding, which is considered a significant factor in the development and potential failure of SMEs, is a significant limiting factor for smaller SMEs (Gupta & Gregoriou, 2018). In a study on the failure factors of SMEs in the United States, Gupta et al. (2018) present evidence of varying degrees of failure of SMEs of different sizes. Also, in this research, it was confirmed that the influencing factors do not affect companies of different sizes equally, while it was not confirmed that the influencing factors are different.

Researches show that the ways in which SMEs respond to challenges arising from financial difficulties depend on enterprise characteristics (Latham, 2009; Archibugi et al., 2013). SMEs that constantly innovate their products and services increase their competitive power (Aghion et al., 2014). In contrast, in a period of the financial crisis, SMEs face declining sales and downsizing investment in innovation. This trend is particularly noticeable in smaller companies (Jung et al., 2018). El Kalak and Hudson, (2016), comparing SMEs failure prediction models, suggested that SMEs, especially micro and small, should be separately observed because their financial statements do not provide sufficient information on failure predictions as opposed to medium-sized enterprises where influential variables can be determined.

The age of the enterprise can affect financial difficulties (Gupta et al., 2018). Firm age is used in the context of the assumption that older firms have more resources and experience than firms that operate for a shorter period of time and are more likely to survive financial difficulties (Williams & Uwi, 2014), as well as a solid basis to change activities in response to problems. Kücher et al. (2020) showed in their research that younger enterprises fail mainly due to internal shortcomings, while more mature enterprises are less responsive to external influences. At the very beginning, newly established enterprises have initial capital and the risk of bankruptcy is moderate. As time passes, start-ups face specific challenges such as market barriers, weak connections and networks, and problems in recruiting adequate staff, start-up capital decreases and the next stage may be an early failure (Strotmann, 2007; Kücher et al., 2020). On the other hand, company age can also be a problem in mature enterprises that develop strong inertia and become less flexible in responding to challenges (Kücher et al., 2020).

3. DATA AND METHODS

The research was carried out during 2018 and 2019, where the respondents were owners or managers of SMEs who had financial difficulties due to which they had to close the enterprise or change activities. It was adopted definition according to which financial difficulties imply bankruptcy, but also a drastic change in the company's activities. The research was conducted through a structured questionnaire in which the respondents rated the statements about SME failure on a Likert five-point scale where 1 represented "completely

disagree" while 5 represented "completely agree". Data analysis was performed on a sample of 128 correctly completed questionnaires.

The sample was analyzed from the aspect of size and age of the company, performing univariate analyzes, using factors defined in the research of Milošević et al. (2019) and by conducting the successive analysis of variance tests.

4. RESULTS

First, the focus is on the size of enterprises, where, in the sample, are 94 micro-enterprises, which represent 73.4% of the total number of respondents, 25 small enterprises, which is 19.5%, and 9 medium-sized enterprises, which is 7.0% of the respondents.

The analysis of the data showed that the largest percentage of micro-enterprises after financial difficulties discontinued operations, 55.3%. The response of small and medium enterprises to financial difficulties is an attempt to develop new services, which is decided by 44.0% of small and 55.6% of medium enterprises Figure 1.

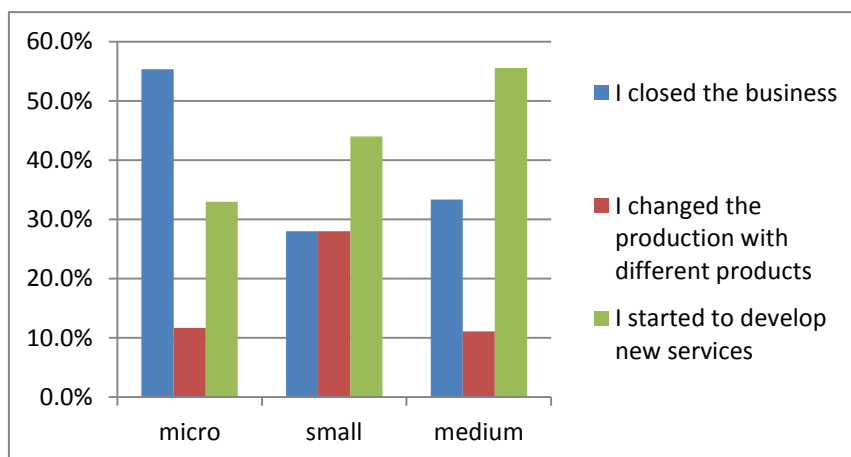


Figure 1. Analysis of SME response to the financial crisis in relation to size

The results of the analysis of variance of SMEs failure factors generated in the study by Milošević et al. (2019) in relation to the size of the enterprise are presented in Table 1. A more detailed analysis of factors influencing failure, using successive ANOVA tests, found there are no statistically significant differences that would confirm that the personal characteristics of entrepreneurs influence the response to financial difficulties. The second proposed factor, internal, as well as the third, external, also do not show statistically significant differences depending on the size of the enterprise.

Table 1. Analysis of variance of failure factors in relation to the size of the enterprise

Factors	Considered variable	Question	F	Sig.
PERSONAL (PF-PM)	PF1	Self confidence	.378	.686
	PF2	Need for achievement	1.043	.355
	PF3	Creativity	2.097	.127
	PM1	Desire to be independent	1.471	.234
	PM2	Self-fulfilment	.021	.979
	PM3	Good networks	1.528	.221
INTERNAL (IF-IO)	IF1	Delay in fulfilling bank obligations	.219	.804
	IF2	The level of fixed assets free from any burden/inscription	.499	.608
	IF3	The level of clearing/ barter transaction	.908	.406
	IO1	Difficulties in absorption/acquisition of new technologies/innovation	.920	.401
	IO2	Inability to find new potential shareholders/ partner	1.918	.151
EXTERNAL (E)	E1	Political issues	.506	.604
	E2	Economic issues	.556	.575
	E3	Social issues	.016	.984

When it comes to the age of enterprises in times of financial problems, the sample includes 35 enterprises that operate for less than 3 years (27.3%), 26 enterprises that operate between 3 and 5 years (20.3%) and 67 enterprises that operate for more than 5 years (52.3 %). Respondents' responses to the financial crisis depending on the age of the enterprise are presented in Figure 2.

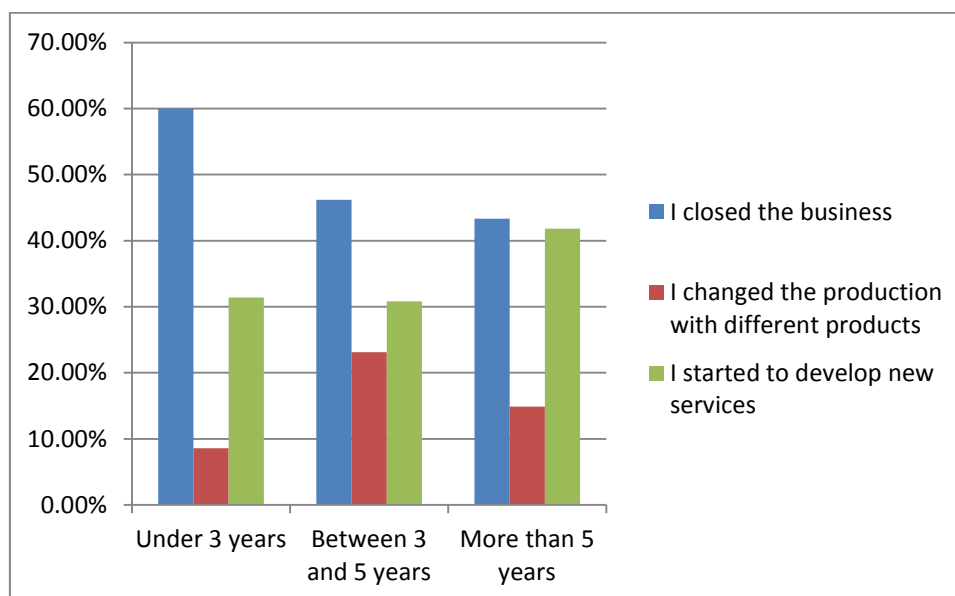


Figure 2. Analysis of SME response to the financial crisis in relation to age

The results indicate that young enterprises in 60.0% of cases respond to the financial crisis by closing, while that percentage decreases with the number of years of operation.

Table 2 shows the results of the analysis of variance of factors that in this case, instead of individual variables, were taken as a group of questions. This analysis showed that there are no statistically significant differences in the attitudes of entrepreneurs about the elements that affect business, regardless of the age of the enterprise.

Table 2. Analysis of variance of failure factors in relation to the age of the enterprise

Factors	F	Sig.
PERSONAL (PF-PM)	.493	.612
INTERNAL (IF-IO)	.426	.654
EXTERNAL (E)	1.160	.317

5. DISCUSION

In order to better understand the causes and failure process of SMEs, two significant demographic factors, size and age of SMEs, were considered. Through the results presented in this study, it has been shown that the size of SMEs has a significant impact on the response of SMEs to financial difficulties. Micro-enterprises and entrepreneurs, that make the largest share in this sector, in a large number of cases close their enterprises. Research conducted in other countries has also shown that micro-enterprises are the largest group of those in financial problems with a tendency to go bankrupt (Gupta et al., 2018).

It was also confirmed that another demographic factor, the age of the enterprise, plays a significant role in the enterprise's response to financial distress. In line with other research, in this study the results indicate that the age of the company affects the ability to overcome the financial crisis in business (Kücher et al., 2020) and that older companies have a better chance of overcoming the crisis and recovery than younger companies.

The results related to the examination of individual failure factors differ slightly from previous research (Nilolić et al., 2018; Milošević et al., 2019) since has not been demonstrated that attitudes about personal, internal and external influences cause different implications depending on size, as well as depending on the age of the enterprise.

6. CONCLUSION

Whether bankruptcy or financial crisis of SMEs is considered, consequences on entrepreneurs and the economy are significant. In this research, a sample of 128 respondents from Serbia was used, based on which results the useful implications can be provided. It has been shown that smaller enterprises find it harder to bear financial losses than larger ones. The reasons for this are less available human and financial resources as well as limited access to external sources of finance. When it comes to the age of companies, it has been shown that younger companies face greater challenges during the financial crisis and close their businesses more often, while older companies have to find ways to follow rapid changes in the environment. The results do not deviate from those obtained in research conducted in

much more developed economies than the Serbian economy (Strotmann, 2007; Gupta et al., 2018). The consistency of the results indicates that SMEs in Serbia face similar problems as in other countries.

The results of the research can be useful to managers, financial institutions and governments because adequate consideration of the position of an SME at a time of financial crisis in terms of size and age, can contribute choosing the right steps to enable SME survival and increase survival rate throughout the sector.

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AIR TRANSPORT FACTOR FOR THE ECONOMIC AND SOCIAL DEVELOPMENT OF REGIONS

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Abstract: The presented report is devoted to the development of air transport in the South-East region of the Republic of Bulgaria during the period 2008-2017. An attempt was made to establish the impact of air transport on the social and economic development of the region at NUTS-2 level. The analyses of socio-economic data and trends related to the development of regions use official statistics from the National Statistical Institute, Eurostat, ministries, state and regional agencies, state commissions, territorial and regional executive offices, as well as socio-economic data from analytical studies, infrastructure and environmental development of the regions and other official sources. This report argues that air transport in the country has potential growth and could to create more employment, higher GDP, and higher incomes.

Keywords: regional development, sustainable, integrated development of the region, socio-economic analysis, air transport

1. INTRODUCTION

Air transport occupies an important place in the world's economy, particularly in the emerging globalization where its significance is growing. Air transport carries out economic links at regional and international level. The rapid pace of global economic development is directed towards increased mobility of people and goods within short deadlines, as well as high quality service and security. This phenomenon creates a conflict between the environment and the steady increase in transport activity, which is expressed in terms of consumption of renewable and non-renewable natural resources, air pollution, land and water quality degradation, as well as the potential risk of transporting dangerous goods. Dangerous loads are classified as materials or objects that may attitude a risk to the health and safety of the transporter's personnel: explosives, combustible liquids, radioactive substances, etc. (Ministry of Transport, 1999). Yet, the link between air transport and regional development has not been fully explored, given all the socio-economic dimensions.

The tracking of passenger flows served by individual carriers at Bourgas Airport in Southeastern region provides an opportunity to analyze the pace of air transport development. From the processing of these data, several conclusions can be drawn regarding trends in air transport development to justify the economic efficiency of air transport and to make predictions about the future development of air transport in the region. Improving the socio-economic performance of the region requires reconciliation and commitment to coordinate the

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development of the transport sector in line with economic and social development at national and regional levels, the improvement of the regional access level to transport corridors, the development of border areas, and the provision of mandatory public transport services at affordable prices for the population. The purpose of the analysis is to show the impact of air transport on the socio-economic development of the regions and on the environment. The study demonstrates that air transport in the country has a positive impact on the socio-economic development of the regions while at the same time having a sparing influence on the environment.

2. ANALYSIS OF SOME SOCIO-ECONOMIC INDICATORS IN THE SOUTHEASTERN REGION

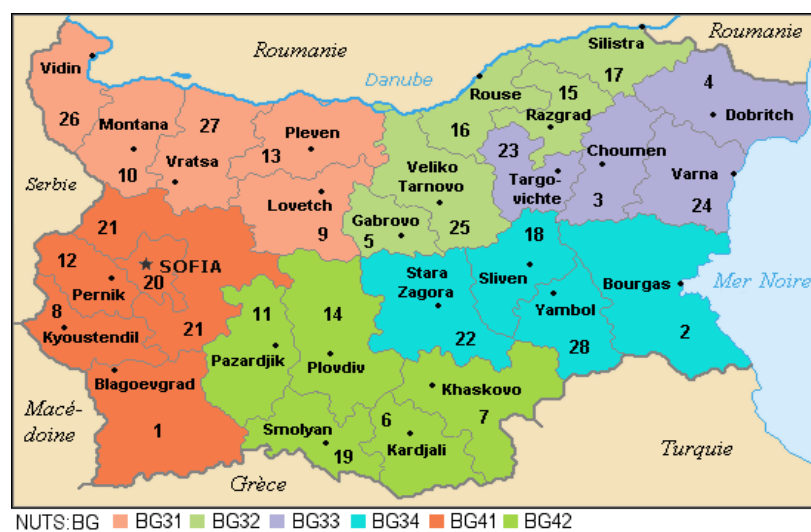


Figure 1. The region is on the second place among the Bulgarian regions of NUTS 2

Looking at the GDP per capita indicator Southeastern region.

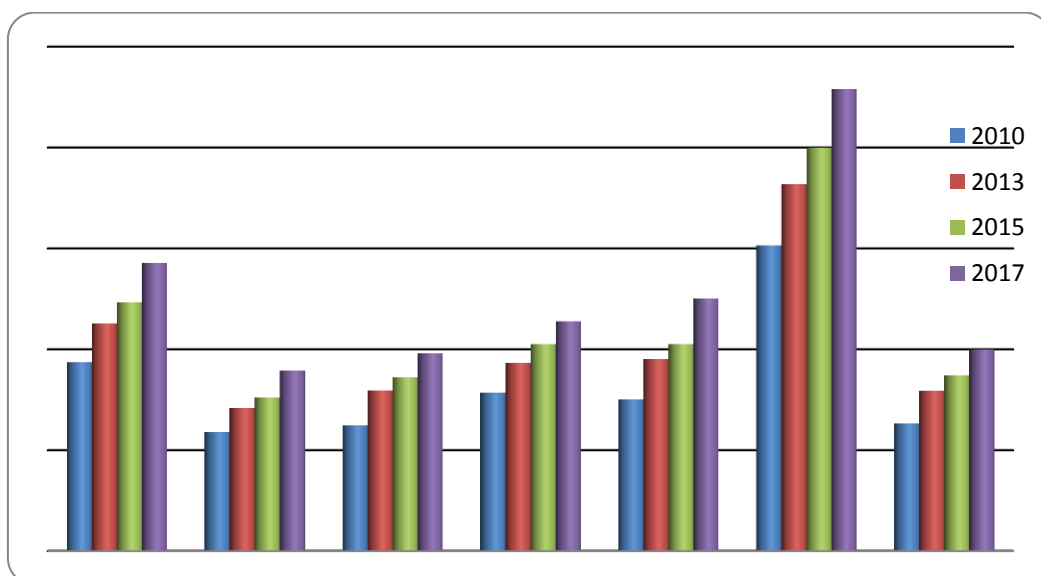


Figure 2. Regional GDP per capita for the period 2010 - 2017, (BGN) leva

Figure 2 show the value GDP per capita for all regions of NUTS 2 in Bulgaria for period 2010 - 2017 years. The regions value GDP per capita are below the national average. An exception is the Southwestern region where the capital is located. The northeastern and south-eastern regions surveyed have a trend of GDP growth. For the 2010-2017 period, the per capita GDP of these two regions grew by 70-80%.

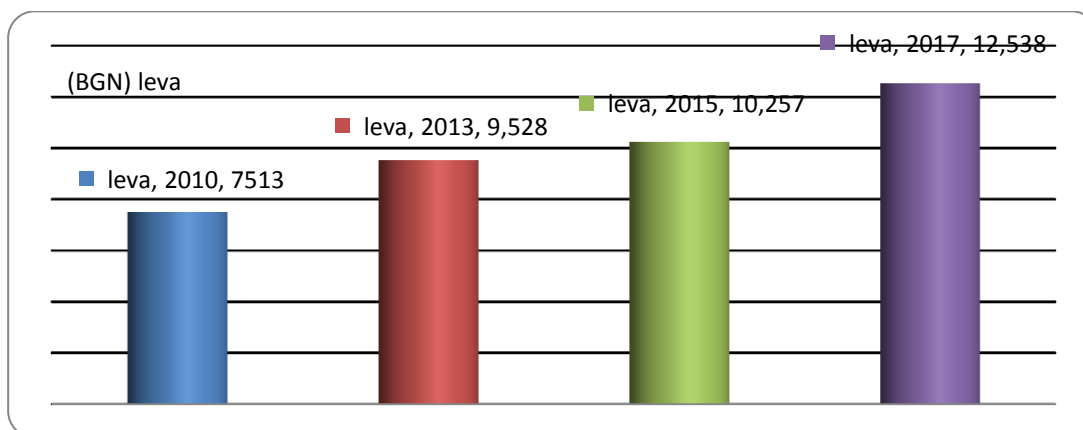
Table 1. Regional gross domestic product in the EU

Region	2017		
	GDP per capita - EUR	GDP per capita - purchasing power EUR	GDP per capita - purchasing power EU- 28 = 100
EU - 28	30 000	30 000	100
Bulgaria	7 300	14 800	49
Northeast region	5 800	11 800	39
Southeastern region	6 400	13 800	43

Source: National statistical institute, Republic of Bulgaria

Table 1 shows the regional gross domestic products in the EU and the disparity between Bulgaria and the EU and the location of the two regions surveyed. The table shows that Bulgaria has the lowest gross domestic product in the EU-28 and is below the average - 49%. But this indicator is growing, although not fast enough. Shown also and the spot in the EU - 28 of the surveyed regions - southeastern and southwestern regions. Table 1 shows the regional gross domestic products in the EU and the disparity between Bulgaria and the EU and the place of the two regions surveyed. The table shows that Bulgaria has the lowest gross domestic product in the EU - 28 and which is below the average - 49%. But this indicator is growing, although not fast enough. In 2017, the regional GDP per capita ranges from 31% for the Northwest region of Bulgaria (it is most poor region in EC) to 626% (maximal value) in West London in the UK.

Figure 3 reflects almost twice increase the growth of GDP per capita in the Southeastern region, for the period 2010-2017 - from 7513 BGN for 2010 to 12583 BGN for 2017, which is a good results for Bulgaria.



Source: National statistical institute, Republic of Bulgaria

Figure 3. GDP in Southeastern Region /per capita, in (BGN) leva

Among the economic sectors of the Southeastern region, the service sector accounted for 51% of the GVA (Gross Value Added) for 2010, with an average share of 63.8% for the country. This is a positive indicator that defines the region as a well-developed one for the Bulgarian conditions and has grown in recent years; it went to 80% in 2014 to 87% in 2017. The second-largest economic sector, the manufacturing sector, has an important role in the regional economy with 43% of GVA with an average of 31% in the country. The agrarian sector forms 5.8% of the GVA for the region and 4.8% for the country. Tourism has a leading position in the economy because of favorable natural factors, the established tourist base and infrastructure, and the traditional experience in providing seasonal tourist services (Ministry of Regional Development, 2013).

Table 2. Gross value added (GVA) on economic sectors and regions for 2017

Statistical region	GVA by economic sectors		
	Agricultural (%)	Industry (%)	Services (%)
Bulgaria	5	28	67
Northeast region	13	29	64
Southeastern region	6	46	48

Source: National statistical institute, Republic of Bulgaria

The average employment rate of persons aged 20-64 at the end of 2011 is 62.9%, which is close to the average of the country (63.9%). Within the country, the Southeastern region is in a relatively favorable position when it comes to individual income in a household and salary average. This is second place after to the Southwestern region. The average annual household income for Bulgaria in 2017 has reached 5,586 leva (2,852 EUR), an increase of 8.1% compared to 2016 and of 20 % compared to 2008. By income level, Bulgaria is the most underdeveloped and poor EU member state; the households' incomes are about 70% lower than the EU average. But in the country, the Southeastern region is in a relatively favorable position on indicators of total household income average wage, second after the Southwestern region (National Statistical Institute, 2017; Ministry of Regional Development, 2013).

The analyses of data in Table 1 and Table 2 give grounds to outline some positive aspects:

- In the Southeastern region, there is almost equal contribution of the services and the industrial sector as opposite to other regions where the service sector prevails, this region benefits economically from having two prevalent sectors. As shown in table 2 unlike other regions where the service sector prevails, this region benefits economically from having two prevalent sectors. They have almost equal relative shares - services and manufacture.
- The services sector occupies a larger part in the GVA of the country, in comparison to industrial and agrarian sectors. In the services sector, tourist services occupy a leading position.
- Tourism continues to occupy a leading position in the economy of the Southeastern region because of favorable natural factors, an established tourist base and infrastructure, and traditional experience in the provision of seasonal tourist services
- Southeastern region ranked first in the number of overnight stays among the regions NUTS-2 in the country and with a steadily growing share, such as 39 % for the year

2017; The Bourgas District leads the share in the overnight stays with over 94% of the total revenues for the region (Burgas Municipality, 2013).

The weaknesses that need to be addressed are:

- Tourism leading position in the economy with new hotel facilities has led to accelerated and large-scale construction along the Black Sea coast;
- Holiday villages and resort areas lead to the overburdening of communal and transport infrastructures and the increase in production for engineering facilities, thus polluting the environment, hence slowing the development of modern domestic and international tourism with high revenue and profitability for regional and local economies;
- Only the southernmost territories of the Black Sea coast are preserved in their natural state and by urban tourism development;
- Significant area disproportions are created because the bulk of the tourist base and the services offered are concentrated in the coastal towns and settlements of resort importance, as well as the resort complexes.

Notwithstanding the potential of the region to expand and diversify the regional tourist product, there are still no tendencies to overcome the seasonal nature of maritime recreational tourism due to insufficient quality of the services provided, such as accommodation and food, and a small number of quality tourism products complementing the maritime. Cultural tourism is not providing an all year-round load for the tourist base.

The high level of accommodation also implies high opportunities for tourism development, and thus a good marketing and advertising strategy for the development of regional tourism is needed, as well as a higher quality and greater variety of services for tourists.

The structure of the regional economy shows in Table 2 the need for continuous, significant investments to sustain the industrial sector's growth rate, in many cases at the expense of increased productivity of the agrarian and service sectors.

There is a need to invest in the development and improvement of the quality of human capital; efforts must be made to increase the quality of the workforce and to provide employment for the unemployed aged over 55 and youths up to 29 years of age, who are the two groups most affected by the population crisis (Institute for Market Analysis, 2018). Authorities should also ensure that labor supply matches the demand, and vice versa.

The following data shows a brief analysis of the socio-economic development of the districts of Varna (Northeast region) and Bourgas (Southeastern region) where international flights occur, in which doing an international flights.

3. AIR TRANSPORT AS A TOOL FOR REGIONAL DEVELOPMENT

The European aviation strategy for 2035 defines air transport as a "strong driver of economic growth, employment, trade, mobility in the EU, and having a synergistic effect on the other economic sectors. It plays a crucial role in the EU economy and plays an increasingly important role in the world" (European Commission, 2018).

There are large regional economic differences between and within EU countries. A challenge for the regional economy and regional policies is to reduce these inequalities and to achieve a specific objective of socio-economic cohesion, which includes mainstreaming,

based on higher GDP growth, greater competitiveness, and higher employment rate. Improving accessibility—especially remoteness and less developed regions is seen as one possible means of facilitating such approximation. A report from the European Parliament recognizes that access to large markets, diversified labor markets, and advanced services are becoming increasingly important for economic development. However, there is insufficient academic evidence on the relationship between air transport development and the level of economic development at the moment. (European Parliament, 2014). The creation and implementation of the Trans European Transport Network (TEN-T) (European commission, 2005) a program to support the construction and upgrade of transport infrastructure in European regions, often peripheral has led to reduce regional socio-economic disparities and improve European competitiveness (European Commission, 2005). These tools are intended to contribute for the development of the internal market and employment, pursuing the objectives of environmental protection and sustainable development. Reviewing the TEN-T Guidelines in 2004 and 2013 creates an integrated network, a two-tier structure (core/wide-meshed) TEN-T corridors and creating environmentally friendly and integrated transport.

4. CONCLUSION

The increase in the total number of passengers served at airports from 2011 to 2018 for the country, which has almost doubled from 6.9 million to 12.5 million, and the number of goods handled result from the expansion of air services airport transport. This growth stimulates economic development in a given region, as the increase in air traffic stimulates employment growth especially in some peripheral regions. Such investment programs could bring several advantages, although they do not always lead to a fast and direct impact on employment. Due to air transport, distances are no longer relevant. Forecasts and trends are for passengers and cargo growth and this is related to economic growth. The international civil Aviation organization estimates that the world merchant fleet will grow from approximately 26000 aircraft in 2016 to 47 500 in 2036.

Over the last forty years there has been a huge jump in airplane efficiency and noise reduction, but future aviation trends could be a major obstacle to achieving sustainability in the economic, social, and environmental development prospects.

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HELMINTH FAUNA OF *BARBUS CYCLOLEPIS* HECKEL, 1837 AND ECOLOGICAL APPRAISAL FOR THE CONDITION OF THE CHEPELARSKA RIVER, BULGARIA

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Abstract: Ecological monitoring was performed on Chepelarska River using *Barbus cyclolepis* Heckel, 1837, and its parasite communities as bioindicators. Helminth parasites are recorded in 45.83% of the examined specimens of the round-scaled barbell from the freshwater ecosystem of the Chepelarska River. Two species of parasites are fixed: one acanthocephalan species *Pomphorhynchus laevis* (Zoega in Müller, 1776), and one nematode species (*Rhabdochona hellichi* (Sramek, 1901)). The analysis of the dominant structure of the found parasite species is presented to the component and infracommunities level. In the component community of *Barbus cyclolepis* from Chepelarska River *R. hellichi* is core parasite species (P%=37.5), and *P. laevis* is an accidental parasite species (P%=7.41). The determined basic ecological characteristics, biotic indices, and bioindicator significance of the established parasite species were discussed for ecological evaluation of the state of the studied freshwater ecosystem. The established in this study parasite species are considered and compared with previous researches of parasite communities of *Barbus cyclolepis* in Bulgaria. This is the first report of *Pomphorhynchus laevis* and *Rhabdochona hellichi* from Chepelarska River, Bulgaria.

Keywords: *Barbus cyclolepis*, *Rhabdochona hellichi*, *Pomphorhynchus laevis*, Chepelarska River, fish parasites, biomonitoring

1. INTRODUCTION

River Chepelarska is a river in Southern Bulgaria that is right tributary of the Maritsa River. The river takes its source from the Rozhen peak (approximately 1,500 m above sea level) in Rhodopes Mountain. It drains the eastern slopes of the Chernatitsa ridge, the northwestern parts of the Prespa section, and the Dobrostan ridge of the Western Rhodopes. The river runs through the town of Chepelare, the village of Bachkovo, and the second-largest city of Plovdiv Province, Asenovgrad, further downstream, before emptying into the Maritsa. Its length is 86 km, which gives it 39th place among the rivers of Bulgaria. Fish parasite communities and biodiversity from the Chepelarska River were studied only from Kakacheva-Avramova (1965) and Kirin (2002).

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Freshwater fish are an essential element of aquatic ecosystems and, at the same time, are significant players in the parasitic flow in these ecosystems. Parasites are established indicators for ecosystem stability and biodiversity and ecological assessment of the ecosystems (Marcogliese & Cone, 1997; Marcogliese, 2003; Marcogliese, 2016; Sures et al., 2017; etc.). This paper presents the diversity and communities of endoparasites of *Barbus cyclolepis* Heckel, 1837 from Chepelarska River, Bulgaria. As a result of this survey new data for helminth fauna of the Chepelarska River is presented.

2. MATERIALS AND METHODS

During June 2020, fish and fish parasites are collected and examined from Chepelarska River near the village Bachkovo. The village of Bachkovo is situated on both banks of Chepelarska River, in southern Bulgaria.

A total of 24 round-scaled barbell specimens (*Barbus cyclolepis* Heckel, 1837) from Chepelarska River are collected and examined in 2020. Fish were caught by angling. The scientific and common names of fish hosts are used according to the FishBase database (Fröse and Pauly, 2020).

The fish samples were examined immediately after their capture for gastrointestinal parasites using standard techniques and. Helminthological examinations are carried out following recommendations and procedures described by Petrochenko, 1956; Bauer et al., 1981; Bykhovskaya-Pavlovskaya, 1985; Moravec, 1994; etc.

Acanthocephalans are examined as temporary slides in ethanol-glycerin and identified (Petrochenko, 1956; Bykhovskaya-Pavlovskaya, 1985). Nematodes are examined as temporary microscopic preparations in glycerin and identified (Moravec, 1994; 2013).

The dominant structure of the component helminth communities was determined according to the criteria proposed by Kennedy (1993) based on the prevalence (P%): accidental (P% < 10), component (10 < P% < 20), and core (P% >20) species. The ecological terms prevalence (P%), mean intensity (MI) and mean abundance (MA) are used based on the terminology of Bush et al. (1997).

Analyses of helminth community structure were carried out in both levels: infracommunity and component community. The component data were used to determine the total number of species, Shannon diversity index (H'), Pielou evenness index (E), Berger-Parker dominance index (d), according to Magurran (2004). The infracommunity data was used to calculate the mean number of species, the mean number of helminth specimens, Brillouin diversity index (HB) (Kennedy, 1993, 1997; Magurran, 2004).

3. RESULTS

3.1. MODEL FISH SPECIES

A total of 24 specimens of the round-scaled barbell (*Barbus cyclolepis* Heckel, 1837) are collected and examined from Chepelarska River. The studied fish species is estimated as least concern species (LC=Least Concern; IUCN Red List Status. The round-scaled barbell is not included in the Red Data Book of the Republic of Bulgaria (Golemanski (Ed.), 2011). *B. cyclolepis* is endemic fish to the Maritsa River Basin (Kolev, 2013).

Round-scaled barbell is freshwater, benthopelagic fish species (Fröse & Pauly, 2020). This fish species inhabits upper and middle reaches of flowing rivers with sandy-gravelly

bottom. *B. cyclolepis* feeds on larvae of chironomids, caddisflies, mayflies and plant detritus (Karapetkova & Zhivkov, 2010).

3.2. HELMINTH COMMUNITY STRUCTURE

Helminth parasites are recorded in 11 round-scaled barbell specimens (45.83%) from the Chepelarska River. Two parasite species are identified: one acanthocephalan (*Pomphorhynchus laevis* (Zoega in Müller, 1776) and one nematode species (*Rhabdochona hellichi* (Sramek, 1901)), presented by 45 specimens (Table 1).

Table 1. Species diversity of helminth parasites of *Barbus cyclolepis* from Chepelarska River (N – number of examined hosts, n – number of infected hosts, p – number of parasites, P – prevalence, MA – mean abundance, MI – mean intensity)

Helminth species	N=24					
	n	p	P%	MI±SD	MA±SD	Range
<i>Pomphorhynchus laevis</i> (Zoega in Müller, 1776)	2	16	7.41	8.0±6.0	0.59±2.66	2-14
<i>Rhabdochona hellichi</i> (Sramek, 1901)	9	29	37.5	3.42±1.98	1.52±2.15	1-6

R. hellichi is core parasite species (P%=37.5), and *P. laevis* is an accidental parasite species (P%=7.41) for the helminth communities of the round-scaled barbell (Table 1).

Species richness in infracommunity of *B. cyclolepis* ranges from 0 to 1 species. With one helminth species were infected 11 fishes (45.83%) (Table 2).

Table 2. Parameters of the infracommunities of *Barbus cyclolepis* from Chepelarska River

	Number of endohelminth species			
	0	1	Mean±SD	Range
<i>Barbus cyclolepis</i>	13	11	0.46±0.50	0-1
	Number of endohelminth specimens			
	Total number	Mean±SD	Range	Brillouin's index HB
<i>Barbus cyclolepis</i>	45	1.88±3.18	0-14	0.604

The largest number of helminth specimens established in a single host specimen is 14. The average species richness (mean number of species for fish specimen) in the infracommunity of the round-scaled barbell is 0.46±0.50 species. The average abundance (mean number of helminths in fish) in these infracommunities is 1.88±3.18 (Table 2).

In general, the parasite communities of *Barbus cyclolepis* are represented by two species of parasites belonging to two classes, two orders, and two families. The total number of isolated and studied helminth specimens is 45. The obtained results were related to a Brillouin diversity index HB=0.604, Shannon diversity index H'=0.651, Berger-Parker dominance index d=0.644, and Pielou evenness index E=0.939 (Figure 1).

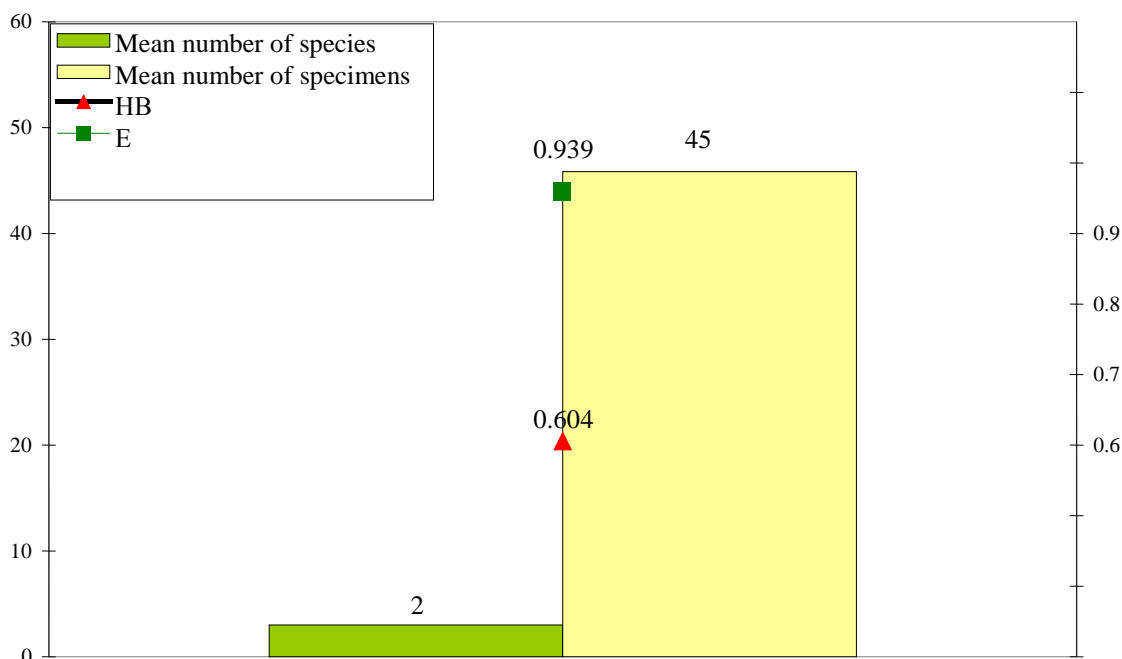


Figure 1. Biodiversity and ecological characteristics of the parasite communities of *Barbus cyclolepis* from the freshwater ecosystem of Chepelarska River

4. DISCUSSION

Pomphorhynchus laevis is an intestinal parasite of many freshwater fish, most often by a family Cyprinidae and less frequently by other families (Kakacheva-Avramova, 1983). This acanthocephalan develops with the participation of an intermediate host – *Gammarus pulex* (Amphipoda) (Petrochenko, 1956). *G. pulex* is a bioindicator for β -mesosaprobity (Johnson et al., 1993). *P. laevis* was reported as a parasite of *B. cyclolepis* from Tundzha River and Topolnitsa River (Kakacheva–Avramova, 1972; Chunchukova et al., in press). There are 3 acanthocephalan species registered for the helminth fauna of *Barbus cyclolepis* in Bulgaria (see Table 3).

Table 3. Overview of acanthocephalan species of *Barbus cyclolepis* registered in Bulgaria

Helminth species	<i>Acanthocephalus anguillae</i>	<i>Neoechinorhynchus rutili</i>	<i>Pomphorhynchus laevis</i>
Authority			
Margaritov (1965)	•		
Kakacheva-Avramova (1965)		•	
Kakacheva-Avramova (1972)			•
Kirin (2002)	•		
Kirin (2003)	•	•	
Chunchukova et al. (in press)			•
This study			•

Rhabdochona hellichi is an intestinal parasite mainly of barbels (Cyprinidae), but it is also found in other fishes serving as postcyclic or accidental hosts (Moravec, 2013). Intermediate hosts of *R. hellichi* are not well known (Kakacheva-Avramova, 1983; Moravec,

2013). But it has been found from Moravec & Scholz (1995) and Moravec et al. (1997) that for River Jihlava the intermediate hosts of *R. hellichi* are stone-fly larvae of genus *Hydropsyche*. Representatives of *Hydropsyche* are bioindicators for 0- α -mesosaprobity (Johnson et al., 1993). There are also two other species of genus *Rhabdochona* registered for *Barbus cyclolepis* in Bulgaria (see Table 4). For Bulgaria, the food spectrum and feeding of *Barbus cyclolepis* from the middle stream of Maritsa River was studied from Rozdina et al. (2008). The authors found that the food of *B. cyclolepis* is dominated by Chironomid larvae, followed by plant detritus and Gamarids, and representatives of Gammaridae and Trichoptera are also significant.

Table 4. Overview of nematode species of *Barbus cyclolepis* registered in Bulgaria

Authority \ Helminth species	Margaritov (1965)	Kakacheva -Avramova (1965)	Kakacheva -Avramova (1972)	Kirin (2003)	This study
<i>Rhabdochona gnedini</i>	•				
<i>Rhabdochona denudata</i>	•	•			
<i>Rhabdochona hellichi</i>				•	•
<i>Schulmanella petruschewskii</i>		•			
<i>Schulmanella</i> sp.			•		
<i>Nematoda</i> g.sp.	•				

From the established in this study helminth parasites and the knowledge of their biology, the circulation of parasitic flow in the studied freshwater ecosystem can be represented as follows: class Acanthocephala: crustaceans - fish - fish (*Pomphorhynchus laevis*); Class Nematoda: insect larvae - fish (*Rhabdochona hellichi*).

5. CONCLUSION

As a result of the study of 24 specimens of *Barbus cyclolepis*, a total of two species of endoparasites (one acanthocephalan and one nematode species) are established. *R. hellichi* is core parasite species (P%=37.5), and *P. laevis* is an accidental parasite species (P%=7.41) for the helminth communities of the round-scaled barbell. *Pomphorhynchus laevis* and *Rhabdochona hellichi* are reported for the first time for the freshwater ecosystem of the Chepelarska River in Bulgaria. Determined parasite species show that Trichoptera and gammarids' larvae are dominant in the diet of the round-scaled barbell in Chepelarska River. This might be because they are preferred food in the diet of *B. cyclolepis* or probably their populations are well represented in the studied freshwater ecosystem. Poor species diversity and indices of invasion indicate negative impacts on the biodiversity of studied the freshwater ecosystem.

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ECOLOGICAL STUDIES OF EURASIAN MINNOW FOR EVALUATION OF THE CONDITION OF GLACIAL LAKE BEZBOG IN PIRIN MOUNTAIN, BULGARIA

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Abstract: The glacial lake Bezbog fall within the boundaries of Pirin National Park and Pirin Protected Area BG0000209. The Park is of particular importance for the protection of the glacial lakes and the upper reaches of the rivers as typical habitats for the ichthyofauna. The fish species integrate the effects of stressors manifested at lower trophic levels, making them an extremely important biological element in understanding the impacts of large-scale environmental changes. The analysis of the parasite populations and communities of fish reflects their conditions and relationships with other organisms in the investigated lake ecosystem. During the ecological study of 30 specimens of Eurasian minnow (*Phoxinus phoxinus* (Linnaeus, 1758)) by applying standard techniques for parasites, an infestation with the nematode species *Salmonema ephemeridarum* ((Linstow, 1872) Moravec, Santos & Brasil-Sato, 2008), the larva was found. This is the first study of the helminth fauna of Eurasian minnow from Bezbog Lake. This study aims to present basic ecological characteristics of populations and communities of Eurasian minnow and the bioindicator significance of the established parasite species for ecological evaluation of the state of the studied freshwater ecosystem.

Keywords: *Phoxinus phoxinus*, *Salmonema ephemeridarum*, glacial lake, Bezbog, Pirin National Park

1. INTRODUCTION

The protection of freshwater ecosystems and fish species and resources is closely related to the adopted European conventions and directives and national legislation (Convention on Biological Diversity, Habitats Directive, Birds Directive, Bern Convention, Biodiversity Act, Red Book of Bulgaria, etc.).

No in-depth systematic research has been carried out on the eutrophication processes on the territory of Pirin National Park and especially about the lake ecosystems with a risk assessment for the fish communities. The aquatic ecosystems in the Park are characterized by a low degree of naturalness due to the annual stocking events in most of them. The Park is of special importance for the protection of glacial lakes and the upper reaches of rivers as typical

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habitats for ichthyofauna. All glacial lakes in the Pirin fall within the boundaries of Pirin National Park.

2. MATERIALS AND METHODS

During summer season, fish and fish parasites are collected and examined from the Bezbog Lake in Pirin Mountain (Bulgaria) (Figure 1). The Bezbog Lake (23 31 26.72E/ 41 43 59.26N) is located north-east of Peak Bezbog, above the town of Dobrinishte.



Figure 1. View of Lake Bezbog

A total of 30 specimens of Eurasian minnow (*Phoxinus phoxinus* (Linnaeus, 1758)) from the Bezbog Lake are collected and examined. Fish are caught by gill nets under fishery catch permits for research purposes issued by the Executive Agency of Fisheries and Aquaculture (EAFA) at the Ministry of Agriculture and Foods (Bulgaria). The fish host's scientific and common names are used according to the FishBase database (Fröse & Pauly, 2020).

For the lake, ecosystems have been applied techniques using gillnets with mesh sizes 0.5 cm - 3.2 cm in the lakeshore and depths of 0.5 - 1.5 m (EN 14757).

Immediately after capture, the fish were weight, measured, and examined for parasites using standard techniques. Each fish specimen is determined total length (L, cm), standard length (l, cm), maximum height (H, cm), weight (W, g), sex, and age (Zashev & Margaritov, 1966).

Helminthological examinations are carried out following recommendations and procedures described by Petrochenko, 1956; Bauer et al., 1981; Bykhovskaya-Pavlovskaya, 1985; Moravec, 1994; etc. Nematodes are examined as temporary microscopic preparations in glycerin and identified (Moravec, 1994; 2013).

The dominant structure of the component helminth communities was determined according to the criteria proposed by Kennedy (1993) based on the prevalence (P%): accidental (P% < 10), component (10 < P% < 20), and core (P% >20) species. The ecological terms prevalence (P%), mean intensity (MI) and mean abundance (MA) are used, based on the terminology of Bush et al. (1997).

3. RESULTS

3.1. MODEL FISH SPECIES

A total of 30 specimens of Eurasian minnow (*Phoxinus phoxinus* (Linnaeus, 1758)) are collected and examined from the Bezbog Lake. The studied fish species is estimated as least concern species (LC=Least Concern; IUCN Red List Status).

Eurasian minnow is freshwater, gregarious fish species. *Ph.phoxinus* feeds on algae, molluscs, crustaceans, and insects (Fröse & Pauly, 2020). Eurasian minnow inhabits the upper reaches of fast-flowing mountain rivers, streams, and lakes, clean, rich in oxygen with a sandy-gravel. It matures sexually in the second, third year at a length of about 5 cm. This fish species reaches 10-12 cm in length and weighs 10-15 g., grows slowly and lives up to 11 years. *Ph.phoxinus* is the natural food of trout (Karapetkova & Zivkov, 2010).

3.2. BASIC ECOLOGICAL CHARACTERISTICS OF POPULATIONS AND COMMUNITIES

The average body length (L, cm) is 8.63, and the average weight (W, g) is 6.51 of *Phoxinus phoxinus* from the Bezbog Lake. Eurasian minnow is found in the studied lake ecosystem with a density of 408 specimens/ha and biomass of 2.89 kg/ha. The size/age structure of the populations contains from 3th to 8th size groups. Sixth (47.30%) and fifth (27.03%) size groups in Bezbog Lake were best represented. There is a clear dominance of sexually mature individuals, and females over males -1♂: 11.4♀ for the studied lake ecosystem (Table 1).

Table 1. Main characteristics of the populations of *Phoxinus phoxinus* from the studied lake ecosystem (L1) on the territory of Pirin National Park (Ecoregion 7)

<i>Phoxinus phoxinus</i>		
Density	408 specimens/ha	
Biomass	2.89 kg/ha	
Prevalence (%)	Juvenile	- (38.21)
	Sexually mature	100 (61.79)
	♀	91.89 (32.93)
	♂	8.11 (28.86)
Age/ Size groups	Prevalence (%)	
	♂	♀
8	2.70	
7	17.57	15.18
6	47.30	18.15
5	27.03	6.63
4	4.05	8.73
3	1.35	6.78
2	-	25.61
	-	12.60

3.3. HELMINTH FAUNA OF EURASIAN MINNOW

Helminth parasites are recorded in 2 Eurasian minnow specimens (6.67%) from Bezbog Lake. Both recorded with parasites specimens of *Ph. phoxinus* were female. One nematode species is identified - *Salmonema ephemeridarum* ((Linstow, 1872) Moravec, Santos & Brasil-Sato, 2008) larva, presented by five specimens (Table 2).

Table 2. Species diversity of helminth parasites of *Phoxinus phoxinus* (N – number of examined hosts, n – number of infected hosts, p – number of parasites, P – prevalence, MA – mean abundance, MI – mean intensity)

Helminth species	N=30					
	n	p	P%	MA±SD	MI±SD	Range
<i>Salmonema ephemeridarum</i> ((Linstow, 1872) Moravec, Santos & Brasil-Sato, 2008) larva	2	5	6.67	0.17±0.64	2.5±0.5	2-3

4. DISCUSSION

Research on glacial lakes in the Pirin National Park is extremely scarce, especially as regards Lake ichthyofauna. Of interest is the published study of Cheshmedjiev et al. (2013) for the assessment of the ecological status of the alpine glacial lakes in Pirin and Rila - Bezbog and Chernoto, respectively, in connection with the requirements of the WFD with the application of European standards for monitoring and ecological assessment based on biological quality elements (algae, macrophytes, macrozoobenthos, and fish), as well as data from accompanying physicochemical monitoring. However, the data for fish are only from literature data and from references from the Directorate of Pirin National Park, as well as from conversations with fishermen. *Salmo trutta* has been reported for Lake Bezbog in the Pirin as a typical species, and the presence of the introduced species *Oncorhynchus mykiss* has been determined by chance. A good representation of the *Phoxinus phoxinus* population has been reported, and a species reported being distributed in the lake by fishermen. According to the authors, the lake is subject to long-term anthropogenic impact related to the introduction of introduced an unnatural species, as well as fishing. According to Cheshmedjiev et al. (2013), even though the Eurasian minnow is an indigenous species for the Bulgarian alpine lakes, in Lake Bezbog it is not an indigenous species but was imported accidentally when stocked with Balkan trout or as bait by fishermen. However, the authors, along with other biological elements, define lakes as specific ultra-oligotrophic ecosystems with low phytoplankton and scarce macrozoobenthos.

Varadinova & Smilyanov (2020) studied the seasonal effects on ecological status/potential assessment in lakes based on macrozoobenthos. The ecological status assessment of Bezbog Lake, according to Varadinova & Smilyanov (2020), shifted during the three different seasons, showing deterioration in spring 2019. The authors explain the changes in the status of the natural water body Bezbog with the influence of specific factors.

Definitive hosts of *Salmonema ephemeridarum* are fishes of the family Salmonidae, but sometimes it is found in other fishes, mainly predatory, that had been accidentally infected (Moravec, 2013). Other fishes like *Phoxinus*, *Barbatula*, *Cottus*, can serve only as paratenic or pardefinitive hosts (Moravec, 2013).

Moravec (1971a) followed the life-history of *Cystidicoloides tenuissima* (= *Salmonema ephemeridarum*) in the River Bystrice (Czech Republic), where mayfly nymphs, *Habroleptoides modesta* and *Ephemerella* sp., act as intermediate hosts. The development of *Cystidicoloides tenuissima* (= *Salmonema ephemeridarum*) was also studied experimentally from Moravec (1971b) and De & Moravec (1979). According to Moravec (2013) for Europe intermediate hosts of *Salmonema ephemeridarum* are mayfly species *Ephemerella vulgata*, *E. danica*, *Oligoneuriella rhenana*, *Leptophlebia marginata*, *Habroleptoides modesta*, *Habrophlebia lauta* and *Ecdyonurus dispar*.

For Bulgaria, *Salmonema ephemeridarum* was reported only as a parasite of *Salmo trutta* and *Oncorhynchus mykiss* (Syn. *Salmo gairdnerii*) from numerous freshwater ecosystems (Kakacheva-Avramova, 1983).

Eight species present the parasite fauna of *Phoxinus phoxinus* in Bulgaria, but so far *S. ephemeridarum* has not been reported (see Table 3).

Table 3. Parasite species reported for *Phoxinus phoxinus* in Bulgaria

Authority	Kakacheva-Avramova (1960)	Kakacheva-Avramova (1965)	Kakacheva-Avramova (1969)	Kakacheva-Avramova (1970)	Kakacheva-Avramova (1973)	Margaritov (1964)
Parasite species						
<i>Allocreadium isoporum</i>	•			•	•	
<i>Pseudochetosoma salmonicola</i>				•	•	
<i>Dactylogyrus borealis</i>					•	•
<i>Gyrodactylus aphyae</i>			•		•	
<i>Gyrodactylus macronychus</i>			•		•	
<i>Gyrodactylus pannonicus</i>					•	
<i>Pomphorhynchus laevis</i>	•			•	•	
<i>Schulmanella petruschewskii</i>		•				

5. CONCLUSION

During this study of 30 specimens of Eurasian minnow, one parasite species is fixed- the nematode species *Salmonema ephemeridarum* ((Linstow, 1872) Moravec, Santos & Brasil-Sato, 2008) larva. Lake Bezbog is a new locality of *S. ephemeridarum* in Bulgaria. *Phoxinus phoxinus* is a new host record for *S. ephemeridarum* in Bulgaria.

In case of the future establishment of representatives of Trematoda, Cestoda, Acanthocephala it will be a serious indication of the growth of the food base and the settlement in this habitat of euryplastic and sustainable types of intermediate hosts. This necessitates the performance of permanent ecological and parasitological studies of Eurasian minnow from potentially vulnerable lake ecosystems of Pirin National Park.

The low ecological and parasitological indicators testify to the good ecological condition of the studied lake ecosystem. The ecological indicators obtained in this study prove

that up to this stage, there is no risk for the protection of fish populations and communities and the strengthening of eutrophication in the monitored lake ecosystem.

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HELMINTH FAUNA OF SOME CYPRINID FISH SPECIES FROM LOWER STREAM OF RIVER TUNDZHA, BULGARIA

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Abstract: During the ecological study are examined 34 cyprinid fish specimens (bleak (*Alburnus alburnus*), asp (*Leuciscus aspius*), rudd (*Scardinius erythrophthalmus*) and Vardar nase (*Chondrostoma vardarensis*)) from River Tundzha. The fish hosts are examined by applying standard techniques for parasites. Four species of parasites are fixed: two acanthocephalan species (*Acanthocephalus anguillae* (Müller, 1780), *Acanthocephalus tenuirostris* (Achmerov & Dombrowskaja-Achmerov, 1941)) and two nematode species (*Rhabdochona denudata* (Dujardin, 1845), *Philometra cyprinirutili* (Creplin, 1825)). All established parasite species are autogenic, matured in fish. This is the first study of helminth fauna of asp from River Tundzha. Bioindicator significance of established parasite species was discussed for ecological evaluation of the state of the studied freshwater ecosystem. As a result of this study, new data for helminths and helminth communities of cyprinid fish species is presented. This is the first report of *Acanthocephalus tenuirostris* and *Philometra cyprinirutili* that are component parasite species for the helminth communities of asp from Tundzha River, Bulgaria.

Keywords: *Alburnus alburnus*, *Leuciscus aspius*, *Scardinius erythrophthalmus*, *Chondrostoma vardarensis*, fish parasites, River Tundzha

1. INTRODUCTION

River Tundzha is a river in southern Bulgaria that is the biggest tributary of Maritsa River. The river takes its source from the central parts of Stara Planina north of Kalofer. Then it flows east and makes a sharp turn to the south before Yambol, in which direction it flows until it reaches the Maritsa River on Turkish territory near Edirne. Its length is 390 km, of which 349.5 km in Bulgarian territory, which ranks it 3rd among the rivers of Bulgaria, after the Danube and Iskar. The ichthyofauna of the Lower stream of River Tundzha is presented by 19 fish species belonging to 8 families (Kolev, 2014). That including three species endemic for Aegian Sea basin, two species endemic for Balkan Peninsula, four species protected by the Bulgarian law, four invasive fish species and one introduced fish species (Kolev, 2014). Fish parasite communities and biodiversity from the Tundzha River were studied only from Kakacheva-Avramova (1972) and Kirin et al. (2013). Parasites and their communities are indicators for the aquatic ecosystem state food web structure and

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biodiversity (Marcogliese, 2004; Marcogliese, 2005). The aim of this study is to present the diversity and communities of endoparasites of 4 cyprinid fish species (*Alburnus alburnus*, *Leuciscus aspius*, *Scardinius erythrophthalmus* and *Chondrostoma vardarensis*) from Tundzha River, Bulgaria. As a result of this survey, new data for helminth fauna is presented.

2. MATERIALS AND METHODS

During summer 2017 fish and fish parasites are collected and examined from the Lower stream of River Tundzha in Bulgaria (city of Yambol). The town of Yambol (42°29'N 26°30'E) is situated on both banks of Tundzha River, in southeastern Bulgaria.

A total of 34 cyprinid fish specimens (17 specimens of bleak (*Alburnus alburnus*), 14 specimens of asp (*Leuciscus aspius*), two specimens of rudd (*Scardinius erythrophthalmus*) and one specimen of Vardar nase (*Chondrostoma vardarensis*)) from the River Tundzha are collected and examined in 2017. Fish were caught by angling. The scientific and common names of fish hosts are used according to the FishBase database (Fröse & Pauly, 2020).

The fish samples were examined for gastrointestinal parasites (incomplete parasitological study) using standard techniques and immediately after their capture. Helminthological examinations are carried out following recommendations and procedures described by Petrochenko, 1956; Bauer et al., 1981; Bykhovskaya-Pavlovskaya, 1985; Moravec, 1994; etc.

Acanthocephalans are examined as temporary slides in ethanol-glycerin and identified (Petrochenko, 1956; Bykhovskaya-Pavlovskaya, 1985). Nematodes are examined as temporary microscopic preparations in glycerin and identified (Moravec, 1994; 2013).

The dominant structure of the component helminth communities was determined according to the criteria proposed by Kennedy (1993) based on the prevalence (P%): accidental (P% < 10), component (10 < P% < 20) and core (P% > 20) species. The ecological terms prevalence (P%), mean intensity (MI) and mean abundance (MA) are used, based on the terminology of Bush et al. (1997).

3. RESULTS

3.1. MODEL FISH SPECIES

A total of 17 specimens of bleak (*Alburnus alburnus* (Linnaeus, 1758)), 14 specimens of asp (*Leuciscus aspius* (Linnaeus, 1758)), two specimens of rudd (*Scardinius erythrophthalmus* (Linnaeus, 1758)) and one specimen of Vardar nase (*Chondrostoma vardarensis* (Karaman, 1928)) are collected and examined from Tundzha River. All of the examined fish species are estimated as least concern species (LC=Least Concern; IUCN Red List Status), except Vardar nase that is near threatened (NT=Near Threatened; IUCN Red List Status).

Bleak is freshwater, brackish, benthopelagic, potamodromous fish species. *A. alburnus* inhabits open waters of lakes and medium to large rivers. This fish species forms large aggregations in backwaters and other still waters during winter. Adults of bleak occur in shoals near the surface, while larvae live in the littoral zone of rivers and lakes while juveniles leave shores and occupy a pelagic habitat, feeding on plankton, drifting insects or invertebrates fallen on the water surface. *A. alburnus* feeds mainly on plankton, including crustaceans and insects (Fröse & Pauly, 2020).

Asp is freshwater, brackish, benthopelagic, potamodromous fish species. *L. aspius* inhabits lower reaches of rivers and estuaries. Juveniles and adults of this fish species feed mainly on fish. The asp is piscivore and also preys on small aquatic birds. Juveniles of this fish species are gregarious predators while adults hunt in small groups or are solitary (Fröse & Pauly, 2020).

Rudd is freshwater, brackish, benthopelagic, potamodromous fish species. *S. erythrophthalmus* occurs mainly in nutrient-rich, well-vegetated lowland rivers, backwaters, oxbows, ponds and lakes. Rudd feeds mainly on plankton, terrestrial insects and plant material. This fish species can adapt to unfavourable environmental condition (Fröse & Pauly, 2020).

Vardar nase is freshwater, benthopelagic, gregarious fish species. *C. vardarensis* occurs in lowland watercourses. Adults of this fish species feed on benthic diatoms (Karapetkova & Zivkov, 2010; Fröse & Pauly, 2020).

3.2. HELMINTH COMMUNITY STRUCTURE

Helminth parasites are recorded in 3 bleak specimens (17.65%) from Tundzha River. One parasite species is identified: the acanthocephalan *Acanthocephalus anguillae* (Müller, 1780), presented by three specimens. *A. anguillae* (P%=17.65) is component parasite species for the helminth communities of bleak.

Helminth parasites are recorded in 4 asp specimens (28.57%) from Tundzha River. Two parasite species are identified: one acanthocephalan (*Acanthocephalus tenuirostris* (Achmerov & Dombrowskaja-Achmerov, 1941)) and one nematode species (*Rhabdochona denudata* (Dujardin, 1845)), presented by six specimens (Table 1).

Table 1. Species diversity of helminth parasites of *Leuciscus aspius* from Tundzha River (N – number of examined hosts, n – number of infected hosts, p – number of parasites, P – prevalence, MA – mean abundance, MI – mean intensity)

Helminth species	N=14					
	n	p	P%	MA±SD	MI±SD	Range
<i>Acanthocephalus tenuirostris</i> (Achmerov & Dombrowskaja-Achmerov, 1941)	2	4	14.29	0.29±0.80	2±1	1-3
<i>Rhabdochona denudata</i> (Dujardin, 1845)	2	2	14.29	0.14±0.35	1±0	1

A. tenuirostris (P%=14.29) and *R. denudata* (P%=14.29) are component parasite species for the helminth communities of asp.

Species richness in infracommunity of asp ranges from 0 to 1 species. With one helminth species were infected four fishes (28.57%) (Table 2).

Table 2. Parameters of the infracommunities of *Leuciscus aspius* from Tundzha River

	Number of endohelminth species			
	0	1	Mean±SD	Range
<i>Leuciscus aspius</i>	10	4	0.29±0.45	0-1
	Number of endohelminth specimens			
	Total number		Mean±SD	Range
<i>Leuciscus aspius</i>	6		0.43±0.82	0-3

The largest number of helminth specimens established in a single host specimen is 3. The average species richness (mean number of species for fish specimen) in infracommunity of asp is 0.29±0.45species. Average abundance (mean number of helminths in fish) in these infracommunities is 0.43±0.82 (Table 2).

From the examined two specimens of *Scardinius erythrophthalmus* in one are identified three specimens of the nematode species *Philometra cyprinirutili* (Creplin, 1825). The established three specimens of *Philometra cyprinirutili* were not gravid female.

From the only examined specimen of *Chondrostoma vardareense* is identified one specimen of acanthocephalan *Acanthocephalus anguillae* (Müller, 1780).

All established helminth species occurred as an adult (Table 3).

Table 3. Helminth fauna of the examined cyprinid fish species from Lower stream of River Tundzha, Bulgaria (N – number of examined hosts, n – number of infected hosts, p – number of parasites)

Host	Helminth species	N	n	p
<i>Alburnus alburnus</i>	<i>Acanthocephalus anguillae</i>	17	3	3
<i>Leuciscus aspius</i>	<i>Acanthocephalus tenuirostris</i>	14	2	4
	<i>Rhabdochona denudata</i>	14	2	2
<i>Scardinius erythrophthalmus</i>	<i>Philometra cyprinirutili</i>	2	1	3
<i>Chondrostoma vardareense</i>	<i>Acanthocephalus anguillae</i>	1	1	1

4. DISCUSSION

Acanthocephalus anguillae is an intestinal parasite of many freshwater fish, most often by a family Cyprinidae and less frequently by families Salmonidae, Percidae, Anguillidae, Gobiidae, Esocidae, Cottidae and others (Kakacheva-Avramova, 1983). This acanthocephalan develops with the participation of an intermediate host – *Asellus aquaticus* (Isopoda)(Petrochenko, 1956; Kakacheva-Avramova, 1983). *A. anguillae* was found in *Alburnus alburnus* from Maritsa River and Arda River (Kakacheva-Avramova, 1965; Margaritov, 1965; Kirin, 2003). For Tundzha River *A. anguillae* was reported as a parasite of *Squalius orpheus* (see Table 4) (Kirin et al., 2013). The helminth fauna of *A. alburnus* from Tundzha River was studied only from Kakacheva-Avramova (1972). The author reported *Dactylogyrus vistulae*, *Dactylogyrus tissensis*, *Dactylogyrus fraternus*, *Dactylogyrus alatus*, *Dactylogyrus minor*, *Gyrodactylus gracilihamatus*, *Gyrodactylus laevis*, *Gyrodactylus hronosus*, *Diplozoon homoion*, *Rhabdochona denudata*, *Pomphorhynchus laevis* and

Caryophyllaeides fennica as parasites of bleak from Tundzha River. *A. alburnus* from Tundzha River is a new host for e *A. anguillae*.

Table 4. Acantocephalan species reported for fish from Tundzha River in Bulgaria

Nematode species Fish species	<i>Pomphorhynchus laevis</i>	<i>Acanthocephalus anguillae</i>	<i>Acanthocephalus tenuirostris</i>
<i>Alburnus alburnus</i>	● ¹	● ³	
<i>Squalius cephalus</i>	● ¹	● ²	
<i>Gobio gobio</i>	● ¹		
<i>Barbus cyclolepis</i>	● ¹		
<i>Tinca tinca</i>	● ¹		
<i>Sander lucioperca</i>	● ¹		
<i>Cyprinus carpio</i>	● ¹		
<i>Rhodeus amarus</i>	● ¹		
<i>Chondrostoma vardareense</i>	● ¹	● ³	
<i>Leuciscus aspius</i>	● ¹		● ³

¹ Kakacheva-Avramova (1972)

² Kirin et al. (2013)

³ present study

Table 4 gives the impression that in the earlier study was reported the acanthocephalan species *Pomphorhynchus laevis* (Müller, 1776). The intermediate host of *P. laevis* is amphipod crustacean *Gammarus pulex* (Linnaeus, 1758), definitive hosts are fish most often from family Cyprinidae, and paratenic hosts are small fish of the same family (Kakacheva-Avramova, 1983). *G. pulex* is a bioindicator for β -mesosaprobity (Johnson et al., 1993). In more recent studies is reported *Acanthocephalus anguillae* (Müller, 1780). The intermediate host of this acanthocephalan species is crustacean *Asellus aquaticus* (Linnaeus, 1758) (Petrochenko, 1956; Kakacheva-Avramova, 1983; Bauer, 1987). *A. aquaticus* is a bioindicator for α -mesosaprobity (Johnson et al., 1993).

Acanthocephalus tenuirostris is an intestinal parasite of *Barbus petenyi* and *Squalius cephalus* from rivers on the Balkan Peninsula (Kakacheva-Avramova, 1983). *A. tenuirostris* was found in *Esox lucius* and *Squalius cephalus* (= *Leuciscus cephalus*) from Maritsa River (Kirin, 2000a; b; c; 2006). *A. tenuirostris* was reported as a parasite of *Squalius cephalus* (= *Leuciscus cephalus*) from Chepelarska River and Stryama River (tributaries of Maritsa River) (Kirin, 2002; Kirin et al., 2005). *Acanthocephalus tenuirostris* (= *Paracanthocephalus tenuirostris*) for Bulgaria was found in *Barbus meridionalis petenyi* and *Squalius cephalus* (= *Leuciscus cephalus*) from the rivers Mesta, Strumeshnitsa, Stryama and Palakaria (Kakacheva-Avramova, 1983). The helminth fauna of fishes from Tundzha River was studied only from Kakacheva-Avramova (1972) and Kirin (2013). Even though the authors investigated 13 fish species, *Leuciscus aspius* was not studied. This is the first study of helminth fauna of asp and the first report of *Acanthocephalus tenuirostris* for Tundzha River (Table 4).

Rhabdochona denudata is an intestinal parasite of many freshwater fish species from family Cyprinidae (Moravec, 2013). *Rhabdochona denudata* is considered as one of the most common nematode species in Bulgaria (Kakacheva-Avramova, 1983). Intermediate hosts of *R. denudata* are insect larvae: *Heptagenia* sp., *Ephemerella* sp. and *Hydropsyche* sp. (Bauer, 1987; Kakacheva-Avramova, 1983). Representatives of the genera *Heptagenia* and

Ephemerella are bioindicators for β -mesosaprobity. *Hydropsyche* sp. is bioindicator for 0- α -mesosaprobity (Johnson et al., 1993). For Tundzha River *R. denudata* was reported as a parasite of *Alburnus alburnus* and *Squalius orpheus* (Kakacheva-Avramova, 1972; Kirin, 2013). *R. denudata* was reported as parasite of *Squalius cephalus* (= *Leuciscus cephalus*) from Chepelarska River and Stryama River (tributaries of Maritsa River) (Kirin, 2002; Kirin et al., 2005; Kirin et al., 2019b) and for *Rutilus rutilus* from Luda Yana River (a tributary of Maritsa River) (Kirin et al., 2019a). *R. denudata* was also reported as a parasite of *Alburnus alburnus* and *Squalius cephalus* (= *Leuciscus cephalus*) from Arda River and Kardzhali reservoir (Kirin et al., 2002; Kirin, 2001; Kirin, 2003). For Maritsa River *R. denudata* was reported as parasite of *Sq. cephalus* (= *L. cephalus*), *Vimba melanops* (Heckel, 1837) (= *Vimba vimba melanops*), *Alburnus alburnus*, *Barbus cyclolepis* (= *B. tauricus cyclolepis*) and *Scardinius erythrophthalmus* (Margaritov, 1965; Kirin, 2000b; 2001; Chunchukova et al., 2019 a, b).

Philometra cyprinirutili is an intestinal parasite of some cyprinid fishes (Moravec, 2013). Intermediate hosts of *P. cyprinirutili* are cyclopoid copepods (Moravec, 2013). The helminth fauna of *S. erythrophthalmus* from Tundzha River was studied only from Kakacheva-Avramova (1965). The author reported only two parasite species (*Gyrodactylus decorus* and *Ligula intestinalis*) for rudd from Tundzha River. The only philometrid species that were reported so far for Tundzha River is *Philometra rischta* that was localized in the tissues of the inner surface of the gill covers (see Table 5). From the fact that no philometrid species from the abdominal cavity was reported, we can conclude that there was no erroneous identification of philometrid parasitic species (see Moravec, 2004). This is the first report of *Philometra cyprinirutili* from Tundzha River, Bulgaria.

Table 5. Nematode species reported for fish from Tundzha River in Bulgaria

Nematode species	<i>Rhabdochona denudata</i>	<i>Salmonema ephemeridarum</i> *	<i>Schulmanela</i> sp	<i>Philometra rischta</i>	<i>Philometra cyprinirutili</i>
<i>Alburnus alburnus</i>	● ¹				
<i>Squalius cephalus</i>	● ^{1,2}				
<i>Salmo trutta</i>		● ¹			
<i>Barbus cyclolepis</i>			● ¹		
<i>Vimba melanops</i>				● ¹	
<i>Scardinius erythrophthalmus</i>					● ³

¹ Kakacheva-Avramova (1972)

² Kirin et al. (2013)

³ present study

* *Salmonema ephemeridarum* was reported with the synonym *Cystidicoloides tenuissima*

The circulation of parasitic flow in the studied freshwater ecosystem can be represented as follows: class Acanthocephala: crustaceans - fish (*Acanthocephalus anguillae*); for Class Nematoda: insect larvae (mayflies and caddisflies) - fish (*Rhabdochona denudata*) and cyclopoid copepods - fish (*Philometra cyprinirutili*).

5. CONCLUSION

This is the first study of the helminth fauna of asp and the first report of *Acanthocephalus tenuirostris* for Tundzha River. This is the first report of *Philometra*

cyprinirutili from Tundzha River, Bulgaria. *A. alburnus* from Tundzha River is a new host for *A. anguillae*. *A. anguillae* (P%=17.65) is component parasite species for the helminth communities of bleak. *A. tenuirostris* (P%=14.29) and *R. denudata* (P%=14.29) are component parasite species for the helminth communities of asp.

The obtained results for the parasites and the bioindication role of their intermediate hosts are demonstrating a favourable development of the studied freshwater ecosystem.

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LP MODEL FOR OPTIMIZATION OF COPPER BATCH COMPOSITION

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Abstract: In this paper, an LP mathematical model was developed to solve the blending composition problem in the copper production process. The task is to define the optimal composition of batch copper concentrate, which is used in the pyrometallurgical process of copper production. An objective function, that maximizes profit by calculating the income generated by the sale of Cu, Ag, and Au on the market and expenses for the supply of raw materials, was proposed. In addition to the basic groups of constraints, which can be found in known mathematical models, also constraints that take into account the specific process of copper production, as well as environmental requirements have been developed. The LP mathematical model harmonizes three contradictory requirements in copper production: economic, technological and environmental. The starting point for optimization consists of five different copper concentrates, which were available on the market at the time of this research. The implementation of the model was done in the software package MATHEMATICA v 8.0. Numerical experiments have confirmed the assumption that it is possible to compose an optimal batch in the production of copper that would harmonize the contradictory requirements, and the obtained results have their practical implications. With minor corrections, the model can be applied in other process industries as well.

Keywords: LP model, blending problem, batch composition optimization, copper production

1. INTRODUCTION

One of the most common applications of linear programming (LP) is the mixture problem, which can be defined as mixing different ingredients (inputs) into one or more mixtures (outputs) while satisfying the data constraints and optimizing the desired objective. Such problems are typical in many industries, such as ferrous and non-ferrous metallurgy, food, petroleum, chemical, mechanical, and textile industry, but similar problems can be encountered in other fields. At the same way, the problem of the mixture in coal production was investigated in the works (Liu & Sherali, 2000, Lyalyuk et al., 2014); in coke production in the paper (Berkutov et al., 2010), in steel production in the paper (Logunova et al., 2013); in brass production in the paper (Sakallı & Baykoc, 2011) in the production of chemical fertilizers in the paper (Ashayeri et al., 1994), in production of biodiesel fuel in the paper (Markov et al., 2016), the problem of the mixture of gases in the LED bulb in the paper (Feng

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et al., 2017), in the production of asphalt in the paper (Sivilevičius & Vislavičius, 2019), in the production of briquettes in the paper (Vashchenko et al., 2018), etc. Problems of batch optimization in copper production were investigated in papers (Nikolić et al., 2009, Saramak, 2011, Jovanović & Stanimirović, 2012, Jovanović et al., 2013).

In this paper, the problem of the composition of the batch mixture used for the pyrometallurgical process of obtaining copper is being solved. The basic idea is to develop and implement an LP mathematical model to optimize the composition of a batch of copper concentrate. When optimizing, care is taken to maximize the profit, while maintaining the desired level of product quality and market supply. In addition to economic and technological requirements and requirements for reaching product quality standards, in the production of copper it is necessary to take into account environmental standards. These are all contradictory requirements that need to be harmonized. For this purpose, the known mathematical models (see paper Ashayeri et al., 1994) were adopted for this particular case and amplified by the introduction of specific constraints. The initial assumption is that by selecting and mixing different copper concentrates, an "environmentally friendly" batch can be assembled that contains a sufficient amount of useful components for economically viable production, and at the same time a smaller amount of harmful components than the recommended values. In this way, a better ecological footprint is achieved.

2. PROBLEM DESCRIPTION

In order to protect human health, World Health Organization (WHO, 2001) prescribed the allowed values of SO₂, PM2.5, and PM10 content and heavy metal content in the air. Also, the EU with its directives (EU Directive, 1999, EU Directive, 2004) limits the values of the content of these pollutants in the air (see Table 1), and this obliges companies to comply with them. Despite the above regulations and directives, there are copper concentrates on the world market that contain harmful elements in greater quantities than prescribed. It should be emphasized that the presence of various components in raw materials (concentrates) determines the quality of the final product.

Table 1. The chemical composition of copper concentrate

Products	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈	P ₉	P ₁₀	P ₁₁	P ₁₂	P ₁₃	P ₁₄
Chemical symbol	Cu	Bi	As	S	Pb	Zn	Cd	Se	Hg	Sb	Ni	Ag	Au	Rest
Units	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Con 1	12.62	0.018	0.0340	10.71	0.19	0.52	0.0025	0.0086	0.00003	0.004990	0.008	0.002192	0.000308	75.88
Con 2	16.21	0.021	0.0029	37.73	0.01	0.10	0.0025	0.0140	0.00001	0.004991	0.012	0.001234	0.000132	45.89
Con 3	14.59	0.024	0.0057	28.72	0.14	0.40	0.0025	0.0110	0.00002	0.004990	0.010	0.003300	0.000460	56.09
Con 4	25.87	0.018	0.0070	33.86	0.13	0.21	0.0025	0.0200	0.00002	0.004990	0.002	0.003350	0.000572	39.87
Con 5	21.45	0.021	0.0180	26.16	0.32	0.42	0.0050	0.0190	0.00003	0.004991	0.003	0.006350	0.000420	51.57
Limit values	>=21	<=0.05	<=0.2	>=32	<=2	<=3	<=0.01	<=0.01	<=0.0005	<=0.3	<=0.1	>=0	>=0	-
Criterion	min	max	max	min	max	max	max	max	max	max	max	min	min	-

Useful components in copper concentrates are: copper (Cu), silver (Ag) and gold (Au). Sulfur (S) can be considered both as a useful and as a harmful component in the concentrate. Among the harmful components, as the most dangerous for people and the environment, are found: bismuth (Bi), arsenic (As), lead (Pb), zinc (Zn), cadmium (Cd), selenium (Se), mercury (Hg), antimony (Sb), and nickel (Ni). The problem comes down to determining the quantities

of individual copper concentrates that will be used to produce a final product of appropriate quality, but so that profit, presented as the difference between income from sales of useful products and expenses for copper concentrates, is maximized, while respecting environmental standards. Concentrates used for copper production are procured at different prices and are of different quality. The presence of useful and harmful elements in copper concentrate directly affects its price, which is formed on the principle of supply and demand on the LME (*London Metals Exchange*).

To optimize the batch, 5 different copper concentrates that were present on the market at that time were considered. Concentrates 1 to 3 were obtained from ore deposits in Serbia. Concentrate 4 is imported from Bulgaria and Concentrate 5 from Romania. The results of chemical analyzes of concentrates are shown in Table 1. The aim is defining LP mathematical model with which an optimal batch for copper production would be compiled, based on available concentrates on the market.

When processing copper concentrate, silver (Ag) and gold (Au) are produced in smaller quantities. The income from sale of Ag and Au is significantly lower than the realized sales income of copper (Cu), but it is not negligible. Therefore, in the mathematical model, the realized income from the sale of Au and Ag cannot be avoided. Heavy metals Bi, As, Pb, Zn, Cd, Se, Hg, Sb, Ni are inevitable elements of concentrates and are very harmful to human health. Therefore, it is desirable that the harmful metals are present in quantities less than the prescribed values. Sulfur (S) is considered a useful component in concentrates, due to its role as a fuel in the frying process.

Thus, the study considered 4 useful and 9 harmful components of copper concentrate, which are labeled as products from P1 to P13. Product P14 represents all other components (elements and compounds) found in copper concentrates. The prescribed upper (Uk) and lower (Lk) limit values of products P1 – P13 are shown in Table 1, in the line “*Limit values*”. The last row of Table 1 shows the criteria according to which the optimization is performed.

3. MATHEMATICAL MODEL

In the paper, the problem of the composition of the mixture for the case of production more products from more raw materials is being solved. The assumption is that $m=5$ different concentrates, marked with K_1, \dots, K_5 , are available for batch composition, and that their processing yields $n=14$ different products, marked with P_1, \dots, P_{14} . Indices for useful products are $I=\{1,12,13\}$. Also, the assumption is that there is about 8% waste and dispersion in production, so the finished product can be expressed with 92% in relation to the amount of all concentrates used for its production. The task is to determine the quantities of each concentrate that will be used to obtain each of the products, while achieving the maximum profit, as well as harmonize all the contradictory requirements (constraints).

The following notation was used to form the mathematical model:

- x_{ij} – the K_i concentrate quantity which will be used for the production of the product P_j ;
- a_i – total amount of the concentrate K_i which will be used for the production;
- g_i – disposable quantity of the concentrate K_i ;
- ci_i – purchase (input) unit price of the concentrate K_i ;
- b_j – quantity of product P_j according to the optimal solution;
- t_j – the amount of the P_j product that can be sold on the market;
- co_j – selling unit price of the final-useful product P_j ;
- p_{ij} – the percentage of P_j product in one unit of the K_i concentrate;
- U_j , –upper approved value limited with the P_j element percentage contained in the batch;

L_j – lower approved value limited with the P_j element percentage contained in the batch;
 Y_i – yielding coefficient for raw material K_i .

Based on the assumptions and introduced symbols, a mathematical model of the problem is formed. Expressions that give a correlation between the variables x_{ij} , a_i and b_j are shown by formulas from (1) to (3).

$$a_i = \sum_{j=1}^n x_{ij}, \quad i = 1, \dots, m \quad (1)$$

$$b_j = \sum_{i=1}^m Y_i \cdot p_{ij} \cdot a_i, \quad j = 1, \dots, n \quad (2)$$

$$p_{ij} = \frac{x_{ij}}{a_i} \Rightarrow x_{ij} = p_{ij} \cdot a_i, \quad i = 1, \dots, m \quad (3)$$

Since $m=5$ and $n=14$, the objective function to be maximized has the form shown by the formula (4).

$$F(x) = \sum_{j \in \{1,12,13\}} co_j \cdot b_j - \sum_{i=1}^8 ci_i \cdot a_i \quad (4)$$

The first group of constraints – *available quantities of raw materials*, shown by the formula (5), refers to the quantities of concentrates that can be provided on the market. In reality, these quantities are practically unlimited. Due to the calculation, the available quantity of 1T for each concentrate is adopted in the model. Thus, all numerical results are expressed per ton of concentrate.

$$a_i \leq g_i \Leftrightarrow \sum_{j=1}^{14} x_{ij} \leq g_i = 1, \quad i = 1, \dots, 5 \quad (5)$$

The second group of constraints – *placement of finished products on the market*, is shown by the formula (6). These restrictions relates to the quantities of finished products (P_1 , P_{12} and P_{13}) which can be sold on the market, and they are unlimited, ie. $t_j \rightarrow \infty$.

$$b_j \leq t_j \Leftrightarrow \sum_{i=1}^8 Y_i x_{ij} \leq t_j \rightarrow \infty, \quad j = 1, \dots, 14 \quad (6)$$

The third group of constraints – *structural constraints*, is shown by the formula (7).

$$x_{ij} - p_{ij} \sum_{j=1}^{14} x_{ij} = 0_j, \quad i = 1, \dots, 5, \quad j = 1, \dots, 14 \quad (7)$$

The fourth group of constraints, so-called *natural constraints* is shown by the formula (8).

$$x_{ij} \geq 0_j, \quad i = 1, \dots, 5, \quad j = 1, \dots, 14 \quad (8)$$

The fifth group of constraints – *lower limit for copper content in the batch*, is shown by the formula (9). This group of restrictions is imposed by the technological process of production. In fact, the technological requirement is that the copper content in the mixture is not below 21%. In this particular case, the lower limit values are selected from the set $L_1 \in \{20\%, \dots, 25\%\}$.

$$b_1 \geq L_1 \cdot \sum_{j=1}^{14} b_j \quad (9)$$

The sixth group of constraints – *lower limit for sulfur content in the batch*, is shown by the formula (10). This group of restrictions is also imposed by the technological process of production. As sulfur is viewed as a useful component in the mixture, only the lower limit is set in the model, ie. $L_4=32\%$.

$$b_4 \geq L_4 \cdot \sum_{j=1}^{14} b_j = 0.32 \cdot \sum_{j=1}^{14} b_j \quad (10)$$

The seventh group of constraints – *upper limits for harmful elements in the batch* is shown by the formula (11). This group of restrictions is imposed by environmental requirements.

$$b_j \leq U_j \cdot \sum_{j=1}^{14} b_j, \quad j \notin I, j \neq 4 \quad (11)$$

The LP mathematical model summarizes certain values x_{ij} of all manufactured products from each concentrate and achieves the highest income, in accordance with the objective function (4). The constraints from (5) to (8) are known limitations that can be found in the literature for the problem of mixture composition, while the constraints from (9) to (11) are defined to respect the technological and environmental aspects.

4. RESULTS AND DISCUSSION

The implementation is done in a programming language MATHEMATICA, using a standard function `Maximize` from the package. The function `Maximize[f, {cons}, {x, y, ...}]` maximizes f with defining function (4), by constraints defined by formulas from (5) to (11), with respect x, y, \dots list (Wolfram, 2003).

Numerical experiments for the content of copper (Cu) in batches in the range from 20% to 25% were performed in this paper. The experiments were done for three scenarios. The first scenario, denoted by "Cu", involves the use of formulas (4) to (9). The second scenario, denoted by "Cu + S + As", involves the use of formulas (4) to (10) and formula (11) for the case $j = 3$. The third scenario, denoted by "Cu + All", involves the use of formulas (4) to (11).

The optimal solutions for all three scenarios are shown in Table 2. The column labeled $F(x)[\$/T]$ represents the profit expressed in dollars per ton of processed batch. The column labeled by $F(x)[\$]$ denotes the total profit expressed in dollars, that is, it denotes the value of the objective function defined by formula (4).

The results of optimal solutions lead to the following conclusions:

- Optimal solutions are possible for all three value scenarios $L_1 \in \{21\%, \dots, 25\%\}$.
- Concentrate Con_1 , which contains the lowest percentage of copper, does not participate in the formation of the optimal batch for any scenario, for the value $L_1 \in \{21\%, \dots, 25\%\}$.
- Concentrate Con_4 , which contains the highest percentage of copper, participates in the formation of the optimal batch in all scenarios, for the value $L_1 \in \{21\%, \dots, 25\%\}$.
- Concentrate Con_5 , does not participate in the formation of the optimal batch only for the third scenario, for the value $L_1=24\%$, while in all other cases it is part of the optimal batch with a large share.
- Concentrate Con_2 with a large share enters the composition of the optimal batch in all three scenarios, for value $L_1 \in \{20\%, \dots, 23\%\}$.

- Concentrate Con_3 with a large share enters the composition of the optimal batch in the first and third scenarios, for value $L_1=20\%$. In all other cases, this concentrate with a very small proportion enters, or does not enter at all, into the optimal batch.
- The optimal solution for the third scenario, which harmonizes the economic, technological and environmental aspects of copper production, was obtained for the value $L_1=25\%$ (bolded in Table 2). Concentrates Con_4 and Con_5 are included in this optimal solution. Their share in the optimal batch is 1 : 0.27, that is 78,74% and 21,26%, respectively.

Table 2. Optimal solutions for all scenarios

L_1	Three scenarios	$F(x)$ [\$/T]	$F(x)$ [\$]	Con_1	Con_2	Con_3	Con_4	Con_5
20	Cu	813.17	2,970	0	1	0.65	1	1
	Cu+S+As	835.02	2,762	0	1	0	1	0.99
	Cu+All	811.61	2,904	0	1	0.64	1	0.94
21	Cu	826.40	2,548	0	1	0.08	1	1
	Cu+S+As	826.40	2,548	0	1	0.08	1	1
	Cu+All	826.40	2,548	0	1	0.08	1	1
22	Cu	866.36	2,230	0	0.57	0	1	1
	Cu+S+As	862.53	2,135	0	0.58	0	1	0.89
	Cu+All	860.67	2,171	0	0.61	0	1	0.92
23	Cu	912.06	2,001	0	0.19	0	1	1
	Cu+S+As	893.50	1,684	0	0.29	0	1	0.60
	Cu+All	893.50	1,684	0	0.29	0	1	0.60
24	Cu	944.33	1,637	0	0	0	1	0.73
	Cu+S+As	924.47	1,407	0	0.10	0	1	0.42
	Cu+All	918.90	1,311	0	0	0.21	1	0
25	Cu	950.54	1,183	0	0	0	1	0.24
	Cu+S+As	941.18	1,076	0	0	0.07	1	0.07
	Cu+All	950.23	1,200	0	0	0	1	0.27

- Concentrate Con_4 is the richest in copper content. Therefore, this concentrate is used for the composition of the optimal batch in all numerical experiments, for value L_1 from 18% to 25%. With increasing values L_1 from 18% to 25% the participation of all other concentrates in the optimal solution varies while the participation of Con_4 concentrate is constant at the maximum value. However, Con_4 concentrate, although it contains the highest percentage of copper, cannot participate alone in the composition of the optimal batch, because in combination with other concentrates it gives a better mixture in terms of the presence of harmful elements.

5. CONCLUSION

In the paper an LP mathematical model was developed which solved the problem of the composition of the mixture where the input raw materials were concentrates, which could be obtained on the market of raw materials, and the output products were imposed by the content of these concentrates. The task was to determine the optimal batch composition, while achieving the maximum profit and respecting contradictory requirements in copper production. The maximum profit is provided based on the objective function formed in the

original way. In forming the constraints, the intention was to meet the technological, economic and environmental requirements, which are present in the pyrometallurgical process of copper production. In addition to the four groups of constraints, which are defined by known mathematical models, three other groups of constraints have been developed that meet the necessary requirements. The fifth and sixth groups of restrictions provide the required technological demands, and the seventh group of restrictions provides environmental requirements.

The case study investigated 5 concentrates that were on the market at that time. The standard Maximize function from the software package MATHEMATICA v 8.0 was used to obtain numerical experimental results. The obtained numerical results unequivocally lead to the conclusion that it is not only possible but also necessary when composing the optimal batch to take into account the presence of all harmful ingredients, and not just some, which has been the case in practice so far.

The considered problem of the mixture has several optimal solutions. It depends on the applied scenario and the desired value $L_1 \in \{20\%, \dots, 25\%\}$. In accordance with the set goal of the research, the third numerical experiment for value $L_1=25\%$ is imposed as the best solution. The optimal batch consists of concentrates Con₄ and Con₅, with share 1 : 0.27, that is 78,74% and 21,26%, respectively.

By implementation of the defined LP mathematical model, the possibility to make an optimal mixture ratio from the available concentrates is created, which represents the optimal batch composition both from the aspect of useful components content and from the aspect of minimizing environmental pollution, which is being created by flue gas emissions and represents danger to the environment. The analysis of the results showed that the optimization of all elements in the batch does not violate the basic principle of business. On the contrary, such an analysis makes it possible to answer the question of which concentrates and in what quantities it is necessary to procure, for the considered period, in order to operate profitably. In this paper, it is shown that the issue of choosing the composition of the mixture can be approached systematically, that is a model can be defined that helps management in making business decisions about which batch to assemble. With minor corrections, the LP mathematical model can be applied in other process industries as well.

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MULTICRITERIA ANALYSIS OF PROJECT MANAGEMENT PERFORMANCE WITHIN PROJECT-BASED ORGANIZATIONS

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Abstract: This paper presents the results of a multicriteria analysis of project management performance, as a key indicator of the business efficiency of project-based organizations. The research was conducted in 29 project-based organizations operating in various industrial sectors on the territory of the Republic of Serbia. Using the PROMETHEE method, a multicriteria analysis of project management performance in different industrial sectors was performed. The multicriteria analysis was performed based on the six criteria: project management leadership, project management staff, project management policy and strategy, project management partnerships, project management life cycle, and project management key performance indicators. As a result of the research, industrial sectors in which organizations do not have satisfactory project management performance have been identified. Within the conclusions of the research, special emphasis is placed on those criteria of project management performance, whose improvement would increase the efficiency of achieving project goals. Finally, the obtained results indicate a significant fact that the creation of satisfactory project management performances also contributes to the long-term growth of the organization.

Keywords: Project management performance, multicriteria analysis, organization

1. INTRODUCTION

Contemporary business conditions bring numerous changes and cause the creation of new paradigms. When it comes to project management the situation is, of course, the same. Project success had long been measured only by tangible parameters, ie project performance. The project performances contribute to the level and opportunities for achieving the results that organizations reach based on the activities undertaken in a given time period (Quereshi et al., 2009). This means that this approach represents a measurement of the achievement of the goals in terms of cost, time, and adherence to product specifications. In fact, it is a one-dimensional view of project success because it is focused within the organization. However, this one-dimensional approach, ie. just observing project performance, is not entirely satisfactory. Numerous recent studies have shown that project success is actually multidimensional and that different people measure project success in different ways and at different times. This primarily refers to stakeholders (Bryde, 2008; Turner & Zolin, 2012;

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Serrador & Turner, 2014). At the moment of project completion, from the aspect of the organization, the most important thing is that the project has fulfilled all the limitations in terms of resources. With the introduction of the time dimension into consideration, such a view of project results is increasingly losing importance. Namely, the impact on the users, as well as their satisfaction, becomes more significant with the time flow after the project completion (Shenhar et al., 1997).

The parameters of excellence in policy and strategy represent how an organization form and allocates resources and transform policy and strategy into plans and activities. The criterion of policies and strategies within project management focuses on project management introduction in a planned and systematic way in an organization, with a link between the strategic, organizational, and project level (Mir & Pinnington, 2014; Zwikael et al., 2018). In order to the adopted strategies contribute to the improvement of performance, the multidimensional approach to project success emphasizes the fulfillment of the expectations of all stakeholders (Bryde, 2005). Thus, this approach emphasizes partnerships as a link between internal and external stakeholders and can often be one of the critical factors for project success (Van den Honert, 1991; Bryde, 2003). Therefore, the existence of the partnership emphasizes the role of a win-win strategy in which profits are being made for all stakeholders in the project. Of course, project participants have a direct, while users have an indirect impact on project management performance (Liu et al., 2010).

This multidimensionality of project success also represents the extension of the focus of project performance to the project management performance. In other words, in order to maximize the project performance, it is necessary to consider the project management itself, ie the project management performance. (Bryde, 2003). Hence, measuring project success has recently experienced significant changes.

Shenhar and Dvir (2007) developed a model for the project's success evaluation based on five dimensions. The time dimension is also incorporated in this model, which emphasizes the importance of project success evaluating by the users. As already mentioned, in the years after the project realization, the project success is most adequately assessed according to whether the organization achieves strategic goals that improve the organization's performance. This view actually extends the focus of project management activities to all stakeholders and their view of the quality of both products and processes. Such a view of project management, ie project performance assessment, is incorporated in the PMPA (Project Management Performance Assessment) model, developed by Bryde in his research (Bryde, 2003). This model proposes six criteria for project management performance assessing based on the EFQM business excellence model: 1. project management leadership, 2. project management staff, 3. project management policy and strategy, 4. project management partnerships, 5. project management life cycle and 6. project management key performance indicators.

Previous research by the authors of this paper has focused on examining the level of impact of PMPA model criteria on project management performance in project-based organizations. This paper presents the results of a research aimed at a multi-criteria analysis of project management performance in various industrial sectors in project-based organizations in Serbia.

2. RESEARCH METHODOLOGY

2.1. QUESTIONNAIRE AND DATA COLLECTION

Within the conducted research, the methodology of the questionnaire for data collection was applied. The questionnaire was developed by modifying of the original questionnaire created by Quereshi (Quereshi et al., 2009) and contains 35 questions, divided into 6 groups describing project management performance and 8 demographic questions. Data collection was performed by anonymous survey of employees in 29 project-based organizations in the Republic of Serbia in the period June - August 2020. The studied companies implement projects in various industrial sectors, as follows: automotive equipment manufacturing (I1), energy production and distribution (I2), agricultural infrastructure equipment manufacturing (I3) furniture production (I4) mechanical industry (I5), telecommunications (I6), civil engineering (I7) and road construction (I8). The mentioned industrial sectors represent the alternatives used in the multicriteria analysis in the next phase of the research. A five-point Likert scale with values from 1 to 5 was used for assessing the responses, where 1 meant the lowest importance (I strongly disagree with the given statement), and 5 meant the highest importance (I strongly agree with the given statement). The survey was conducted on a sample of 315 employees, 288 of which were properly filled out representing 91.42%. Data preparation and calculations necessary for the applying of multicriteria analysis were performed in MS Excel.

2.2. PROMETHEE CALCULATIONS

Using the PROMETHEE method, based on six criteria of the PMPA model for assessing project management performance (GQ1 - project management leadership, GQ2 - project management staff, GQ3 - project management policy and strategy, GQ4 - project management partnerships, GQ5 - project management life cycle, and GQ6 - project management key performance indicators) a multicriteria analysis of project management performance in project-oriented organizations was performed in eight different industrial sectors. In this way, a multicriteria analysis of eight alternatives was performed. After data collecting by surveying the staff engaged in projects, assigning the preference function, calculating the weight coefficients using the entropy method (Puška et al. 2018) and forming of evaluation matrix using the Visual PROMETHEE software package, the project management performance level was ranked in eight industrial sectors. Finally, the sensitivity analysis of the weight coefficients of the criteria was performed.

The PROMETHEE method is based on determining the positive (ϕ^+) and negative flow (ϕ^-) for each of the alternatives. The positive flow of preference indicates how much a particular alternative dominates over other alternatives. If the value is higher ($\phi^+ \rightarrow 1$) the alternative is more significant compared to other alternatives. The negative flow of preference indicates how much a particular alternative is preferred by other alternatives. The alternative is more significant if the flow value is lower ($\phi^- \rightarrow 0$). Complete alternatives ranking by PROMETHEE II method is based on the calculation of net flow (ϕ). The net flow represents the distinction between the positive and negative flow of preference. The ranking of alternatives is done as follows: the alternative with the highest net flow value is the best ranked and so on to the alternative with the lowest net flow value, which is ranked the worst (Brans & Mareschal 1994; Anand & Kodali 2008).

3. RESULTS AND DISCUSSION

Based on the above, a complete ranking (PROMETHEE II) of project management performance was performed in eight different industrial sectors. Initial data for the PROMETHEE method applying represent the average scores of respondents answers in different industrial sectors for each of the six groups of questions in the questionnaire (six criteria for project management performance assessing) (Table 1).

Table 1. Initial data for PROMETHEE calculations (project management performance in different industrial sectors)

Alternative	Criterion					
	GQ1	GQ2	GQ3	GQ4	GQ5	GQ6
I1	3.83	2.95	4.13	4.30	4.29	4.26
I2	4.01	1.86	4.14	4.47	4.21	4.30
I3	3.34	3.37	3.17	3.31	3.33	3.36
I4	2.50	2.28	2.72	3.67	3.37	2.90
I5	3.30	2.52	2.97	3.55	3.06	2.99
I6	3.23	2.29	3.17	4.42	3.58	4.18
I7	4.12	1.82	3.96	4.26	4.32	4.46
I8	3.97	2.11	4.00	4.02	4.06	4.20

After the entering of the input data, assigning the weight coefficients for all criteria and, assigning the most appropriate preference function for the used type of data, an evaluation matrix was formed (Table 2). Based on the evaluation matrix, the ranking of alternatives was performed.

Table 2. Preference functions and weight coefficients for evaluating and ranking of project management performance in different industrial sectors

Criterion	GQ1	GQ2	GQ3	GQ4	GQ5	GQ6
Weight coefficient	0.166603	0.167651	0.166716	0.165996	0.166253	0.166780
Preference function	Level	Level	Level	Level	Level	Level
Min/Max	MAX	MIN	MAX	MAX	MAX	MAX

The results of the complete ranking (PROMETHEE II) of project management performance based on the opinion of employees in different industrial sectors, as well as the flows of preferences, are shown in Table 3, as well as in Figure 1. Figure 1 shows industrial sectors which have satisfactory project management performance, based on the attitudes of their employees (I7, I2, I8, I1 i I6). On the other hand, there is a cluster of industrial sectors where project management performance can be considered as unsatisfying (I5, I3 i I4).

Table 3. Results of complete ranking of project management performance in project-based organizations based on the opinion of employees in different industrial sectors

Rank	Alternative	$\Phi+$	$\Phi-$	Φ
1	I7	0.3814	0.0594	0.3220
2	I2	0.3694	0.0475	0.3219
3	I8	0.3217	0.1308	0.1909
4	I1	0.2737	0.1671	0.1067
5	I6	0.2500	0.2025	0.0475
6	I5	0.1546	0.4169	-0.2622
7	I3	0.1308	0.4528	-0.3220
8	I4	0.1191	0.5238	-0.4047

Based on the obtained results, it can be noticed that the best ranked alternative is I7 (civil engineering). This means that based on the responses of the surveyed employees, the project management performance was assessed as very favorable. Such situation is a significant prerequisite for the efficient project goals achievement, as well as a positive impact on all stakeholders, during and after project realization. On the other hand, according to the respondents, the worst ranked alternative is I4 (furniture production). In this industrial sector, there is a threat of discordance between the goals of the organization on the one hand and the needs and requirements of the customer on the other. Such a situation inevitably leads projects in the wrong direction and they cannot be characterized as successful.

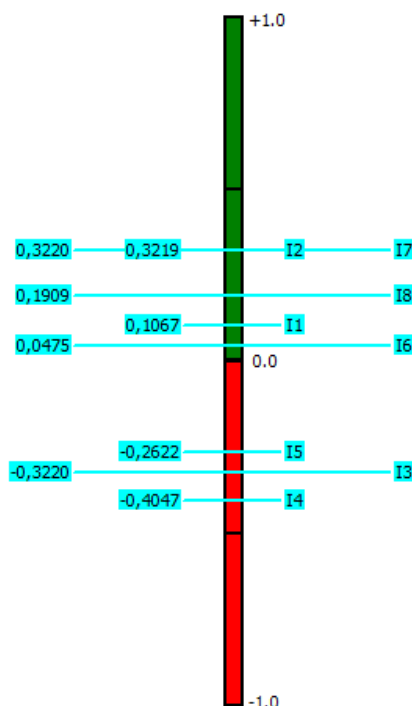


Figure 1. PROMETHEE II complete ranking of project management performance in different industrial sectors

The Visual PROMTHEE software package offers a visual comparison of alternatives according to each criterion – GAIA (Geometrical Analysis for Interactive Aid). The GAIA plane facilitates the evaluation of the obtained solutions, as well as the interpretation of the significance of individual variables. In fact, with this presentation of results, it is very easy to

determine the strength or weakness, as well as the quality of each alternative according to each criterion. Also, the strength of the influence of each criterion on the ranking can be determined. The positions of the considered alternatives (green squares) determine the strengths or weaknesses of the properties of the actions in terms of the selected criteria (blue rhombuses), which actually determines the future result of the conducted final ranking. The closer the alternative is to the direction of the criterion vector, that alternative is better based on that criterion (Brans & Mareschal 1994).

Figure 2 shows the position of the eight considered alternatives at the GAIA plane, as well as the criteria on the basis of which the ranking was performed. It can be noticed that project management performance in the civil engineering (I7) and energy production and distribution (I2) sectors are very good according to all project management performance criteria, with the exception of criterion GQ5 (project management life cycle). This result indicates that the project management performance in these sectors are very good in terms of efficiency in project goals achieving, but that over time there may be a problem in terms of customer satisfaction. On the other hand, the two industrial sectors where project management performance is ranked the worst are agricultural infrastructure equipment manufacturing (I3) and furniture production (I4). Project management performance in these two industrial sectors is poor based on almost all performance indicators. In addition to the fact that employees in these industrial sectors believe that the project goals are not achieved effectively, there is a large discordance between the interests of organizations and the interests of clients (alternatives are poorly ranked according to the criterion GQ4 - project management partnerships). In other words, the results of the conducted multicriteria analysis indicate that managers from organizations operating in these industrial sectors should focus their efforts both on improving the performance of their projects and on the aspect of meeting customer needs.

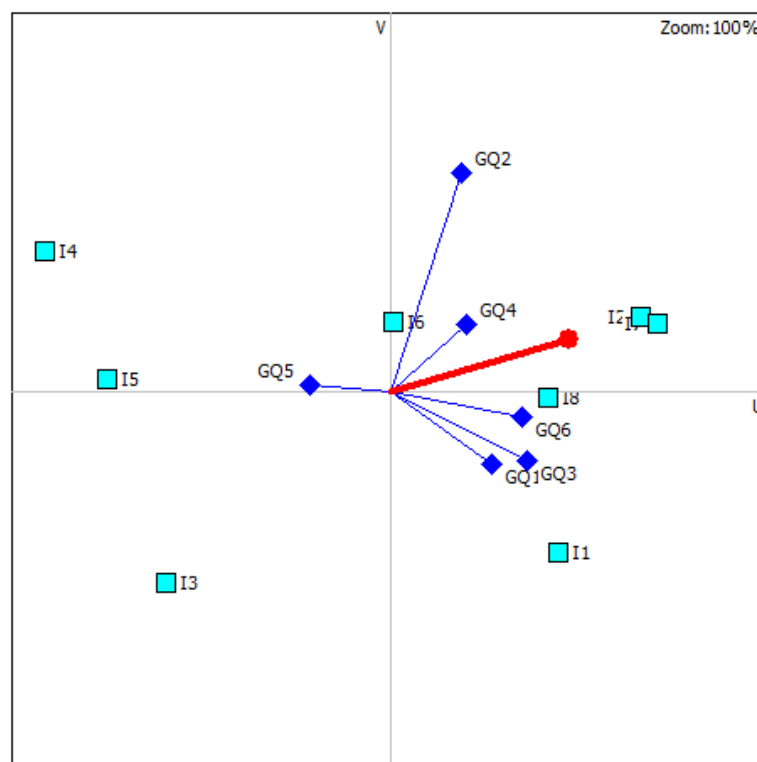


Figure 2. GAIA plane of selection of the most favorable industrial alternative from the aspect of project management performance

Sensitivity analysis

In order to determine the size of the preferred relationships with the obtained ranking of project management performance in different industrial sectors, the sensitivity analysis of the criteria weight coefficients was performed. (Table 4). Conducting this analysis, it is possible to determine stability intervals for each criterion used. The stability interval defines the limits within which the value of the weight coefficient of the observed criterion can change the value without affecting the obtained ranking solution. In doing so, the weight coefficient of one criterion changes, while the relative weights of the other criteria retain their value. (Doan & De Smet, 2018).

Table 4. Weight coefficient stability intervals

Criteria	Starting weight coefficients (%)	Stability intervals (%)	
		min	max
GQ1	16.6603	16.56	84.38
GQ2	16.7651	8.24	23.57
GQ3	16.6716	10.49	16.72
GQ4	16.5996	0.00	16.70
GQ5	16.6253	0.00	16.73
GQ6	16.6780	16.64	25.57

Based on the obtained results of the sensitivity analysis of the criteria weight coefficients used after the multicriteria analysis of project management performance in different industrial sectors, quite narrow stability intervals are identified for most of the criteria. Narrow stability intervals indicate that a change in the ranking order of alternatives could occur with relatively small changes in weight coefficients. Only criterion GQ1 (project management leadership) has a fairly wide stability interval, but only in the case of an increase of value. Namely, the value of the weight coefficient of this criterion can be significantly increased without influencing the obtained ranking solution. On the other hand, a change of the solution would occur with a slight decrease in the value of the weighting factor.

4. CONCLUSION

Project management performance determines the efficiency of project goals achieving, as well as the impact on all stakeholders during and after project realization. In other words, such a multidimensional approach fully characterizes the project's success. In order to the organization more efficiently implements the projects and fully meet the needs of all stakeholders, the analysis of project management performance, ie the key criteria of project management performance, should serve as a mean to draw useful conclusions. For this purpose, multicriteria analysis can be very useful tool. In this paper, based on six key criteria of project management performance (project management leadership, project management staff, project management policy and strategy, project management partnerships, project management life cycle and project management key performance indicators) multicriteria analysis of project management performance in project-based organizations in different industrial sectors was performed. In that way, certain important conclusions were formed and presented. The studied sample identified industrial sectors in which project management performance is not at a satisfactory level, which is a limiting element in the operations of

companies. Finally, the applied methodology has exactly determined the criteria whose more detailed analysis and adoption of measures for eliminating deficiencies, will improve the overall performance of project management. Consequently, this would improve the efficiency of project goals achieving, as well as the satisfaction of all stakeholders, which contributes to the long-term growth of the organization.

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USE OF QUALITATIVE MODELS IN RISK ASSESSMENTS

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Abstract: Models offer simplified versions of concepts and relationships that we face in the real world. A risk model aims to identify relevant risks, to understand their sources and to estimate their positive and negative potential consequences. In the absence of models developed for and devoted to risk assessment, scholars and practitioners tend to borrow the qualitative models developed for other professions and adapt them to risk management. Adaptation without a critical evaluation of the assumptions of the model may limit both the use and credibility of the model. Using qualitative models require critical reasoning to ensure that the model reflects the concepts and relationships that we face in the real world. The purpose of this paper is to contribute to such critical reasoning through two examples. The first example, Nordal & Kjørstad- Risk maturity model challenges the “step by step” progression approach employed by the standard maturity models and introduces a multi-dimensional spider-web model. The second example, Nordal -risk assessment model for start-ups introduces a “likelihood barometer” instead of a traditional “frequency/guesstimated probability” approach to likelihood scale in a risk assessment matrix.

Keywords: Qualitative models, risk maturity, start-up, risk model, scenarios, likelihood barometer

1. INTRODUCTION

Models offer simplified and abstract versions of concepts and relationships that we face in the real world. They can be physical, qualitative or quantitative depending on the subject matter in question. Models’ contribution to the understanding of a problem will be dependent of their ability/goodness to reflect the real world. Today we have access to extensive research which aims to define and to measure the said ability, depending on whether qualitative or quantitative methodology is adopted in the underlying model. For qualitative models, the literature indicates a consensus among the scholars and practitioners on a set of criteria. These are the following:

- Trustworthiness
- Credibility
- Consistency
- Applicability
- Transferability
- Confirmability

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- Dependability

Hammerberg, Kirkman and De Lacey as well as StatisticsSolutions mention these criteria (Hammarberg, Kirkman, De Lacey, 2016; StatisticsSolutions, 2020). Similarly, J. S. Tracy suggests eight “Big-Tent” criteria for qualitative research (Tracy, 2010). These are:

- worthy topic
- rich rigor
- sincerity
- credibility
- resonance
- significant contribution
- ethics
- meaningful coherence.

The criteria which are mentioned above apply to all qualitative models, inclusive those which are used for risk identification and assessment.

1.1. QUALITATIVE RISK MODELS

“The purpose of a risk model is to identify and understand sources of risks, to analyze their causes and to estimate the positive and negative potential consequences” (Nordal, 2016).

Risk assessments generally follow the principles and processes which are described by the acknowledged standards and frameworks, such as the International Organization for Standardization (ISO) 31000, Committee of Sponsoring Organizations of the Treadway Commission (COSO) Enterprise Risk Management (ERM) and Federation of European Risk Management Associations (FERMA) Risk Management Standard (ISO, 2018), (COSO, 2017), (FERMA, 2003). These standards do not suggest a specific model for the identification and assesment of risks. For instance, the COSO publication Enterprise Risk Management states that “Depending on the size, geographic footprint, and the complexity of an entity, management may use more than one technique” (COSO, 2017). Accordingly, the ISO standard 31010, Risk management — Risk assessment techniques presents 31 different assessment techniques which may be used by risk managers (ISO, 2009).

2. MATERIALS AND METHODS

2.1. MATERIALS

In the absence of models developed for and devoted to risk assessment, scholars and practitioners in risk management profession tend to borrow the qualitative models developed for other professions and adapt them to risk management. Such practice, without due concern to models’ assumptions may limit models’ applicability and credibility.

2.2. MODELS

In the following, this paper will present two examples where the assumptions behind the widely used models are challenged. The first example concerns risk maturity modelling. The second example concerns the assessment of start-up risks.

2.2.1. Risk maturity models

“Risk maturity” measures to which extent an organization has implemented Enterprise Risk Management (ERM), in accordance with prevailing best practice (Nordal, 2017).

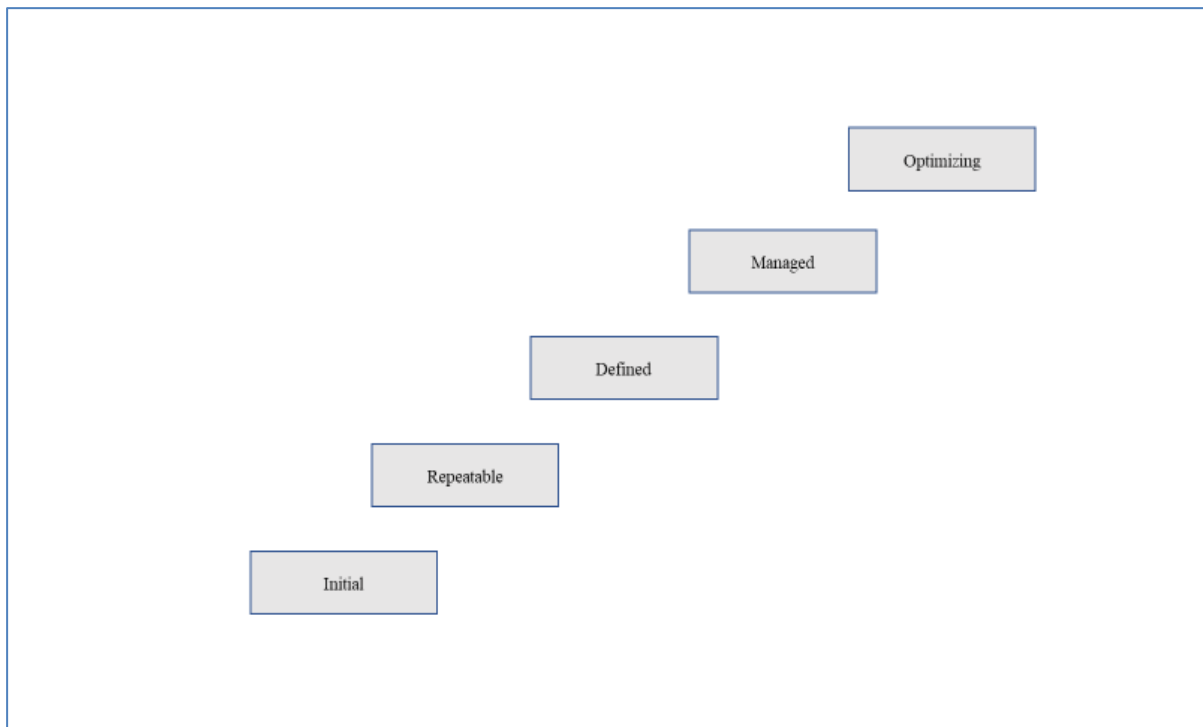
Many risk maturity models are built on the basic principles of Capability Maturity Model (CMM) which was developed by the Software Engineering Institute at the Carnegie Mellon University in 1993. The model is devoted to software maturity, which is defined as “(...) the extent to which a specific process is explicitly defined, managed, measured and controlled and effective. Maturity implies a potential for growth in capability and indicates both the richness of an organization’s software process and the consistency with which it is applied in projects throughout the organization” (Paulk et al., 1993).

The model defines five maturity levels and highlights the process changes necessary to bring an organization from the prevailing level to the next level. Figure 1 below, describes these levels. At the initial level, the software process is characterized as ad hoc and occasionally, even chaotic. A disciplined process brings the organization to the next level. At this level the process is repeatable. The basic project management processes are established to track cost, schedule and functionality. A standard and consistent process will be needed in order to reach the next level, i.e. defined process. When the organization reaches this level, the software process for both management and engineering activities is documented, standardized and integrated into a standard software process for the organization. In order to reach a still higher level, managed, the organization should ensure that the process is now predictable. Detailed measures of the software process and product quality are collected. Both the process and the products are quantitatively understood and controlled. The highest level is called optimizing. It will be reached through the implementation of continuous improvement actions.

When describing the applicability of the CMM, the authors underline that the “(...) CMM focuses on the process aspects of a Total Quality Management (TQM) effort. A successful process improvement implies that aspects outside the scope of software process are also addressed” (Paulk et al., 1993).

Available risk maturity models which are presented in the literature and risk maturity assessment tools offered by the consultancy companies often build on the assumption of the “step by step” development described above. A such widely used model is the Risk Management Society (RIMS)’s on-line assessment model. (RIMS, 2006). These models have to common characteristics. They assume:

- A continuous progression to higher and higher maturity levels through time
- A step by step development, where it is not possible to skip one or several steps



Source: Paulk et al., 1993, p.8

Figure 1. Capability Maturity Model

Said models do not

- recognize that different areas, processes and functions in an organization may have different risk maturity levels. (For instance, IT, HR, production, quality controls etc.)
- employ a common scale, which enables a universal and homogenous assessment of risk maturity
- recognize that the requirements for and expectations to risk management may be different in different organizations, depending on the sector, the size of the organization and the transaction/production volume.
- recognize that traditionally, risk maturity has not been an area where the Board and management were expected to formalize and state their ambition levels.

PricewaterhouseCoopers suggest four alternative paths of evolution of an ERM-programme (PwC, 2015):

- Start and stop
- Start and stagnate
- Start slowly, react and atrophy
- Evolve steadily and consistently

Traditional risk maturity models build solely on the fourth option. Thus, for many organizations these models have limited applicability.

2.2.2. Nordal & Kjørstad risk maturity model

In order to combat with the applicability challenge, I, together with Ole Martin Kjørstad have developed a simple alternative model in 2017. This model focus on a set of maturity objectives instead of the traditional maturity levels. The maturity objectives are defined for five core dimensions of an organization (Nordal, 2017).

Table 1 gives an overview of these dimensions and objectives.

Table 1. Organizational dimensions and maturity objectives

Dimensions	Objectives
Risk management, strategy and decision-making processes	All decisions (strategical, tactical and operational) base on documented assessments of risks and opportunities.
Communication, information and reporting	The organization ensures continual communication and reporting of relevant information, with appropriate frequency.
Organization, authority and interaction	The risk management function has an appropriate organization and resource allocation.
IT-tools and analyses	Risk management is based on best available information and is suitable to organisation's needs.
Framework and processes	The organization has implemented an effective and suitable risk management framework

Ten criteria are defined to evaluate the degree of achievement of each objective and the risk maturity is assessed separately in each dimension. Results are visualized by a spider-web diagram. An example is shown in Figure 2.

The model is made available for free testing and use on the website of IIA, (The Institute of Internal Auditors) Norway and it received positive responses from many public and private organizations. Further, The Norwegian School of Economics (NHH) has tested the model by sending a questionnaire to 811 members of IIA and 190 organizations. (Meidell, 2019) The results support our core assumption that organizations have different risk maturity levels in different organizational dimensions. Said results indicate that the average risk maturity level on risk management, strategy and decision-making process dimension is 2,2, whereas the figure is 2,8 on communication, information and reporting dimension. The average figures include both public and private enterprises.

2.2.3. Risk assessment model for start-ups

The second example is my model which challenges the assumptions attached to the likelihood scale of the traditional risk matrix.

Risk matrices are widely used in risk identification and risk assessment. They assume that risk may be expressed as:

$$R = L * C \quad (1)$$

where L is likelihood and C is consequence (impact).

According to COSO, the likelihood is the possibility of a risk occurring. This may be expressed in terms of a probability or a frequency. (COSO, 2017) The likelihood scale of a risk matrix includes either an estimate or a guesstimate of the frequency of an event or a probability distribution for the event. This information may be obtained from statistical data, from market research or from interviews. However, it can also be obtained by asking the participants of a risk assessment workshop their views about the expected occurrence of an event.

Start-ups tend to experience specific challenges when they assess their risks and opportunities. They have limited benefits from the use of a traditional risk matrix. This is due to a lack of information which would enable them to set up a reliable *likelihood scale* for potential events. They have neither statistical data nor experience data to create a probability distribution of the potential events, or to attach frequencies or probabilities to a potential event.

As Leveson states “(...) One problem in assessing likelihood is that little real information is available about the future, especially at the beginning of the development process, when decisions about where to focus efforts are made.” (Leveson, 2019).” (...) Methods like market research, decision trees/ what- if analysis...will help ..to tackle this uncertainty to some extent” (Nordal, 2015). However, a meaningful likelihood scale, which could have been used in a risk matrix is not easily accessible.



Figure 2. Nordal & Kjørstad Risk maturity model (example)

Start-ups have limited resources and their priority is to know where to set proactive controls to hinder the likelihood of potential negative events and to promote the positive ones. This necessitates a creative process, which may build on a scenario analysis, since “ (...) In complex settings, scenarios can be used to identify a wide range of risks, rather than existing or obvious risks. Therefore, a problem- based scenario may not start with a single issue (...) but aim to identify all the relevant problems. The act of scenario building opens up possibilities in a creative manner, both with what might happen and what can be done to

prevent or promote those outcomes based on whether they are viewed as harmful or beneficial” (Jones, 2010).

Start-ups have limited resources to implement sophisticated risk assessment processes. Organizing workshops for identifying risks, using computerized solutions to analyze them, keeping risk registers and formal reports may not be achievable for start-ups, at least at the very beginning. On the other hand, start-ups have a unique quality: “Having articulated their business intent and emphasized the customer connection, leaders give their people freedom within a framework—the liberty to operate within well-delineated boundaries—as well as opportunities to influence key decisions, such as which strategies to pursue or products to develop (Gulati, 2019).

In order to enable the traditional risk assessment matrix to take the above- mentioned realities of the start-ups into consideration, I have substituted the frequency figures and probability distributions on the likelihood scale with a likelihood barometer. (Nordal, 2020). The creation of a likelihood barometer is a process which involves scenario analysis. The process requires evaluation of scenarios and stimulates the development of strategies to handle these.

As the initial step of creating a likelihood barometer, I assume that a start-up is exposed to 4 major risk dimensions, which are shown in Table 2. These are:

- (D1): Market access
- (D2): Product characteristics
- (D3): Line & support functions
- (D4): Contracts and commitment

Each of these consists of 10 elements. Each element can materialize as 6 different scenarios which affect the uncertainty in positive or negative direction, as shown in Table 3. These effects are:

- MN: Moderate negative effect (2)
- LN: Low negative effect (1)
- LP: Low positive effect (-1)
- MP: Moderate positive effect (-2)
- HP: High positive effect (-3)

Table 2. Risk Dimensions and Elements

MARKET ACCESS	PRODUCT CHARACTERISTICS	LINE & SUPPORT FUNCTIONS	CONTRACTS & COMMITMENTS
Dependency on a single product	Compliance with ethical and legal standards	Organization structure	Flexibility and terms of the office space solution
Access to complementary product market	Compliance with environmental targets	Dependence on specialized work force	Flexibility and terms of the leasing agreements
Existence of substitutes on the market	Degree of innovation embedded in the product	Entrepreneurial experience	Financial strength
Access to several customer income segments	Universal design	Knowledge about industry standards	Liquidity
Possibility to offer maintenance services to own product	Product security	Understanding the context	Environmental commitments
Possibility to sell again (repeat sales)	Access to raw materials	Supplier and sub-contractor operations	Legal commitments, product warranties and other liabilities
Patents and protection rights	Price and terms	Competition on human resources	Support and grant schemes
The product is relevant only for the luxury product market	Production process features and complexity	Outsourced activities	Quality commitments to customers
Access to international markets	Technical requirements and constraints	Cost structure	The control system
Availability of multiple market channels	Market readiness	Payment schemes	Commitments re. certifications

Table 3. Representative Scenarios for All Elements in Market Access Dimension

	HN (3)	MN (2)	LN (1)	LP (-1)	MP (-2)	HP (-3)
1. Dependency on a single product	X					
2. Access to complementary product market	X					
3. Existence of substitutes on the market				X		
4. Access to several customer income segments				X		
5. Possibility to offer maintenance services to own product	X					
6. Possibility to sell again (repeat sells)		X				
7. Patents and protection of rights		X				
8. The product is relevant only for the luxury product market					X	
9. Access to international markets	X					
10. Availability of multiple market channels	X					
Sum	5	2	0	2	1	0

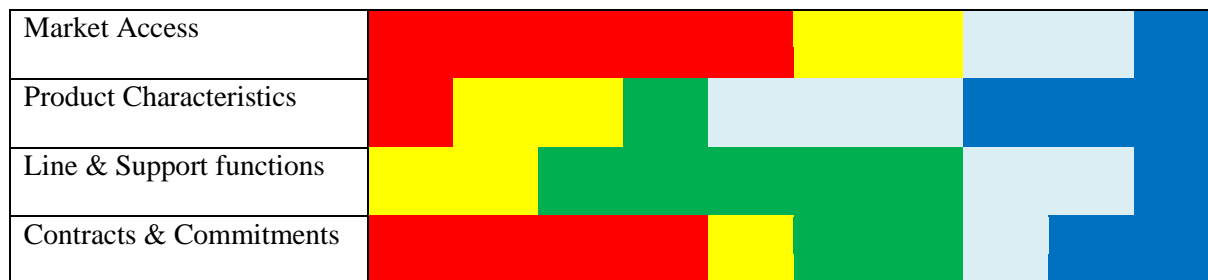


Figure 3. The likelihood barometer

The model has 240 scenarios in total. The likelihood barometer is constructed through two steps. At step 1, the start-up identifies the relevant scenario which describes its prevailing status for each risk element on a risk dimension. Table 3 gives an example of this step. The identified scenario provides information about the likely direction and extent of the uncertainty. At step 2, the total numbers of scenarios associated with each column in Table 3 are calculated. This will provide information for the likelihood structure presented in the likelihood barometer in Figure 3.

In the theoretical example which is presented in Figure 3, the start-up receives two important signals: The first signal is that it is likely that *market access* and *contracts & commitments* dimensions represent more risks than opportunities and they should be given priority when the start-up defines its policies and plans its actions. The second signal is that it is likely that the *product characteristics* dimension offers the start-up more opportunities than threats. The start-up's risk on each risk dimension is a product of the consequence of a scenario as well as its likelihood.

3. RESULTS

The results of the questionnaire mentioned in section 2.2.2 seems to provide reasonable support to the risk maturity model by Nordal & Kjørstad, which challenges the applicability of the assumptions behind the traditional risk maturity models.

The second model presented in this paper can be viewed as a first step in creating an elaborate risk assessment model for start-ups. However, from a scientific point of view, it suffers also from the weaknesses associated with the qualitative approach, among others:

- a. The selected risk dimensions might not represent the complete picture which is relevant for the start-up
- b. The scenario descriptions are subjective and might not be realistic for all start-ups
- c. The scenarios may be correlated
- d. The scenarios may represent cause-and-effect relations
- e. Different risk elements in a certain risk dimension might not necessarily have equal weight

At the moment, an EXCEL- version of the model is being tested by several start-ups. The results will illuminate if the weaknesses described above are relevant and which of these are the most important ones.

4. CONCLUSION

The qualitative models do not have the same possibilities as the quantitative models for testing the goodness to fit to the real world. However, it is crucial that the underlying assumptions of these models are made subject to critical evaluation by critical reasoning or by alternative models.

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INTEGRATING HUMAN RESOURCES AND CUSTOMER RELATIONSHIP MANAGEMENT FOR STUDENT SATISFACTION IN HIGHER EDUCATION: GAINING A COMPETITIVE ADVANTAGE

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Abstract: Human resource management as a scientific discipline and practice provides valuable recommendations and guidelines regarding the organization of functions and processes. If organizations adhere to these proposals, combining them with best practices and lessons learned, they increase their success in achieving organizational goals and specific business goals. Due to different forms of financing the operations of educational institutions, management models, regulatory constraints, Human resource management in the field of education must take into account several different variables in creating an optimal model of function and process.

Through the implementation of customer relationship management, higher education institutions adopt adequate instruments that adequately measure the real needs of students, but tailor their service in accordance with the real requirements of the knowledge market. Thanks to such measurement indicators, student satisfaction as a user of services is monitored, which gives a higher education institution a clearer insight into the current situation when it comes to educational needs, but also enables comparison with other educational institutions of the same or similar rank.

The paper analyzes available library and other sources by searching for these variables, and gives an example of good practice in the form of a case study - College of Information Technology, ITS - Belgrade, which illustrates how caring for human resources is also caring for students and in a specific way connects Human resource management and customer relationship management.

Keywords: Human Resources Management, Higher Education Institutions, Case Study, Student, CRM, Stakeholders

1. INTRODUCTION

Human resource management is a complex set of activities whose purpose is to provide and maintain a long-term competitive advantage and to conduct daily activities and business operations of companies. Human resource management is a complex business function that includes the following main activities (Ilić, 2018):

- Human resource planning

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- Job analysis and design
- Recruitment of human resources
- Selection and socialization of human resources
- Training and development of human resources
- Evaluation of employee performance
- Compensation and rewarding of employees
- Labor relations and collective bargaining
- Safety and health at work
- Leaving the organization

The complexity of human resource management and its importance for the conditions of modern business requires carefully and thoroughly planned all activities related to human resources. Any human resources plan must be aligned with organizational strategies and aimed at achieving and maintaining long-term competitive advantage (Ranković et al., 2020).

The quality of the teaching workforce should enhance in order to improve the educational standard. To achieve a higher-standard of learning, it is important to determine the factors that increase the work of teachers. In order to effectively achieve the goals and objectives of high quality educational standards, teacher performance management plays a vital role as it is an ongoing process for identifying, evaluating, and developing teacher performance.

It is also well known that human resources play a vital role in achieving the performance of educational organizations. (Chinyere, 2014). Although there is abundant literature that has explored the relationship between human resource management and organizational performance, there is a lack of literature on strengthening the relationship between human resource management and teacher performance, especially in developing countries. Unfortunately, only a few studies have been conducted on issues related to the impact of human resource practices, such as training and development or impact analysis of teacher training programs. In order to improve the quality of teachers, a good performance management system, ie. planning, monitoring and supervising the needs of teachers and teaching staff in schools is essential. (Mercer et al., 2010).

Even providers of public services (public university, faculties of professional studies) must keep in mind that only consumers (student in this case) and their (di)ssatisfaction determine the quality of services. (Radnović et al., 2015).

Human resource management in educational institutions has become very complex within the meaning various factors influence the behavior of individuals. The productivity of teachers and teacher assistants is significantly dependent on their educational and pedagogical capacities. The same content cannot be delivered every time. Numerous factors have contributed to this complexity. These include the following (Chinyere, 2014):

- *Poor working condition.* It is not lacking if the employee expects to be paid financial rewards in proportion to the services provided. It is ideal to have a systematic manufacturer to establish a healthy reward system and structure. A good salary strives to reduce inequalities between employees' salaries, raise their individual morale, motivate them to work on salary increases and promotions, reduce friction between groups and employee complaints. Teachers' salaries are not paid together with other civil servants, and in some cases, teachers are owed for several months' salaries.
- *Problems with employees.* There are problems with the quality and number of employees engaged in education. The possible reason is the bad process of recruiting and selecting employees.

- *Use of ICT in education.* Since the world of the 21st century experiences sudden changes, there is an expressed need to use information and communication technologies (ICT) in education. The use of ICT in educational processes is still low in many countries, and therefore training of teachers in ICT is necessary to prepare them for the reengineering of society through skills; ICT is the most efficient means of rapid dissemination of information and knowledge transfer, decentralization of work, development of the workforce, but it is also expensive. With the help of ICT, the teacher becomes a facilitator, supervisor and leader in classroom teaching. However, the mandatory acquisition of ICT skills by teachers should be given priority attention, despite the fact that in some countries a large number of teachers do not have a basic level of knowledge of hardware and software or IT technology.

Nowadays on a global level universities and other higher education institutions are facing a challenging task - reshaping relationships with users of their services, students. New trends in the knowledge market inevitably trigger the need for fast services and responses, which can be most adequately covered by customer relationship management. Customer relationship management (CRM) is a complex process of activities thanks to which a certain organization defines the target of its consumers and through building long-term relationships with them builds its success and profitability (Adikaram, 2016).

A group of authors defines CRM in higher education institutions as the satisfaction of users of educational services through certain emotions with which students can measure their expectations of the school, against everything they receive, including their needs, desires, and goals (Rigo et al., 2016). Customer relationship management (CRM) has become an indispensable part of the business strategy of every higher education institution, overcoming the basic function of simple marketing activities. It supports management in making all important decisions, using all available information related to the work of the organization itself (Meyliana et al., 2017) and outside the school, following developments in the education market (Badwan et al., 2017).

Using CRM activities, managers of higher education's institutions, like any other industrial sector, want to increase their efficiency, to promote the good educational practice, but also to improve relations with both existing and future students. In addition to student satisfaction, the CRM strategy influences the building of their loyalty to the school, which is best recognized through building stronger ties with the educational institution, spreading positive recommendations to new students, and low dropout rates (de Juan-Jordan et al., 2018).

It is believed that an effective CRM strategy depends on the quality management of the following elements of the organizational process: people, technologies, and activities (Rigo et al., 2016).

The higher education institution should certainly hire both **teaching and administrative staff** that will be completely focused on the user of educational services, and that is the student. Personnel management and quality setting of the school organization are crucial for student satisfaction, which is reflected in several elements: the effectiveness of the study program, quality of lectures, feedback on colloquia and exams, learning support, use of technology in the knowledge process, and social life.

Regarding the technology, the most efficient support for students is certainly IT equipment, but also the possibility of online transmission of all communications, including lectures, as well as all administrative correspondence that can also be done remotely. The third CRM basis in higher education activities is **the school activity**, which takes place

continuously in a turbulent and competitive environment, and it is necessary to provide a competitive advantage.

2. CASE STUDY: ITS – BELGRADE, THE SECRET OF EDUCATION IS MET BY THE RESPECT FOR THE STUDENT

About the organisation

Information technology school (ITS) is an independent higher education institution with four accredited study programmes in basic applied studies: information technology, computer multimedia, electronic business, information systems and one programme at master applied studies. Information technology school was founded by two leading regional companies in IT field – LINK group and Comtrade. High grade education and a successful career are guaranteed by professional competence and vast experience of the founding companies ITS, as a private higher education institution, has been financed by scholarships which are, for the moment, the only source of incomes. The organisational structure has all the elements predicted by the Law on Higher Education of the Republic of Serbia as well as the other elements necessary for efficient management and achievement of set goals.

The main actors are investors, ITS employees, ITS management, students, parents, community, Ministry of Education, Science and Technological Development.

Problem

Higher education institutions, in this case ITS Belgrade, must choose an optimal model of management for its most important stakeholders: the employees and the students, in order to achieve the satisfaction of both sides, as well as the aims of the organisation.

Solution

An optimal solution of the problem is being offered by the disciplines of Human resource management and Customer relationship management as well as the application of their postulates in school business.

ITS teaching staff consists of 80 teachers and associates. ITS employs teachers who fulfill its basic tasks and goals. Teachers are elected to different titles according to the Law on Higher Education of the Republic of Serbia (assistant professor, associate and full professor, professor of applied studies, senior lecturers and lecturers, as well as skill teachers and language teachers) and the classes are conducted at basic and master applied studies at ITS. The teacher selection process in the School statute has been coordinated with the above law and recommendations of the National Council. Teachers have been selected according to the criteria of the profession and pedagogical experience. There are 38 PhDs. 8 postgraduates and 7 masters form different scientific fields.

Teaching staff is recruited and selected according to the principles of Human resource management and in accordance with the recommendation of the discipline and best practices for higher education field. What matters when choosing a new teacher are his scientific and professional references depending on the field, that is area, that the teacher is being selected for, number and type of scientific, professional or artistic projects, scientific and professional works, exhibitions, formal work experience, success in previous jobs, patents, his/her intellectual and ethical integrity, teaching capital and recognised potential.

Every teacher went through several stages of candidate selection with mandatory verification of biographical data, references, tests, interviews and unavoidable trial lecture to ensure that the best candidates will receive a job offer. The new employees are introduced to the corporate culture, strategies, school policies and its organisation, within the socialisation phase. They also go through various trainings to be prepared for teaching and communication with students. Some of the trainings and workshops that are always organised are: training for a new teacher, training for final work application, training to work on an interactive whiteboard, exam and assessment workshop, workshop on learning outcomes and exams, objectivity and evaluation workshop.

There is two-way existing communication system between ITS and students. Every student inquiry is answered in a timely manner. Moreover, the needs are often anticipated by continuously monitoring the needs of our customers. This is the way to look in advance for new solutions to new challenges in the field of knowledge. All users of the educational services are treated with full respect and esteem by hired ITS staff and through CRM strategy. This results in flexibility and adaptability in every way – teaching schedule, reception, as well as examination period adjusting when possible (a significant number of our students has already been considerably involved in practice, worked occasionally or constantly). ITS is a rare educational institution in the field of higher education that offers its students the opportunity to practice and work at Comtrade but also at other professional business IT companies.

Teachers and associates are provided by great support of non-teaching staff, whose professional work ensures successful implementation of study programmes, basic tasks and goals of the school, but also of both founders **Link Group** and **Comtrade**, by sharing knowledge and availability of these companies expertise. Courses and sources of knowledge of Link Group, as a leader of non-formal education in the region, are available to teachers and associates within the development of employees, as well as professional experiences of the Comtrade company that is a leader in IT sector, for lectures, instructions for submitting teaching materials, instructions for creating a script etc. (Information Technology School, ITS-Belgrade, 2020).

Individual evaluation of teacher and associate performance is conducted after each semester on the basis of surveys conducted for each semester. Student survey results on the quality of pedagogical work of teachers show that ITS has a quality teaching staff in terms of categories: clarity and comprehensibility of lectures, transparency and the emphasis of the most important, encouraging student involvement and participation in teaching, contemporaneity of the programme, communication and email response speed, the previous grades of the teachers correspond to the demonstrated knowledge of a student, the manner of conducting the exam, objectivity and proper relations with students and good preparation for class. If any of the teachers and associates has a lower individual or average grade under 3.5, the school management has a conversation with him to find the reasons for the lower grade and the possibility of performance improvement.

ITS supports the effort of teachers and associates engaged in publishing the results of scientific research work. An analysis of scientific research activities is conducted once a year as well as a plan for next year. It is planned and expected that teachers and associates participate in scientific and professional conferences, organisation of exhibitions and participation in various projects. Publishing scripts, practicums and textbooks is stimulated within the plan of publishing business as a crown of teacher's scientific research work. The books are reviewed before publication by two independent reviewers. The teaching professional council of the school decides whether they are going to be accepted or not.

The cooperation and engagement of teachers on real projects in the economy are especially appreciated and encouraged that is the experiences of teachers in the real sector (economy) which are ITS students prepared for.

Teachers are encouraged to personal development and their careers are managed at the individual and organisational level in order to connect needs, knowledge and skills of the employees with the current and future needs of the school.

There is zero tolerance for any kind of violence and discrimination against employees. Every employee is equal in his rights and obligations which he is obliged for by the contract of employment and professional integrity. There is special attention that is paid to the motivation and safety at work of all employees, including teachers and associates as well as to the salary and benefits necessary to provide the quality of their lives.

It is not easy to become an ITS teacher and keep the position, as said at ITS. The one thing that teachers say and show every day is their great satisfaction at work that is confirmed by the survey results on the employee satisfaction on working conditions and student satisfaction on pedagogical work of teachers that are conducted on a regular basis as well as individual teacher performances that could be related to their satisfaction. Employee satisfaction survey is conducted once during the study year. It is anonymous, being filled online. User data is not recorded or stored in the archive of achieved answers. The elements that could be evaluated by employees indicate a fairly high level of employee satisfaction in the survey in the 2018/19, given the fact that 8 out of 15 elements of the survey were rated higher than 4.5 (the maximum score is 5). Grades are higher in all criteria, compared to the previous year (Employee satisfaction survey, 2018/19).

The effects of Human resource management, at ITS, are visible and are being complemented, besides expression in the form of employee and student satisfaction, low rate of fluctuation and absence. The goal of this approach is met by the idea: “...*the secret in education lies in respecting the pupil...*”

The development of relationship with students is visible through application of CRM in this higher education institution. (ITS is working on personalising them), marketing campaigns (online monitoring of both the existing and the potential students and work on mutual interaction), developing internal communication (through various professional and sports events and seminars where it is possible to monitor the progress of each student individually).

3. CONCLUSION

Optimal combination of human resource management models and customer relationship management – students, in this case, could be helpful to high education institutions in achieving organisational goals and satisfaction of the most important stakeholders – employees and students. The case study presented above has just confirmed the assumption that the postulates of these disciplines are something that needs to be applied for the success of the high education institution and employee satisfaction achievement. Even though, at first sight, the solution seems easily applicable, there is no “one size fits all” model but every educational institution must consider numerous variables when combining its elements in an optimal set.

Successful business at higher education institution does not only require continuous dynamics but also acceptance of new challenges from the natural environment. Since student contentment and satisfaction are part of a strategy, conducted by the high education institution, that, inevitably, leads to HR and CRM strategy application. Both help in creating a

special bond in the school-student relationship because in the manner of time there could be some fields identified in terms of higher benefits towards the user of educational services. HR and CRM electronic system is the challenge of the modern age that is going to personalise all student inquires in accordance with the characteristics of the educational system but also through them and their families, graduate students and community. It is obvious that artificial intelligence will be an integral part of these strategies in near future, to help recommend the most adequate academic product for a specific type of students with all possible predictions.

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LEADERSHIP ATTITUDE EXPECTATIONS IN AGRICULTURE

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Abstract: Numerous researches were conducted on what abilities and skills a leader needs to have. The research was directed at the leaders of various organizations in terms of both size and scope of activities, but for some reason the agricultural sector was always left out of the research as a stepchild. This may be due, among other things, to the fact that a significant proportion of farms operating in Hungarian agriculture - almost 98% - are individual farms. However, according to statistical data, their number has been steadily declining in recent years, as many of the older, single farmers have stopped production (Hungarian Central Statistical Office (HCSO), 2016). Previously, it was not relevant to research what managerial competencies they consider important, but there is an increasingly urgent need to change attitudes in Hungarian agriculture, both in terms of organizational cooperation and generational change. The present study is aim to find out what competencies Hungarian farmers expect from a manager during the development of a possible cooperation.

Keywords: agriculture, managerial competencies, agriculture, generations

1. INTRODUCTION

In today's changing economic conditions, the competitiveness and performance growth of companies, especially small and medium-sized enterprises, can be maintained if they work in cooperation with their partners and competitors (Takács-György & Benedek, 2016). In order for a company to remain competitive in the long run today, it must have distinctive competencies that provide a sustainable competitive advantage, and even key competencies (Csath, 2012). To this day, corporate social responsibility has remained a special and interesting area of scientific life, yet apparently the main character of responsible corporate governance, the company manager, is not examined at all or only tangentially (Benedek & Takács-György, 2016). Previous research in agriculture has shown that the most important thing for successful cooperation seems to be finding a reliable, suitable leader (Baranyai – Szabó, 2017).

2. LITERATURE OVERVIEW

Let's talk about either the public sector or the business sector, in both cases an attractive goal is a managerial career. The clear reason for this is the exceptionally high

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salary. In Hungary, managers are usually paid much higher than their employees (Gajduscek, 2018).

International studies show that the proportion of female leaders in agriculture remains low (Fisher et al., 2012; Knezevic et al., 2017; Dramac et al., 2017; Pavlovic et al., 2018). In the workplace, women and men are often characterized by people based on proven stereotypes. Thus, they believe that women are more sensitive, more communicative, engage in more conflict, while men are more considered, their concentration is stronger, they are more determined in decision-making situations. At the same time, women are more cautious, more open to change, show more emotion, focus on persuasion. Men are bolder, easier to give instructions, and pay much less attention to feelings (Goleman, 1995).

Spence and Buckner (2000) also argued that people attribute different characteristics to women and men depending on gender. Women's traits are expressive: helpful, emotional, understanding, kind-hearted, and sensitive to the problems of others. Male traits are instrumental: independent, competitive, capable of decisive decisions, aggressive, and dominant.

Eagly et al (2003) distinguished between female and male behaviors: women are community-oriented, men are action-oriented. Community-oriented behaviors include friendliness, selflessness, caring for others, and expressive communication. Action-oriented behavior is characterized by independence, domination, determination, and a systemic mindset.

However, leadership models and leadership theories are not for only women or only men. They focus especially on how effective a leader can be to make the task, roles, and organization entrusted to him or her successful (Vukovic et al., 2017; Knezevic et al., 2017).

What leadership style is needed in agriculture? What are the personal qualities that can help change? Landale Cuckney (2005) identified three areas for critical leadership patterns: skills, personality, and intelligence. Skills include, for example, the leader's experience, knowledge and competencies. A personality trait is, for example, self-knowledge or what impact he/she has on the people around them. In addition to measuring classical intelligence quotient, intelligence is also characterized by EQ (emotional intelligence) and SQ (spiritual intelligence) metrics, which characterizes the extent to which an individual is able to handle interactions or win stakeholders (Bauer, 2005).

In addition to recruitment and retention difficulties, the difficulties of cooperation between different generations cause another challenge for HR professionals (Lazányi & Bilan, 2017). The age difference affects cooperation; working together can be difficult for both the younger and older generations (Ian et al., 2017). Today, there are 4 generations present in the job market: Baby Boomers, Generation X, Generation Y and Z and the emergence of young workers belonging to the Alpha generation will soon appear (Meretei, 2017).

Based on the micro-census conducted by the HCSO in 2016, the majority (more than 40%) of the management positions were selected from Generation X, however, one-third were still represented by Generation BB and a quarter were already represented by Generation Y. To a negligible extent (slightly more than 3%), but representatives of Generation Z also appeared in company management.

What characterizes these generations?

The Baby Boomer generation (1944-1964) is a large generation not only in terms of numbers, but also in terms of grades, whose childhood and youth are determined by ideologically dominated school and leisure spaces; compared to Western countries, television had an impact on this generation in Hungary later (Székely, 2012). The main workplace values of baby boomers are equality, optimism, loyalty, involvement, questioning everything or team spirit (Bokor, 2007). Generations X (1965-1979) are mentioned as digital immigrants

(Tari, 2010); the cable TV and PC appeared during their childhood. Following the change of regime, with the proliferation of multinational companies, there was a huge demand from companies for intellectual workers, for young people who learn easily, want a stable job, and could quickly become a good workforce. It was during this period that many X generation took leadership positions (Bokor, 2007). They are highly qualified, speak languages, they also have two or even more degrees and computer skills (Besenyei, 2016). The extremely rapid technological development, including the spread of the Internet, started after the Y (1980-1994), also known as the Millennium Generation's birth (Twenge et al., 2010), which went hand in hand with globalization. As a result, a fairly new world has opened up for everyone, which created the largest gap between generations X and Y (Soulez, 2011). Their main workplace values are self-confidence, tolerance, competitive spirit, practicality, spirituality, immediate willing, proficiency in technology (Twenge et al., 2010). Generation Z (1995-2015) is less willing to follow the rules, they handle electronic devices professionally. They are the first global generation in the world; this globalism is also typical in their use of language. They prefer to use words that are not understood by other generations (Tari, 2011). For Generation Z, the most important is the opportunity to achieve a work-life balance (Pregnotato et al., 2017; Krajcsák, 2018). They have managerial ambitions, they have the need to make comments on their work and also receive feedback from their supervisor regarding the work done. They don't like constraint, they like flexible working hours and to work from home, where they can organise their day themselves.

3. MATERIAL AND METHOD

The first phase of the research was targeted sampling, where farmers, working full time in agriculture, from all over the country, were contacted. Subsequently, in the second phase of the research, the snowball method was applied: with the help of the respondents of the first stage, the online version of the questionnaire reached more than 400 farmers across the country. The questionnaire can be divided into three parts. The first part sought to explore demographic data and some basic characteristics of the agricultural enterprise, the second part examined the operation of the company, and the third part is the attitude of the respondents towards possible cooperation, its advantages and disadvantages, as well as the competencies expected from potential leaders. In this article, we have focused on the content of the third part, the primary objective of which was to examine the relationship between the expected competencies and the gender and generations of the respondents. The data reported in the study were processed using SPSS 20 software.

Out of 435 people 299 people drew what they thought were the qualities a leader needed to have. The narrowed sample consisted of 224 male and 72 female farmers (3 respondents did not wish to declare their gender). According to the Central Statistical Office, 72% of those employed in agriculture are men, and the sample can be considered representative in terms of the gender of the respondents. Our attempt to reach all regions of the country, the overall sampling (435 people) was also successful, which is illustrated by the following graph. The Northern Great Plain region is slightly over-represented, the involvement of the other six regions can also be considered representative (based on HCSO).

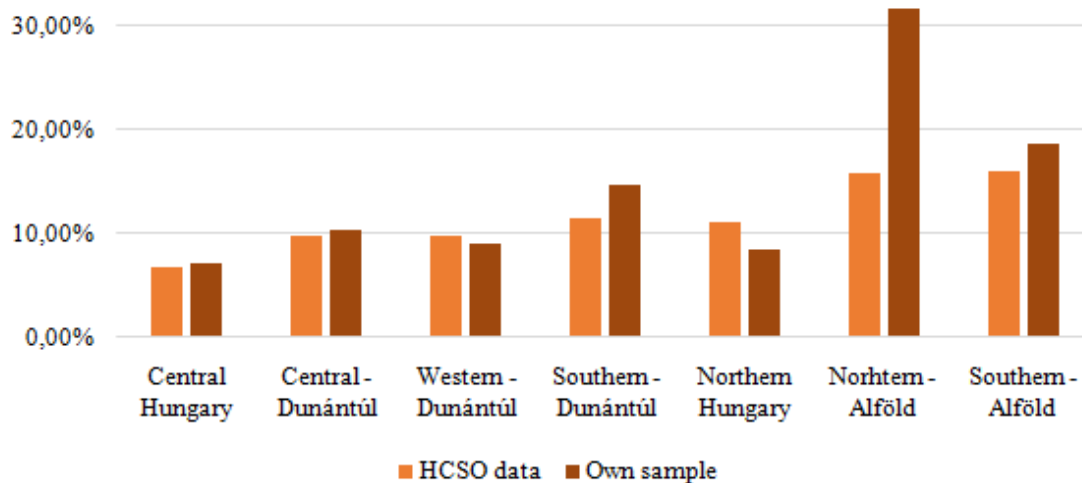


Figure 1. Distribution of respondents by region (own source, own editing)

The largest proportion of respondents came from the baby boomers generation, which can also be considered representative in terms of the HCSO census. Generations X and Y were almost equally represented in the questionnaire, while Generation Z was slightly over-represented based on the 2016 agricultural census.

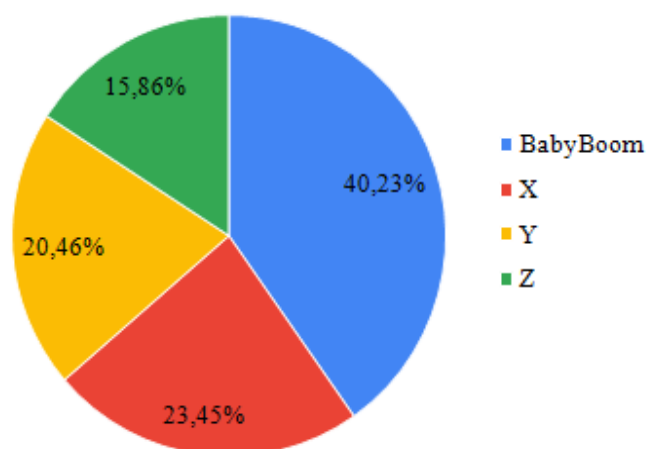


Figure 2. Distribution of respondents by generations (own source, own editing)

4. RESEARCH RESULTS

Despite the fact that the size of an agricultural enterprise is very difficult to determine the first step in analyzing the survey was to establish a well-applicable scale. An open question has been raised regarding the examination of managerial attitudes, however, not all respondents in the sample commented. In addition to leadership attitudes, we formulated it as an additional issue, whether they would undertake to lead a producer cooperation for which we have extended our investigation. The latter question was answered in 293 of the 299 cases.

Free-verbal responses were categorized into three groups according to Chuckney's (2005) theory. Abilities, personality, and intelligence were compared by gender and with a distribution by generations using an independent sample t-test. In terms of gender, no significant difference was detected using the t-test in any of characteristic groups. For both men and women, leadership competencies related to the capability were considered most important. In most cases, both genders emphasize expertise, however, men highlighted, among others, agricultural skills, organizational skills and legal and economic expertise, while women focused primarily on administrative competencies such as precision or proficiency in tender matters. In terms of personality traits, men are honest, fair, cooperative, independent, credible leaders, women thought of a helpful, respectable, determined, guiding leader. In terms of intelligence, men also used the word 'intelligence', they considered it important to keep the group together, have a proper network of contacts, and be attentive to the group's interest. In addition to common interests, women considered it important to have proper communication, charismatic action, and if the prospective leader treats the organization as if it were his/her own.

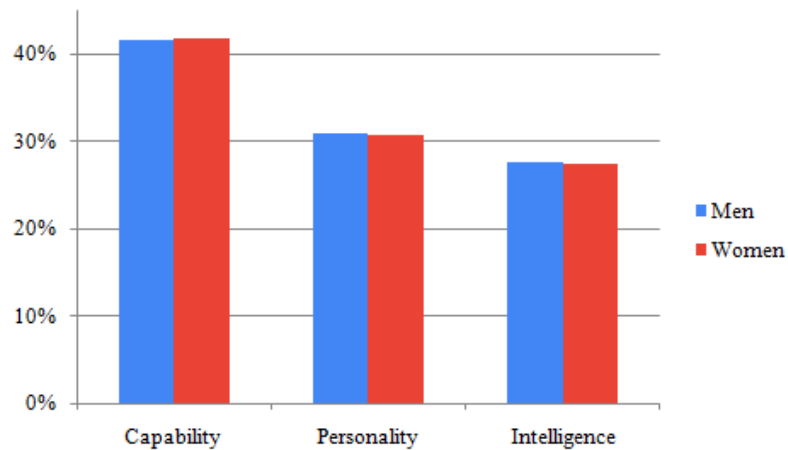


Figure 3. distribution of managerial characteristics by gender (own source, own editing)

For the generations, after the t-test, it was found that in terms of personality traits the p-value is less than the significance level, thus, the assumption that there was no correlation between the criteria was rejected.

Table 1. Leadership personality traits and intergenerational t-test in SPSS (own source, own editing)

T-Test					
Group statistics					
	personality	N	Mean	Std.Deviation	Std.Error Mean
generations	not important	187	0,99	1,112	0,081
BabyBoom, X, Y, Z	important	112	1,33	1,196	0,113

		Levene's Test for Equality of Variances		t-test for Equality of Means				95% Confidence Interval of the Difference		
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std Error Difference	Lower	Upper
generations	Equal variances assumed	4,807	0,029	-	297	0,013	-0,341	0,137	-0,61	-0,072
BabyBoom, X, Y, Z	Equal variances not assumed			-	220,43	0,015	-0,341	0,139	-0,615	-0,067

Regarding personality, the BB generation marked qualities such as being honest, ready to serve, fair, and even “not stealing” in their case. Generation X wants a democratic, loyal, fair, confident leader, Generation Y wants a persistent, forward-thinking, purposeful leader. Generation Z has formulated an emotionless, tough, determined leadership of personality. However, there was no significant difference between generations in terms of ability and intelligence. In terms of leadership skills, all generations have given priority to professional knowledge and experience; there were only nuanced differences in responses. Keeping intelligence in mind, the BB generation said that it is important for them that a leader maintains close contact with members, helps producers and be non-political at work. Generation X said that it doesn't matter to them how, but to stand up objectively and fairly to the members and to represent the interests of the public. Generation Y raises a common problem, it is important for them to jointly resolve any problems by seeking the opinions of members. In addition to the idea of a leader with an emotionless personality, Generation Z has also added that a leader would not necessarily be needed, but even to a supervisory board which ensures independence and truly represents the interests of producers.

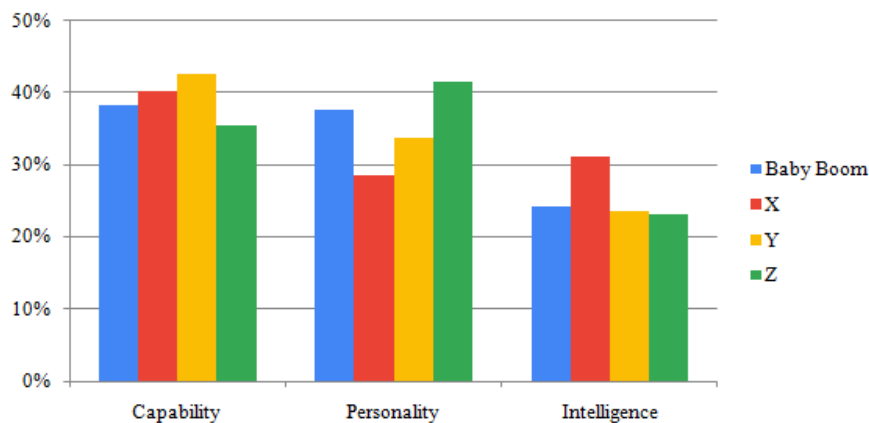


Figure 4. leadership characteristics by generations (own source, own editing)

Regarding the question, "Would you undertake to lead a producer cooperation?" of the former 299 respondents, 3 did not want to comment on their gender, 6 did not indicate any alternatives, 62 gave the "don't know" answer, so 231 responses were included in the analysis. For both gender and generations was found after the t-test, that there was a correlation with regard to the issue of producer cooperation. The p-value showed a lower value in both cases, than the level of significance, so that the assumption that there was no correlation between criteria was rejected.

Table 2. Question „would you take lead in a producer cooperation” and t-test values for gender and generations in the SPSS (own source, own editing)

T-Test					
Group statistics					
Would you take the lead in a producer cooperation?		N	Mean	Std.Deviation	Std.Error Mean
gender	no	172	1,28	0,450	0,034
	yes	56	1,14	0,353	0,047
generations BabyBoom, X, Y, Z	no	175	0,85	1,042	0,079
	yes	56	1,64	1,182	0,158

		Levene's Test for Equality of Variances				t-test for Equality of Means			95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std Error Difference	Lower	Upper
gender	Equal variances assumed	23,09	0,000	2,067	226	0,040	0,136	0,066	0,006	0,266
	Equal variances not assumed			2,335	117,9	0,021	0,136	0,058	0,021	0,252
generations BabyBoom, X, Y, Z	Equal variances assumed	4,173	0,042	4,820	229	0,000	-0,797	0,165	-1,123	0,471
	Equal variances not assumed			4,516	84,092	0,000	-0,797	0,177	-1,148	0,446

Nearly one-fifth of men answered "yes" to this question and another fifth to "don't know", and approximately 60% would not take the lead. In the case of women, almost 70% would not take the lead in producer cooperation, a little over 10% of them would undertake, and in their case about 20% said they didn't know.

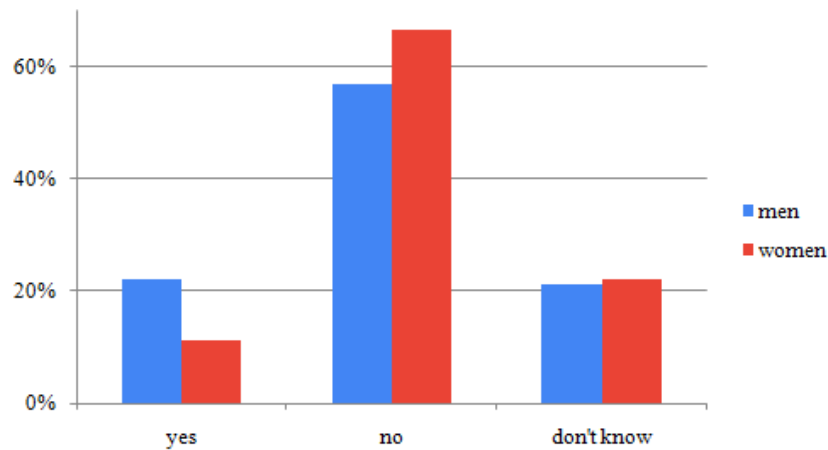


Figure 5. "Would you undertake to lead a producer cooperation?" gender distribution of answers to question (own source, own editing)

The question analysed for generations is as follows: leadership of producer cooperation in the BB generation, in the lowest proportion (11%), in generation X 5% higher (16%), in generation Y more than a quarter (26%), while Generation Z received the highest rate - more than a third would do it (34%). There is also an increasing trend between generations in terms of 'don't know' responses, which was formed in the following order: 16%, 21%, 25%, and 30%. The proportion of those who would not take the lead in a producer organization, on the other hand, shows an inverse proportion for generations: generation BB has the highest, almost two-thirds (73%), generation X more than three-fifths (63%), nearly half of Generation Y (49%) and 36% of Generation Z stated that they would not take the lead in the organization. The reason for the differences in the answers of each generation may be the presence or absence of experience arising from their age. The BB generation presumably does not want to take the lead based on past experience, they can already see that this is not easy to achieve, while members of Generation Z have little experience, however, they believe they are able to take the lead in the collaboration.

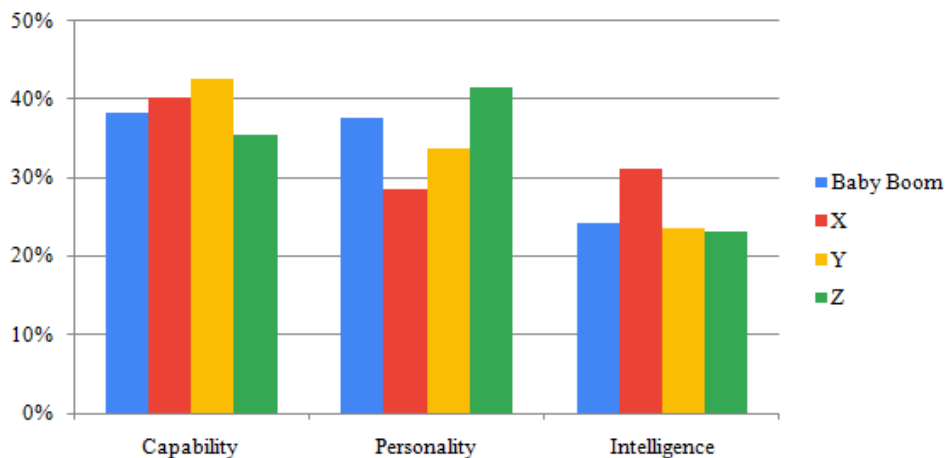


Figure 6. "Would you undertake to lead a producer cooperation?" distribution of answers to question by generation (own source, own editing)

5. SUMMARY

A significant proportion of organizations operating in Hungarian agriculture are individual farms, however, in order for those working in agriculture to succeed, it is essential that to overcome their size disadvantages, to change attitudes in agriculture and to cooperate. The basic condition of cooperation within the framework of an organization is the existence of appropriate management, leadership; however, research rarely addresses what qualities a leader who leads the organization should have. In the present study, how farmers perceive the management of a possible producer cooperation by gender and generations. Based on the analyses performed in the SPSS on the basis of the sample, it can be established that a statistical correlation can be demonstrated in both respects. According to gender, a larger proportion of men would take the lead in a producer collaboration. With regard to generations that there is the least willingness to lead in the older generation and the highest willingness to lead in the youngest generation. Based on the classification of leadership competencies into 3 main groups (ability, personality, intelligence), there is a significant difference between the generations in terms of personality. Regarding personality, the BB generation marked such traits such as honest, service-minded, fair, and even “not stealing” in their case. Generation X wants a democratic, loyal, fair, confident leader, Generation Y wants a persistent, forward-thinking, purposeful leader. Generation Z has formulated an emotionless, tough, determined leadership of personality. Overall, the person selected to lead a successful collaboration should be a leader who is accepted by the members of the organization. We did not find a significant difference in answers given by the responding farmers in terms of gender, thus, our sample can be considered homogeneous by gender. Regarding the generations, there was a unanimous opinion that the existence of leadership skills (knowledge, experience) was preferred, personality was considered important and intelligence factors were rated less important compared to personality traits. There was a significant difference between the generations in terms of the responses marked for personality, in other respects, the group of respondents can also be considered homogeneous.

6. LIMITATIONS OF THE RESEARCH

The sample of 299 people used in the analysis can be considered representative in terms of gender and generations according to the statistical data, however, based on the answers to the question, the spatial distribution is not representative of the total sample thus, the conclusions drawn cannot be generalized to the country as a whole. Leadership traits were categorized using content analysis (1: ability, 2: personality, 3: intelligence); the code system used for the SPSS analysis was also determined on the basis of these. We believe that in terms of skills and competencies, if a non-free verbal answer had been used, a more nuanced picture would have emerged for respondents. Looking to the future, based on the answers to the question, we plan to further quantify the characteristics using the Likert scale.

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THE MAIN MANAGEMENT, FARM ORGANIZATION AND MARKET LESSONS OF ORGANIC FARMING BASED ON THE HUNGARIAN EXPERIENCE OF THE LAST DECADES. THAT IS, WHAT NEEDS TO CHANGE FOR SUCCESSFUL PRODUCTION AND SALES?

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Abstract: Since the 1990s, the popularity of organic farming has increased significantly. By the turn of the millennium, a growth trajectory had been assumed that had characterized the Chinese economy in recent years. However, this did not happen. In Hungary, too, and in most countries this growth rate has slowed down, it has been where it has fallen. In Hungary, we can currently see stagnation in the size of the area and the number of producers. What was behind the recovery and the turndown? One of the main reasons is that smaller producers with poorer conditions considered exploring the possibility of breaking out in the transition to organic production. Lack of capital, worse arable land, lack of well organization methodology. These were able to be offset for a few years by a significant increase in turnover in organic markets. On the other hand, we see that the basic management and financial problems can only be temporarily remedied by an emerging market. The other producer groups are the larger units that produce for export to Western Europe, which typically export raw materials. Where these raw materials are processed with the available processing capacities and then some of them are shipped back to the markets of the producing country, selling them at a significant margin. This indicates a structural problem. There is no processing capacity with significant added value. The aim of the study is to show what has changed in recent decades, what management, organizational and other issues we have progressed in, what has not changed. Based on production data, proving that organic production can be viable, but the lessons need to be drawn and changed, because without it there is no successful neither Hungarian or regional production.

Keywords: organic farming, sustainability, competitiveness, management, yields

1. INTRODUCTION

For consumers that take into account the needs of the environment and nature, organic farming offers a better natural solution, rather than industrial farming. At the same time, organic farming takes into account the needs of consumers for health, wholeness, and morality. In this situation the consumer feels he/she has done something useful for their health and, for the environment.

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The first section of this paper, defines organic farming briefly but succinctly. The following section briefly presents the legal background of organic farming, which is necessary for a full understanding, as they provide the regulatory framework. If a product, process, or farming methodology meets these regulations, we are examining an organic farming method, if it does not comply, then it is not considered organic farming.

The aim of this research is to examine how the situation of organic production has developed in recent decades, mainly in Hungary. It is also worthwhile to deal with markets that are strongly related to production, as these markets can determine and change the production and quality of organic products. What issues does an organic producer or trader have to deal with? Answering key questions will help you be a successful organic producer. This paper examines the yields, costs, the main motivation of consumers as to why they choose these products, the development of the ecological footprints, and market characteristics and difficulties.

2. LITERATURE REVIEW

The first step is to define organic farming and describe its characteristics.

„Organic production is a comprehensive system of farm management and food production that combines best environmental practices, a high level of biodiversity, the conservation of natural resources, the application of high animal welfare standards and products produced using certain materials and processes by certain consumers. production methods in line with its preference for The organic production method thus has a dual social role, on the one hand, it provides a special market that on the other hand, it produces public goods that contribute to the protection of the environment and animal welfare, as well as to rural development.” (Council Regulation (EC) No 834/2007 on organic production and labeling of organic products and repealing Regulation (EEC) No 2092/91.).

It means another way of production and life thinking from the producer and retailer. Alternative (organic) forms of farming deny the industrial dependence of industrial agriculture. For this reason, they rely on the natural materials and natural processes found in the economy. They want to implement a form of farming that which is economically, ecologically and socially sustainable in the long term. They want to re-create traditional agricultural production based on the higher biological knowledge and technical conditions of the age. In its management, all farms within the farm are characterized by the organic connection between the soil plant animal and the soil, as far as possible a closed system, where a closed flow of material and energy similar to natural cycles is realized (SÁNTHA, 1996).

Based on the formulations of the authors, the definition of the organic farming:

1. Organic farming shall refrain from the use of chemicals and fertilizers,
2. relying on natural processes and natural materials,
3. regulated,
4. controlled throughout the product chain,
5. and a production mode that seeks to operate profitably.
6. Due to the high system of requirements and regulations resulting from the special quality, successful organic farming requires outstanding expertise and the appropriate technical standard during production.

Based on the system of conditions for the production and qualification of the organic product, according to Radics (Radics, 2001) the following principles can be laid down.

- Avoid all polluting technologies: The essence of this is to minimize the pollution and damage associated with agricultural activity and to prevent the risks from erosion, nutrient leaching and the accumulation of pesticide residues.

- Diverse production structure and crop rotation: Where possible, the use of techniques to ensure the supply of nutrients and energy to the land and plants (year-round soil cover, cultivation following strata, use of active substances of natural origin).

- Maintenance and improvement of soil fertility in the long run: The basic elements of this are biological activity, organic matter content, nutrient balance, soil structure and nutrient content. Means of this include the use of crop rotation, butterfly and mulch crops, the exclusion of fertilizer use, appropriate manure treatment and application.

- Integration of livestock into the farming system: This will ensure the right quality and quantity of organic manure.

- Economical use of non-renewable energy sources: Stimulation of biological processes and promotion of renewable energy sources instead.

- Satisfaction of the natural needs of species, varieties: This means, on the one hand, satisfying the physiological needs of the given species in a natural way (eg adequate space for movement, feeding, keeping, hygiene) and, on the other hand, ensuring the ethological needs of the given species.

- Establish a closed management system that uses mainly local resources: At the regional level, implement a minimum of energy, materials, investment and mitigate losses. In the process, the use of home-grown feed, composting of organic household waste and the sequestration of biological nitrogen take place.

- Production of sufficient amounts of highly nutritious food: Increasing the amount of useful ingredients (such as amino acids, fiber, enzymes, vitamins, minerals) and reducing the amount of hazardous substances.

- Ensuring good livelihoods for farmers and their families: Ensuring decent living conditions, a standard of living for farmers, while not reducing the rural population.

- Preservation of the rural environment and non-agricultural habitats: In addition to the protection of the landscape and the environment, the aim of organic farming is to restore the original landscape as much as possible.

We can find some opportunities of organic farming and products vs. normal methods and products. The two most important properties of organic production crops are chemical-free and avoidance of fertilizer use. Because of this, there are many physiological benefits to consuming it. However, it should also be taken into account that in case of improper production, the product may be harmful in terms of diseases that may occur on the product or in the product.

Although many of the benefits of organic crops are known - they have a higher content value, are free of accumulating chemical residues and are produced using environmentally friendly technology - they are usually brought to the attention of the population during the treatment of an established disease or during childbearing. International practice of health and education institutions with their involvement in public catering (Nezdei, 2018).

Organic production is often linked to local markets and the local consumers who appear there. Community agriculture seeks to produce high quality food for a local community, often using organic farming methods, in a risk-sharing membership marketing structure. This type of farming activity involves a much higher degree of involvement of consumers and other stakeholders than usual, resulting in a stronger consumer-producer relationship. In the 2017 survey of Gombkötő et al., 55% of the surveyed producers follow a conventional, ie traditional, method of production, and only 10% of them use organic

farming. This special trend was characteristic only of fruit and mixed fruit and vegetable growers (Gömbkötő et al., 2017).

Higher turnover

With the exception of oilseeds, where the same values can be observed, the turnover per hectare can exceed that of traditional farms by up to 10-70%, depending on the vintage. In other parts of the product path - depending on the degree of processing of the crop. - of course, higher surcharges can be realized (Koltai et al., 2007).

Advantage of market

Nezdei's 2016 (nearly a year-long) consumer survey of markets in the area found that demand for organic, chemical-free and natural foods has reached about 10%. Furthermore, the qualitative survey of (non-organic) producers in 2017, which affected producer markets, revealed that the weakness of producer capacity in the sample area is mainly caused by the lack of helping family members and casual workers, as well as the seasonal demand in the region (Nezdei, 2018). Organic production, organic farming, can be a strong selling quarell and establish the core of new brands in the consumption of food and tourism, due to the growing demand for organic, ecologically increased agricultural products. (Némethy et al., 2016). Its economic benefits are mainly through direct sales become perceptible in Hungarian terms, as supplier opportunities are scarce, in retail chains foreign organic products are sold. In addition to direct sales, branded and trademarked products carry the promise of quality, and certification marks referring to the controlled farm, and various markers (such as the product mark from the organic farm) mean quality assurance (Nezdei, 2018).

In 2014, Voicilas et al. found that due to the higher premium of organic products in Hungary, there is a demand for it in markets where purchasing power is high, and knowledge of higher education and the benefits of organic products increases the demand for the products. For this reason, it is appropriate to increase consumer information (Voicilas et al., 2014).

The large ratio of consumers are willing to pay more than 30% price premium to the organic product, if they would trust the origin of the product (Vehapi & Dolicanin, 2016).

The differences in price between organic and conventional products are highest for eggs; the organic egg price is 52.04% higher than the price for non-organic eggs. The differences in prices for milk and potatoes are significantly smaller at 19.36% and -7.18% (Yufeng, Chengyan, 2020).

Benefits of ecological footprints.

The total CO₂ emissions of the world economy are about 38 billion tons per year, of which the agricultural load is 10-12% (Kondor & Kovács, 2017).

Positive feedbacks from organic farming are of paramount importance in environmentally sensitive, vulnerable areas, where the use of environmentally friendly technology can be the basis for the long-term sustainability of the region. In addition to preserving the landscape values, tourism creates a potential market for the special, niche market products produced, and promotes the sale of organic products (Nezdei, 2018).

Although, for example, the issue of yields can be a disadvantage if plant protection or yield increases cannot be resolved differently from traditional methods.

Koltai and Mazán (2007) found yields of 65–90% for cereals (including maize) and 70–90% for oilseeds. In 2003, the advantages of extensive varieties used on organic farms were demonstrated, as despite average drought weather, higher average yields were achieved than in the past in conventional systems. In traditional production the yield averages of the super-intensive varieties used were up to 50% lower than the multi-year average (Koltai et al., 2007).

3. RESEARCH METHODOLOGY

The examination of the organic production of Hungary, Europe and the world can be done by processing the available literature., In addition to using different statistical analysis methods based on the relevant data of various national research institutes and statistical offices. Informal conversations with professionals in recent decades have also helped to approach the topic from a distinct perspective. Unfortunately, the amount of trustworthy data is limited, one of the reasons for which may be the need to comply with the mandatory minimum organic regulations. Or, in order to protect business interests, no data is available that allows wider comparisons to be made, either in terms of production data, yields, or sales. While the size of the winter wheat production area and the amount produced in a given year are available at the national level, the same data is no longer found for organic production after 2003, it has been removed from the annual reports. Thus, research encounters difficulties and in many cases fumbles. Fortunately, the Swiss-based FiBL collects reports and basic data from most of its organic-producing countries, so the work also relies on their annual reports. However, it is very difficult to collect and estimate information on sales markets. This is because many Eastern European countries export raw materials, the prices of which cannot be collected due to trade secrets, so only FiBL reports can be relied on. Where possible and meaningful, time series analyses are also done and drawing conclusions based on trends.

4. OBJECTIVES OF THE STUDY

The aim of this study is to examine, from a management perspective, the areas in which an organic farming organization needs to make decisions for successful market and producer operations. To do this, I first present the domestic and international market and production situation, second I examine in which countries the organic production method is most widespread, and in each country what are its main characteristics. In summary, in my research I am looking for the answers to the following questions:

1. How does the domestic and international literature evaluate the significance and development of organic production?
2. What kind of regulation of organic production prevails in the markets, and how does this affect the development of domestic production and sales?
3. How has organic production and the market developed in the world?
4. What factors characterize the development of domestic organic production?
5. In terms of its product structure, products and target markets, how is the development of Hungarian organic products evolving?
6. What are the main characteristics of the domestic retail turnover of organic products?
7. What are the main difficulties and challenges of the management of organic producers in light of the results of the study?

5. RESULTS

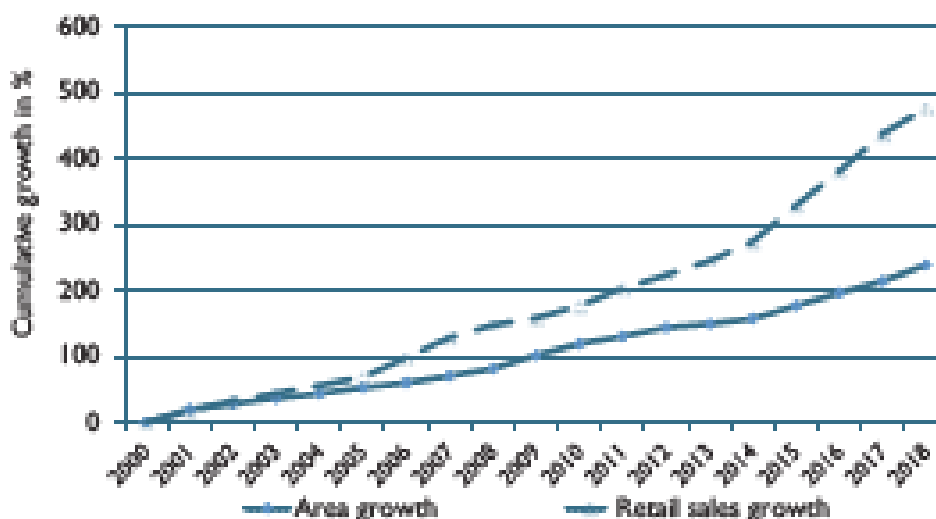
We can find a large increase in the world markets in production and turnover in the last decades. If we separate the world large territories according to factors we can see a North American market, a South American, a European and Asian and Oceanian ones.

North America had 52.5 billion dollar turnover in organic market which means 6% increase from the previous year. This increase was higher than food market increase (2.3%) and non-food increase (3.7%).

There are 11.650 organic farms with minimus 50% turnover from organic sales. Us organic export was 34 million US dollars. In this factor we can find strong market and supply. Organic land is approximately 3.3 million hectar.

South America had 8 million hectar organic land which means much more larger territory than North one. But the market is lower. Main producers are in Argentina, Brasil and Uruguay. Permanent grassland and animal husbandry is typical there. The number of producers is 227 609 which means much more higher number than in North. The larger of the market we do not have data but we assume is lower than in North because of higher level of poverty.

In Europe we can see a permanent growth both in sales and in the large of the territory (Graph 1).



Graph 1. Change of organic area and retail sales in Europe between 2000 and 2018

In 2018 therefore, a new rule was adopted (Regulation 2018/848) which can help to handle the new challenges of the larger production and sales. In Europe the land and the market one the largest in the world. 15.6 million hectares production land with 3.1% is organic and 40.7 billion retail sales is available. The significant annual growth of the European market of 7.8% means that there is a demand and a solvent demand for these products in the welfare states. The significant strength of producers, on the other hand, shows that these farmers have a significant number and capital. At the same time, states also support this activity. Not only the basic agricultural activity, but also its organic version. There is demand and there is adequate supply in European markets. However, these producers do not only produce unprocessed food. It is important that the producers' goods are taken up by the processing industry and produce a high value-added finished product, which is then resold to other markets, such as Eastern European countries or overseas. This should be emphasized in

order to produce products with significant added value. It is only secondary to the organic product. Commercially, the primary consideration is that the product is processed.

Barriers to profitability in the Eastern European region are low sales prices, unfavorable atmospheric conditions, high cost of training and a high level of bureaucracy. Producers are heavily dependent on state aid. Without this, they would not be able to continue their activities. The search for alternative factors to increase the profitability of organic production, such as support for the processing of agricultural products, improved sales organization (horizontal and vertical coordination) and shortening supply (Short supply chains), seems important (Przygodzka et al., 2019).

The larger territories are in Spain, France, Italy and Germany. The largest share is in Liechtenstein (38.5%), Austria (24.7%), Estonia (21.6%), Sweden (19.9%), Italy (15.8).

Approximately 115 countries make export activity into EU. In volume, China is the biggest one with 415 243 tonnes of produce, this means 12.7% of the total. Other countries like Ecuador, Ukraine, Turkey, and the Dominican Republic has 8%. Three-quarters of the imports from China in volume consists of oilcakes. The remaining products are mainly soybeans, oilseeds and soya with 5-6%.

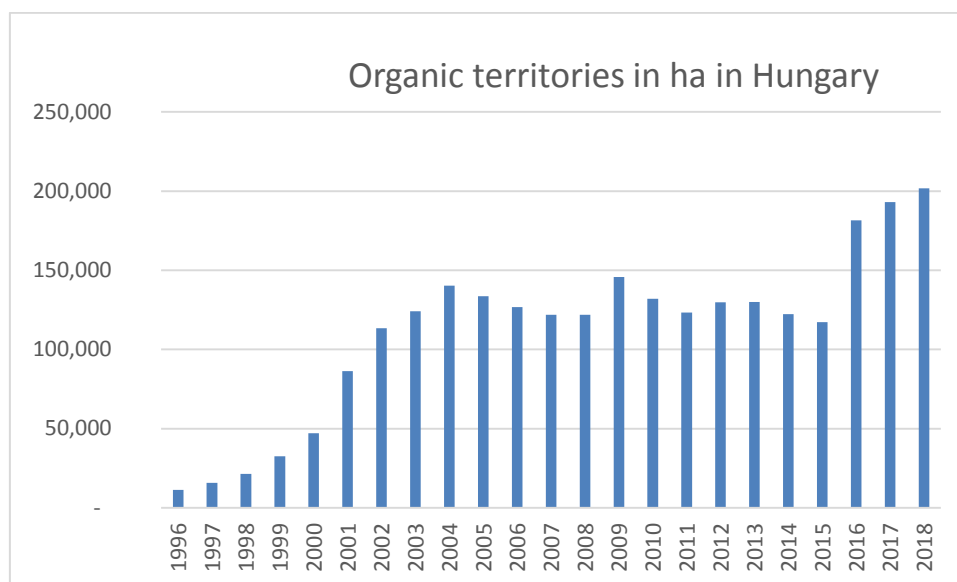
Organic farming has a right within agricultural production, but runs a different path than integrated production capable of meeting mass needs. Therefore, the main question is not what economic characteristics it has compared to other production methods, but whether this mode of production alone is viable in the face of increasingly intense market competition. Viability begins with production, - with what yields and specific costs the product can be produced, - and continues with processing and trade. The issues of efficiency, economy and profitability are important at all stages of the product chain. We can see that in developed countries this can work well (Table 1).

Table 1. The data of world organic

	2010	2011	2012	2013	2014	2015	2016	2017	2018
<i>Number of countries</i>	160	160	164	170	172	179	178	181	186
<i>Organic agricultural land in million ha</i>	37,2	37,0	37,5	43,1	43,7	50,9	57,8	69,8	71,5
<i>Organic share of total agricultural land</i>		0,90%	0,87%	0,98%	0,99%	1,10%	1,20%	1,40%	1,50%
<i>Wild collection in million ha</i>	41,9	43,0	31,0	35,1	37,6	39,7	39,9	42,4	35,7
<i>Producers in million</i>	1,8	1,6	1,9	2,0	2,3	2,1	2,7	2,9	2,8
<i>Organic market in million euro</i>	40 000	44 500	500 000	66 503	76 529	75 000	80 000	90 000	967 000
<i>Per capita consumption</i>		7	9	10	11	10	11	11	13
<i>Number of countries with organic regulations</i>	74	84	88	82	87	87	87	93	103
<i>Affiliates of IFOAM</i>	757	870	732	815	784	833	1 003	726	779

In Australia and Oceania has the largest territory of organic with 36.7 million ha, but the market is not too high because of export centered activity. The countries of British National community transport a large amount of processed production to North America and Europe.

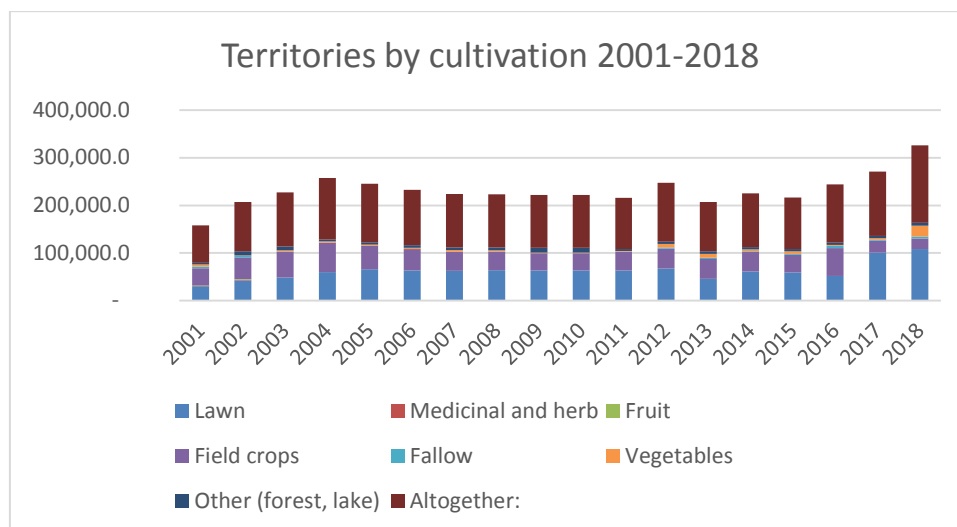
In Hungary we can see a highest increasing until 2004 and after that there was a stagnation in the large of territory (Graph 2).



Graph 2. Territories changes in Hungary between 1996 and 2018

High ratio of producers and farmers changed to organic in Hungary because of the hope of favorable supports, market and sales opportunities. It can be stated that in the areas with favorable conditions, under large-scale conditions, the yields of organic crop production were 20-40% lower than the traditional ones (Gyarmati, 2007). In the case of crops requiring more fertilizers and pesticides in traditional production, but less live labor, the specific costs per unit area and per unit produced in my own studies were 0-15% lower than in organic production. In the cost structure of organic production, the decrease in nutrient replenishment and plant protection expenditures, as well as the increase in the cost of living labor are conspicuous. At the same time, thanks to subsidies and higher sales prices, the profitability of organic production exceeded that of traditional crops, which was a prerequisite for the successful sale of crops as organic products. Due to lower yields, organic farming in areas where overproduction problems are struggling can be a means of regulating overproduction. This is one of the reasons why the rate of organic production is higher in Western Europe.

We can divide domestic producers into export market and domestic market into producers. The vast majority of producers for the domestic market have smaller farms and are equipped with only the most necessary machinery. Producers for the export market include larger farms and production units with a high degree of mechanization and coexistence. In the case of organic farms, compared to agriculture as a whole, the proportion of grassland (meadow, pasture, 53.6%) and arable land (26.4%) is much higher (Graph 3).



Graph 3. Territories by cultivation in Hungary between 2001 and 2018

In organic farming, grasslands are important, but not because of animal husbandry, as the number of animals is not very significant in Hungary, but because these areas can easily be classified as ecological, as no chemicals have been used for decades. It is also characteristic of Hungarian organic farming that by classifying pastures as ecological areas, they increase the size of the ecological area, and also include disadvantaged, poorly endowed lands in organic farming in the hope of support, thus reducing losses. Cereals (49.8%), fodder crops (26.4%) and oilseeds (19.3%) are dominant in the sowing structure. In organic farming, too - in accordance with the agricultural production conditions of the country - the cultivation of cereals and oilseeds is of the greatest economic importance.

Compared to the Central European states, the sectoral indicators of the Hungarian organic areas clearly focus on mechanization. showing a preference for crops that require less live labor. Good mechanizability of field crop production it reduces the vulnerability resulting from labor shortages, and the production of a larger batch allows for better advocacy (Nezdei, 2018).

70-90% of domestic organic products are exported directly, more than 90% together with animal products and processed products. Of the major products, the export base is provided by larger economies. A significant part of organic exports is raw, unprocessed and, like all domestic food exports, a significant part of it is cereals (mainly wheat, spelled and maize) as well as sunflowers and oil pumpkins. The high unprocessed nature of organic products is partly due to the lack of processing capacities, and partly due to the fact that it pays to carry out processing activities in the processing plants available for Hungarian agriculture only in larger quantities. The production of such large quantities requires secure, predictable buyer demand that domestic organic farming does not have in export markets. This is due to the lack of market knowledge and contacts of domestic organic farmers, on the one hand, and the strong competition in the processed products segment in Western European markets, so our processing plants are sought and welcomed as raw materials by processing plants.

6. CONCLUSIONS

There are no Hungarian products accepted, sold in larger quantities on the market, soybeans perhaps met this requirement the most, although its quantity is negligible. For this reason, it can be stated that Hungarian exports based on cereals and oilseeds are only able to stand on foreign markets as long as we can produce them in a guaranteed quality and at a favorable cost. The Western European market has ceased to be a demand market, where supply is dominant, limiting market access. The abundance of the supply of organic products is indicated by the fact that exports from the transition areas are constantly declining and markets require more than 90% organic products. Hungarian exports to Western Europe are also expanding, but their annual fluctuations are significant. The main reason for this is that importing countries do not play a role in providing supplies, but in supplementing, expanding and sometimes filling in gaps.

Domestic organic products were able to maintain their markets primarily where quality played a greater role. The export markets of domestic organic products essentially correspond to the export markets of traditional agricultural products, so the role of Central European German-speaking countries, Germany, Austria, Switzerland is decisive, but the Netherlands and France can also be included here. Neighboring countries (Austria already has) would play an important role, but their weight, with the exception of Slovakia, is not significant. Western European countries have significant processing capacity, they only need organic raw materials. As Hungarian organic products are often only partial raw materials for the processing of organic products, they can be easily replaced by lower quality but cheaper products. It was not possible to develop a product range that would be less substitutable in the markets, a specialty. The export of Hungarian organic products is greatly influenced by the fact that it does not have a high-quality logistics base, so producers strive to sell the produced products as soon as possible after harvest (Table 2).

Table 2. Swot analyses of Hungarian organic production

<p>Strengths High expertise, prepared cultivators Our lands are less polluted, fertilized, chemicalized than in Western Europe Due to lower industrial density, less polluted environment than in industrial regions, more industrialized countries High quality domestic requirements system Closed domestic market, which benefits the producer, trader but detrimental to the consumer</p>	<p>Weaknesses Low degree of mechanization Lack of capital in agriculture Many small farms Unprocessed product range Scarce domestic market with less affluent consumers Lack of special products Centralized, "comprehensive" organizational and institutional background There is no real competition between inspection bodies Lack of cooperation, producer advocacy association Additional, gap-filling role in the export market Lack of lasting, stable export market relations Lack of logistics base Weakness of manufacturing background Low level of language skills and market relations</p>
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<p>Opportunities Production of processed, quality products Special product range Achieve lower domestic prices through efficient means of production and trade and thus increase consumption Involvement of large farms in production Establishing advocacy associations Establish logistics bases to increase exports To meet higher standards in order to expand markets</p>	<p>Threats Intensifying competition in Western European markets may displace domestic exports Dumping of exports of cheap bulk goods in the East to Western European markets Exports of raw materials for printed goods remain typical, while additional income from processing is realized by importers Imports of cheap organic products can limit domestic production With their processed products, capital-intensive companies can cut off domestic development opportunities and the development of the manufacturing industry Due to the low number of animals, the supply of organic manure and the utilization of domestic production facilities (good fodder production opportunities, large grassland) are questionable.</p>
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7. SUGGESTION

What can be done to remain competitive in the future?

- a. Offering a lower price is dangerous in the long run because it can deplete farmers' resources and jeopardize their existence.
- b. Where possible, higher quality systems (Demeter, Bio Suisse, Naturland) and markets that recognize it should be met.
- c. To sell the product as an organic product in the domestic markets (smaller margin).
- d. Or forced to sell as conventional (most unfavorable to the producer).
- e. By increasing processing, other market segments where eastern bulk goods are not yet present can be satisfied.
- f. Export products to markets outside Europe, such as USA, Japan.
- g. Emphasize a characteristic that is recognized by the market. e.g. organic Tokaji must
- h. Increasing the organization (integrations) of organic production and creating logistics bases that offer organic products in line with market needs.
- i. Making investment in organic farming and production attractive. As investors decide on rates of return, this should be improved in this segment. This could be done by supporting food processing or research and development.

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