University Business Academy in Novi Sad
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INNOVATION AS AN INITIATOR OF THE DEVELOPMENT "INNOVATIONS – DEVELOPMENT PROSPECTS"

International Thematic Monograph – Thematic Proceedings

INNOVATIONS

Belgrade, 2019

University Business Academy in Novi Sad
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FOREWORD

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

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

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

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

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

Belgrade,
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Editors
Darjan Karabašević, PhD
Svetlana Vukotić, PhD

CONTENTS:

APPLICATION OF FUZZY WEIGHTED GEOMETRIC POWER HERONIAN AGGREGATOR IN MULTI-CRITERIA DECISION MAKING

***Dragan Pamučar*[1]**

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Abstract: Heronian mean (HM) operator enables the presentation of interconnections between elements and their fusion into a unique utility function. On the other hand, the Power aggregation (PA) operator eliminates the influence of unreasonable arguments taking into account the degree of support between input arguments. Apparently, Heronian and Power aggregators can successfully achieve this goal. In order to unify the common advantages of the Heronian and Power aggregators, in this paper, we propose a new fuzzy Weighted Geometric Power Heronian aggregator (TrWGPHA), which is created by combining the Heronian and Power aggregators. The TrWGPHA aggregator uses all the benefits of the Heronian and Power aggregators. The development of a new aggregator enables more accurate decision-making in fuzzy environment. The TrWGPHA aggregator is tested on real-world engineering problem.

Keywords: Multi-criteria decision making, Aggregation operators, Heronian mean, Power mean.
JEL: C44, C52

1. INTRODUCTION

Decision-making is the process of choosing the best by dealing with encountered problems and uncertainties. Multiple attribute decision making (MADM) problem is a type of multi-objective decision problem encountered in many fields from politics to engineering. Sometimes decision process becomes so complex that it makes more sense to reach a decision by making use of group power. Taking into consideration the social and technological developments, more experts are needed for the decision making process, so it leads to multiple attribute decision group making (MAGDM) problems. Since such problems are complicated, its characterization with crisp numbers can lead to loss of information. In order to overcome this drawback, Zadeh (1965) suggested fuzzy set theory which took place in many different areas.

In complex MCDM models, a large number of experts participate in order to find the most objective solution (Chatterjee *et al.*, 2018). Such models require the application of mathematical aggregators to obtain aggregated initial decision-making matrix. Information aggregation generally became an important topic of MAGDM and received increasing attention from researchers (Deli & Subas, 2014; Ye, 2015; Han & Wei, 2017). There are many traditional aggregators used in group MCDM models, such as Dombi aggregators (Dombi, 1982), Bonferroni aggregators (Bonferroni, 1950), Einstein and Hamacher operators (Wang & Liu, 2011), Heronian aggregation operators (Xu & Yager, 2006). These aggregation operators have been widely used in theories of uncertainty, such as: rough MCDM models (Stevic *et al.*, 2018; Pamucar *te al.*, 2018; Djordjevic *et al.*, 2019), single-valued neutrosophic MCDM models (Ye, 2014, 2015; Li *et al.*, 2016), linguistic neutrosophic models (Fang & Ye, 2017; Liang *et al.*, 2017 Pamucar *et al.*, 2019), etc.

In this paper, a new approach in the theory of fuzzy sets is applied to the treatment of uncertainty and imprecision contained in the data in initial decision making matrix, an approach based on triangular fuzzy numbers (TrRN). This paper presents the application and development of a new fuzzy Weighted Geometric Power Heronian aggregator (TrWGPHA). The application of the new TrWGPHA operator is shown in real MCDM problem. In the literature, there are numerous examples of use traditional MCMD models for the evaluation of alternatives. However, in the literature so far the Power aggregation (PA) operator and Heronian mean (HM) operators based on TrRN are not familiar. According to the knowledge of the author, there is no hybrid TrWGPHA model in the field of MCDM, which in this way considers mutual dependence of criteria, evaluates alternatives and treats imprecision and uncertainty with the TrN. One of the goals of this paper is the development of new TrWGPHA operator for the TrN aggregation. The second goal of this paper is the improvement of the MCDM area through the development of new hybrid TrWGPHA model based on the TrN.

The rest of the paper is organized as follows. The second chapter presents mathematical analysis of fuzzy numbers. The third chapter presents the development of new IRNWGBM operator, which is later tested in the fourth chapter through real example. In the fifth chapter, concluding observations are presented with special emphasis on the directions for future research.

2. FUZZY SETS

In their decision making people often manipulate with vague or imprecise concepts which can mostly be expressed successfully in spoken language. The way of modelling of decision making process was proposed by Zadeh (1965). It is based on the theory of approximate reasoning, which enables representation of linguistic assertions by means of mathematical models.

Fuzzy sets are introduced with the main goal of ensuring mathematically formalized ways of representation and modelling of indefiniteness in linguistics. Thus defined sets can be understood as generalization of the classical set theory. The main idea of fuzzy sets is very simple. In classical (non-fuzzy) sets the defined element (a member to the universal set) either is included or is not included in the defined set. A fuzzy set, in this sense, is generalization of a classical set, because the membership of an element to a set can be characterized by a number from interval [0,1]. In other words, *membership function* of a fuzzy set maps each element of the universal set into this interval of real numbers. One of the biggest differences between classical and fuzzy sets is that classical sets always have a unique membership function, while, in the case of fuzzy sets, there are an infinite number of different membership functions by which it can be described.

A fuzzy set is extension and generalization of a discrete set (Bozanic *et al.*, 2015). It represents a set of elements with similar properties. The degree of membership of an element to a fuzzy set may be any real number from interval $[0,1]$.

Definition (Teodorovic & Kikuchi, 1994): Regulated pair $(\mu_A(x), x)$ is denominated fuzzy set A on non-empty set U , where $\mu_A(x)$ is the degree of element membership to $x \in U$ fuzzy set A. The membership degree is a number from interval [0 1]. As the membership degree rises, the extent to which the element of universal set U corresponds to the characteristics of the fuzzy set increases.

Formally, fuzzy set A is defined as a set of regulated pairs

$$A = \left\{ \left(x, \mu_A(x) \right) \middle| x \in X, 0 \le \mu_A(x) \le 1 \right\} \quad (1)$$

If we define the referent set as $V = \{o,\ p,\ r,\ s,\ t\}$. one fuzzy set can be like this $B = \{(0.3,\ o), (0.1,\ p), (0,\ r), (0,\ s), (0.9,\ t)\}$. This means that element o is included in set B with 0.3 degree, p with 0.1 degree, t with 0.9 degree, and r and s are not included in set B.

Each fuzzy set can be represented by its membership function. If a reference set is discrete, the membership function is a set of discrete values from interval [0,1], as in the previous example. If a reference set is continual, we can express it by means of membership function.

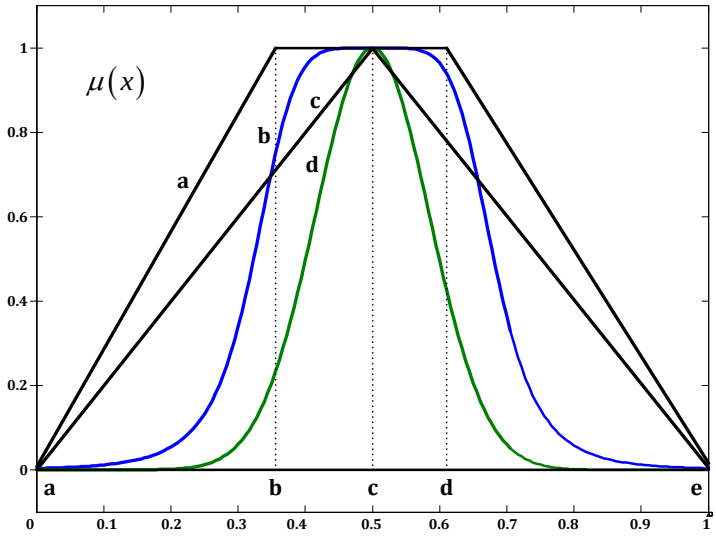
The most frequently used forms of membership functions are:

Triangular function, figure 1v,

Trapezoid function, figure 1a,

The Gauss curves, figure 1g,
Bell-shaped curves, figure 1b.

Figure 1. *Most frequent forms of membership function*



In figure 1, the ordinate represents the membership degree. Fuzzy variable x is shown on the abscise. Mathematical expressions describing membership functions shown in figure 3 have the following form:

$$\mu_c(x) = \begin{Bmatrix} 0, & 0 < x < a \\ (x-a)/(c-a), & a \le x \le c \\ (e-x)/(e-c), & c \le x \le e \\ 0, & x > e \end{Bmatrix} \tag{2}$$

$$\mu_a(x) = \begin{Bmatrix} 0, & 0 < x < a \\ (x-a)/(b-a), & a \le x \le b \\ 1, & b \le x \le d \\ (e-x)/(e-c), & d \le x \le e \\ 0, & x > e \end{Bmatrix} \tag{3}$$

$$\mu_d(x) = e^{-\frac{1}{2}(\frac{x-c}{e})^2} \tag{4}$$

$$\mu_b(x) = \frac{1}{1+(x-c)^2} \tag{5}$$

Most tools for fuzzy system design enable the user to define different random membership functions.

Arithmetic operations on fuzzy numbers are defined by application of the interval arithmetic rules and the extension principle.
α – intersections A_α and B_α can be defined for two fuzzy numbers A and B, where α may be interpreted as the degree of confidence that the number falls within the interval defined by the corresponding intersection. By rules of interval arithmetic, for sets, that is to say intervals $A_\alpha = \left[a_1^\alpha , a_2^\alpha \right]$ and $B_\alpha = \left[b_1^\alpha , b_2^\alpha \right]$ and arithmetic operator $\circ$ set $C_\alpha = \left[c_1^\alpha , c_2^\alpha \right]$ is defined representing the interval in which, with the same degree of confidence, the result of operation $\circ$ exists. For the basic arithmetic operation it is:

$$\left[a_1^\alpha , a_2^\alpha \right] + \left[b_1^\alpha , b_2^\alpha \right] = \left[a_1^\alpha + b_1^\alpha , a_2^\alpha + b_2^\alpha \right] \tag{6}$$

$$\left[a_1^\alpha , a_2^\alpha \right] - \left[b_1^\alpha , b_2^\alpha \right] = \left[a_1^\alpha - b_2^\alpha , a_2^\alpha - b_1^\alpha \right] \tag{7}$$

$$\left[a_1^\alpha , a_2^\alpha \right] \times \left[b_1^\alpha , b_2^\alpha \right] = \left[a_1^\alpha \times b_1^\alpha , a_2^\alpha \times b_2^\alpha \right] \tag{8}$$

$$\left[a_1^\alpha , a_2^\alpha \right] : \left[b_1^\alpha , b_2^\alpha \right] = \left[a_1^\alpha : b_2^\alpha , a_2^\alpha : b_1^\alpha \right] \tag{10}$$

Based on these rules and the extension principle for two fuzzy numbers *A* and *B* and arithmetic operator $\circ$ so that $A \circ B = C$, fuzzy set *C* is defined as

$$C = \left\{ \left(z, \mu_C (z) \right) \middle| z = x \circ y, \mu_C (z) = \max_{x \circ y = z} \min \left[\mu_A (x), \mu_B (y) \right], \quad \forall x \in A, \forall y \in B \right\}$$

Using this general rule, arithmetic operations with triangular fuzzy numbers $A = (a_1, a_2, a_3)$ and $B = (b_1, b_2, b_3)$ takes the following forms.

Addition
The result of adding *A*+*B* is triangular fuzzy number $C = (c_1, c_2, c_3)$

$$C = (a_1 + b_1, a_2 + b_2, a_3 + b_3) \tag{11}$$

For example, adding fuzzy numbers $A = \tilde{4} = (3, 4, 5)$ and $B = 2.5 = (2, 2.5, 3)$ gives fuzzy number $C = (5, 6.5, 8)$ as the result. It should be noted that the indefiniteness of results of arithmetic operations on two indefinite numbers is bigger than the indefiniteness of individual numbers (Pamučar *et al.*, 2011).

Subtraction
The result of subtraction $A - B$ is triangular fuzzy number $C = (c_1, c_2, c_3)$

$$C = (a_1 - b_3, a_2 - b_2, a_3 - b_1) \tag{12}$$

It should be noted that in fuzzy arithmetic $A-B=C$ does not come out of $A=B+C$.

Multiplication by constant
The Result of multiplication of fuzzy number $A=(a_1, a_2, a_3)$ by constant *k* is a triangular number (ka_1, ka_2, ka_3) (Teodorovic & Kikuchi, 1994).

Multiplication
Multiplication of two triangular fuzzy numbers $A \cdot B$ results in curved triangular fuzzy number $C=(c_1, c_2, c_3)$

$$C=(a_1 \cdot b_1, a_2 \cdot b_2, a_3 \cdot b_3) \tag{13}$$

The set of fuzzy triangular numbers is not closed with respect to the operation of multiplication, but in practical application a curved triangular number is mostly approximated by an ordinary triangular number.

Division
Assuming that 0 (zero) in not a member to fuzzy set B, the division of two triangular numbers $A:B$ results in curved triangular fuzzy number $C=(c_1, c_2, c_3)$.

The set of triangular fuzzy numbers is not closed with respect to the operation of division, but in practical applications the result is also approximated by a triangular number. If 0 (zero) belongs to the basis of fuzzy set B, then the basis of fuzzy set C is not limited.

3. POWER AGGREGATION OPERATOR AND HERONIAN AGGREGATION OPERATOR

The Power aggregation (PA) operator proposed by Yager (2001) is a very significant aggregation operator that eliminates the impact of unreasonable arguments by considering the degree of support between input arguments. The traditional PA operator is defined in the following section.

Definition 1 (Yager, 2001): Let $(\xi_1, \xi_2, ..., \xi_n)$ be a set of non-negative numbers and $p,q \geq 0$. If

$$PA(\xi_1, \xi_2, ..., \xi_n) = \frac{\sum_{i=1}^{n} (1+T(\xi_i))\xi_i}{\sum_{i=1}^{n} (1+T(\xi_i))} \tag{14}$$

where $T(\xi_i) = \sum_{j=1, j\neq i}^{n} Sup(\xi_i, \xi_j)$. We shall denote $Sup(\xi_i, \xi_j)$ ass the support degree for ξ_i from ξ_j, where $Sup(\xi_i, \xi_j)$ satisfies the following axioms:

1) $Sup(\xi_i, \xi_j) = Sup(\xi_j, \xi_i)$;

2) $Sup(\xi_i, \xi_j) = [0,1]$;

3) $Sup(\xi_i, \xi_j) > Sup(\xi_i, \xi_k)$, *if* $|\xi_i - \xi_j| < |\xi_i - \xi_k|$.

Beliakov (2007) was the first to propose a Heronian mean (HM) operator, which allows the input arguments to be displayed and processed for interconnectivity (Liu & Pei, 2012). The HM operator is defined in the following section.

Definition 2 (Yu, 2013): Let $p,q \geq 0$, $(\xi_1, \xi_2, ..., \xi_n)$ be a set of non-negative numbers. If

$$HM^{p,q}(\xi_1, \xi_2, ..., \xi_n) = \left(\frac{2}{n(n+1)} \sum_{i=1}^{n} \sum_{j=i}^{n} \xi_i^p \xi_j^q \right)^{\frac{1}{p+q}} \tag{15}$$

then $HM^{p,q}$ is called the Heronian mean (HM) operator.

Definition 3 (Xu, 2010): Let $p,q \geq 0$, $(\xi_1, \xi_2, ..., \xi_n)$ be a set of non-negative numbers. If

$$GHM^{p,q}(\xi_1, \xi_2, ..., \xi_n) = \frac{1}{p+q} \left(\prod_{i=1, j=i}^{n} (p\xi_i + q\xi_j)^{\frac{2}{n(n+1)}} \right) \tag{16}$$

then $GHM^{p,q}$ is called the geometric Heronian mean (GHM) operator.

Definition 4 (Zhao, 2019): Let $p,q \geq 0$, $(\xi_1, \xi_2, ..., \xi_n)$ be a set of non-negative numbers. If

$$WGHM^{p,q}(\xi_1, \xi_2, ..., \xi_n) = \frac{1}{p+q} \left(\prod_{i=1, j=i}^{n} (p\xi_i^{nw_i} + q\xi_i^{nw_j})^{\frac{2}{n(n+1)}} \right) \tag{17}$$

then $WGHM^{p,q}$ is called the weight geometric Heronian mean (WGHM) operator.

Based on the definitions of the traditional PA and HM operators, Eqns. (14) - (17), a new fuzzy hybrid weight geometric power Heronian aggregation (WGPHA) operator is developed in the next section.

Definition 5: Set $\xi_i = \left(\xi_i^{(l)}, \xi_i^{(m)}, \xi_i^{(u)}\right)$ (i = 1,2,..,n) as a collection of triangular fuzzy numbers (TrFNs) in Ψ, then TrWGPHA can be defined as follows:

$$TrWGPHA^{p,q}(\xi_1, \xi_2, ..., \xi_n) = \frac{1}{p+q}\left(\prod_{i=1, j=i}^{n}\left(p\xi_i^{\frac{nw_iw_i}{\sum_{t=1}^{n} w_t w_t}} + q\xi_i^{\frac{nw_iw_j}{\sum_{t=1}^{n} w_t w_t}}\right)^{\frac{2}{n(n+1)}}\right) \quad (18)$$

where $w_t \dfrac{\left(1+T(\xi_i)\right)}{\sum_{i=1}^{n}\left(1+T(\xi_i)\right)}$, $T\left(\xi_i\right) = \sum_{j=1, j\neq i}^{n} Sup(\xi_i, \xi_j)$ and $\sum_{i=1}^{n} w_i = 1$. We shall denote that $Sup(\xi_i, \xi_j)$ as support degree for ξ_i from ξ_j, gde $Sup(\xi_i, \xi_j)$ satisfies the following properties:

1) $Sup(\xi_i, \xi_j) = Sup(\xi_j, \xi_i)$;

2) $Sup(\xi_i, \xi_j) = [0,1]$;

3) $Sup(\xi_i, \xi_j) > Sup(\xi_i, \xi_k)$, *if* $d(\xi_i, \xi_j) < d(\xi_i, \xi_k)$, where $d(\xi_i, \xi_j)$ is the distance between TrFN ξ_i and ξ_j.

Then $TrWGPHA^{p,q}$ represents the fuzzy weighted power Heronian aggregation operator. TrWGPHA combines the benefits of PA and HM operators and is a powerful tool with the following features: 1) eliminates the impact of unreasonable arguments; 2) takes into account the degree of support between input arguments and 3) takes into account the interconnectedness of input arguments.

Theorem 1: Set $\xi_i = \left(\xi_i^{(l)}, \xi_i^{(m)}, \xi_i^{(u)}\right)$ (i = 1,2,..,n) as a collection of TrFNs in Ψ, then according to Eqn. (18), the aggregation results are obtained for TrFNs, and the following aggregation formula can be developed:

$$TrWGPHA^{p,q}(\xi_1,\xi_2,...,\xi_n)=\frac{1}{p+q}\left(\prod_{i=1,j=i}^{n}\left(p\xi_i^{\frac{nw_iw_i}{\sum_{t=1}^{n}w_tw_t}}+q\xi_j^{\frac{nw_iw_j}{\sum_{t=1}^{n}w_tw_t}}\right)^{\frac{2}{n(n+1)}}\right)$$

$$=\left(\begin{array}{l}\frac{1}{p+q}\left(\prod_{i=1,j=i}^{n}\left(p\xi_i^{\frac{nw_i^{(l)}w_i^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}}+q\xi_j^{\frac{nw_j^{(l)}w_j^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}}\right)^{\frac{2}{n(n+1)}}\right),\\ \frac{1}{p+q}\left(\prod_{i=1,j=i}^{n}\left(p\xi_i^{\frac{nw_i^{(m)}w_i^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}}+q\xi_j^{\frac{nw_j^{(m)}w_j^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}}\right)^{\frac{2}{n(n+1)}}\right),\\ \frac{1}{p+q}\left(\prod_{i=1,j=i}^{n}\left(p\xi_i^{\frac{nw_i^{(u)}w_i^{(u)}}{\sum_{t=1}^{n}w_t^{(u)}w_t^{(u)}}}+q\xi_j^{\frac{nw_j^{(u)}w_j^{(u)}}{\sum_{t=1}^{n}w_t^{(u)}w_t^{(u)}}}\right)^{\frac{2}{n(n+1)}}\right)\end{array}\right)$$

Proof:

By the operational rules of TrFNs defined in (Zadeh, 1965), we have

a) $$p\xi_i^{\frac{nw_iw_i}{\sum_{t=1}^{n}w_tw_t}}=\left(p\xi_i^{\frac{nw_i^{(l)}w_i^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}},p\xi_i^{\frac{nw_i^{(m)}w_i^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}},p\xi_i^{\frac{nw_i^{(u)}w_i^{(u)}}{\sum_{t=1}^{n}w_t^{(u)}w_t^{(u)}}}\right);$$

b) $$q\xi_i^{\frac{nw_iw_j}{\sum_{t=1}^{n}w_tw_t}}=\left(q\xi_j^{\frac{nw_j^{(l)}w_j^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}},q\xi_j^{\frac{nw_j^{(m)}w_j^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}},\xi_j^{\frac{nw_j^{(u)}w_j^{(u)}}{\sum_{t=1}^{n}w_t^{(u)}w_t^{(u)}}}\right);$$

c) $$\left(p\xi_i^{\frac{nw_iw_i}{\sum_{t=1}^{n}w_tw_t}}+q\xi_j^{\frac{nw_iw_j}{\sum_{t=1}^{n}w_tw_t}}\right)=\left(\begin{array}{c}\left(p\xi_i^{\frac{nw_i^{(l)}w_i^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}}+q\xi_j^{\frac{nw_j^{(l)}w_j^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}}\right),\\ \left(p\xi_i^{\frac{nw_i^{(m)}w_i^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}}+q\xi_j^{\frac{nw_j^{(m)}w_j^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}}\right),\\ \left(p\xi_i^{\frac{nw_i^{(u)}w_i^{(u)}}{\sum_{t=1}^{n}\overline{w_t^{(u)}}w_t^{(u)}}}+q\xi_j^{\frac{n\overline{w_j^{(u)}}w_j^{(u)}}{\sum_{t=1}^{n}\overline{w_t^{(u)}}w_t^{(u)}}}\right)\end{array}\right);$$

d) $$\prod_{i=1,\,j=i}^{n}\left(p\xi_i^{\frac{nw_i^{(u)}w_i^{(u)}}{\sum_{t=1}^{n}w_t^{(u)}w_t^{(u)}}}+q\xi_j^{\frac{nw_j^{(u)}w_j^{(u)}}{\sum_{t=1}^{n}w_t^{(u)}w_t^{(u)}}}\right)^{\frac{2}{n(n+1)}}$$

$$=\left(\begin{array}{c}\frac{1}{p+q}\left(\prod_{i=1,\,j=i}^{n}\left(p\xi_i^{\frac{nw_i^{(l)}w_i^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}}+q\xi_j^{\frac{nw_j^{(l)}w_j^{(l)}}{\sum_{t=1}^{n}w_t^{(l)}w_t^{(l)}}}\right)^{\frac{2}{n(n+1)}}\right),\\ \frac{1}{p+q}\left(\prod_{i=1,\,j=i}^{n}\left(p\xi_i^{\frac{nw_i^{(m)}w_i^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}}+q\xi_j^{\frac{nw_j^{(m)}w_j^{(m)}}{\sum_{t=1}^{n}w_t^{(m)}w_t^{(m)}}}\right)^{\frac{2}{n(n+1)}}\right),\\ \frac{1}{p+q}\left(\prod_{i=1,\,j=i}^{n}\left(p\xi_i^{\frac{n\overline{w_i^{(u)}}w_i^{(u)}}{\sum_{t=1}^{n}\overline{w_t^{(u)}}w_t^{(u)}}}+q\xi_j^{\frac{n\overline{w_j^{(u)}}w_j^{(u)}}{\sum_{t=1}^{n}\overline{w_t^{(u)}}w_t^{(u)}}}\right)^{\frac{2}{n(n+1)}}\right)\end{array}\right),$$

So, *Theorem* 1 is true.

Theorem 2 (Idempotency): Set $\xi_i = \left(\xi_i^{(l)}, \xi_i^{(m)}, \xi_i^{(u)}\right)$ (i = 1,2,..,n) as a collection of TrFNs in Ψ, if $\xi_i = \xi$, then $TrWGPHA^{p,q}(\xi_1, \xi_2, .., \xi_n) = TrWGPHA^{p,q}(\xi, \xi, .., \xi)$.

Proof: Since $\xi_i = \xi$, i.e. $\xi_i^{(l)} = \xi$, $\xi_i^{(m)} = \xi$ and $\xi_i^{(u)} = \xi$, then

$$TrWGPHA^{p,q}(\xi_1, \xi_2, .., \xi_n) = TrWGPHA^{p,q}(\xi, \xi, .., \xi)$$

$$= \begin{pmatrix} \frac{1}{p+q}\left(\prod_{i=1, j=i}^{n}\left(p\xi_i^{\frac{nw_iw_i}{\sum_{t=1}^{n}w_tw_t}} + q\xi_j^{\frac{nw_jw_j}{\sum_{t=1}^{n}w_tw_t}}\right)^{\frac{2}{n(n+1)}}\right), \\ \frac{1}{p+q}\left(\prod_{i=1, j=i}^{n}\left(p\xi_i^{\frac{nw_iw_i}{\sum_{t=1}^{n}w_tw_t}} + q\xi_j^{\frac{nw_jw_j}{\sum_{t=1}^{n}w_tw_t}}\right)^{\frac{2}{n(n+1)}}\right), \\ \frac{1}{p+q}\left(\prod_{i=1, j=i}^{n}\left(p\xi_i^{\frac{n\overline{w_iw_i}}{\sum_{t=1}^{n}\overline{w_tw_t}}} + q\xi_j^{\frac{n\overline{w_jw_j}}{\sum_{t=1}^{n}\overline{w_tw_t}}}\right)^{\frac{2}{n(n+1)}}\right) \end{pmatrix} = \left(\xi, \xi, \xi\right) = \xi$$

The proof of *Theorem* 2 is completed.

Theorem 3 (Boundedness): Set $\xi_i = \left(\xi_i^{(l)}, \xi_i^{(m)}, \xi_i^{(u)}\right)$ as a collection of TrFNs in Ψ, let $\xi^- = \left(\min\left(\xi_i^{(l)}\right), \min\left(\xi_i^{(m)}\right), \min\left(\xi_i^{(u)}\right)\right)$ and $\xi^+ = \left(\max\left(\xi_i^{(l)}\right), \max\left(\xi_i^{(m)}\right), \max\left(\xi_i^{(u)}\right)\right)$ then

$\xi^- \le TrWGPHA^{p,q}(\xi_1, \xi_2, ..., \xi_n) \le \xi^+$.

Proof: Let $\xi^- = \min(\xi_1, \xi_2, ..., \xi_n) = \left(\min\left(\xi_i^{(l)}\right), \min\left(\xi_i^{(m)}\right), \min\left(\xi_i^{(u)}\right)\right)$ and

$\xi^+ = \max(\xi_1, \xi_2, ..., \xi_n) = \left(\max\left(\xi_i^{(l)}\right), \max\left(\xi_i^{(m)}\right), \max\left(\xi_i^{(u)}\right)\right)$.

Then, it can be stated that $\xi^{(l)-} = \min_i(\xi_i^{(l)})$, $\xi^{(m)-} = \min_i(\xi_i^{(m)})$, $\xi^{(u)-} = \min_i(\xi_i^{(u)})$, $\xi^{(l)+} = \max_i(\xi_i^{(l)})$, $\xi^{(m)+} = \max_i(\xi_i^{(m)})$ and $\xi^{(u)+} = \max_i(\xi_i^{(u)})$. Based on that, the following inequalities can be formulated:

$\xi^- \le \xi_i \le \xi^+$;

$\min_i(\xi_i^{(l)}) \le \xi_i^{(l)} \le \max_i(\xi_i^{(l)})$;

$\min_i(\xi_i^{(m)}) \le \xi_i^{(m)} \le \max_i(\xi_i^{(m)})$;

$\min_i(\xi_i^{(u)}) \le \xi_i^{(u)} \le \max_i(\xi_i^{(u)})$.

According to the inequalities shown above, it can be concluded that $\xi^- \le TrWGPHA^{p,q}(\xi_1, \xi_2, .., \xi_n) \le \xi^+$ holds.

Theorem 4 (Commutativity): Let the fuzzy set $(\xi_1', \xi_2', ..., \xi_n')$ be any permutation of $(\xi_1, \xi_2, .., \xi_n)$.

Then $TrWGPHA^{p,q}(\xi_1, \xi_2, .., \xi_n) = TrWGPHA^{p,q}(\xi_1', \xi_2', .., \xi_n')$.

Proof: This property is obvious.

Example 1. Let $\xi_1 = (2,3,4)$, $\xi_2 = (3,4,5)$ and $\xi_3 = (2,3,4)$ be three TrNs, $w_1 = 0.45$, $w_2 = 0.35$, $w_3 = 0.20$ and let p=q=1, then applying TrWGPHA we obtain an aggregated TrN $\bar{\xi} = \left(\bar{\xi}^{(l)}, \bar{\xi}^{(m)}, \bar{\xi}^{(u)}\right)$) using the following calculations:

Step 1: For the lower, medium and upper limit of a TrN, the normalized functions are calculated:

$$f\left(\xi_1^{(l)}\right) = \frac{2}{2+3+2} = 0.286;\ f\left(\xi_2^{(l)}\right) = \frac{3}{2+3+2} = 0.429;\ f\left(\xi_3^{(l)}\right) = \frac{2}{2+3+2} = 0.286;$$

$$f\left(\xi_1^{(m)}\right) = \frac{3}{3+4+3} = 0.300;\ f\left(\xi_2^{(m)}\right) = \frac{4}{3+4+3} = 0.400;\ f\left(\xi_3^{(m)}\right) = \frac{3}{3+4+3} = 0.300;$$

$$f\left(\xi_1^{(u)}\right) = \frac{4}{4+5+4} = 0.308;\ f\left(\xi_2^{(u)}\right) = \frac{5}{4+5+4} = 0.385;\ f\left(\xi_3^{(u)}\right) = \frac{4}{4+5+4} = 0.308$$

Step 2: Calculating the degree of support of the limits of TrNs:

$Sup(\xi_1^{(l)}, \xi_2^{(l)}) = 0.143$, $Sup(\xi_1^{(l)}, \xi_3^{(l)}) = 0.0$, $Sup(\xi_2^{(l)}, \xi_3^{(l)}) = 0.143$,

$Sup(\xi_1^{(m)}, \xi_2^{(m)}) = 0.10$, $Sup(\xi_1^{(m)}, \xi_3^{(m)}) = 0.0$, $Sup(\xi_2^{(m)}, \xi_3^{(m)}) = 0.10$,

$Sup(\xi_1^{(u)}, \xi_2^{(u)}) = 0.077$, $Sup(\xi_1^{(u)}, \xi_3^{(u)}) = 0.0$ and $Sup(\xi_2^{(u)}, \xi_3^{(u)}) = 0.077$.

Step 3: By applying Equation (5), TrWGPHA^{1,1} is calculated

$$TrWGPHA^{1,1}\left((2,3,4);(3,4,5);(2,3,4)\right)=$$

$$=\left(\begin{array}{l}
\frac{1}{1+1}\left(\left(1\cdot 2^{\frac{3\cdot 0.45}{0.45(1+0.143)+...+0.2(1+0.143)}}+1\cdot 2^{\frac{3\cdot 0.45}{0.45(1+0.143)+...+0.2(1+0.143)}}\right)\cdot...\cdot\left(1\cdot 2^{\frac{3\cdot 0.2}{0.45(1+0.143)+...+0.2(1+0.143)}}+1\cdot 2^{\frac{3\cdot 0.2}{0.45(1+0.143)+...+0.2(1+0.143)}}\right)\right)^{\frac{2}{3(3+1)}},\\
\frac{1}{1+1}\left(\left(1\cdot 3^{\frac{3\cdot 0.45}{0.45(1+0.143)+...+0.2(1+0.143)}}+1\cdot 3^{\frac{3\cdot 0.45}{0.45(1+0.143)+...+0.2(1+0.143)}}\right)\cdot...\cdot\left(1\cdot 3^{\frac{3\cdot 0.2}{0.45(1+0.143)+...+0.2(1+0.143)}}+1\cdot 3^{\frac{3\cdot 0.2}{0.45(1+0.143)+...+0.2(1+0.143)}}\right)\right)^{\frac{2}{3(3+1)}},\\
\frac{1}{1+1}\left(\left(1\cdot 4^{\frac{3\cdot 0.45}{0.45(1+0.143)+...+0.2(1+0.143)}}+1\cdot 4^{\frac{3\cdot 0.45}{0.45(1+0.143)+...+0.2(1+0.143)}}\right)\cdot...\cdot\left(1\cdot 4^{\frac{3\cdot 0.2}{0.45(1+0.143)+...+0.2(1+0.143)}}+1\cdot 4^{\frac{3\cdot 0.2}{0.45(1+0.143)+...+0.2(1+0.143)}}\right)\right)^{\frac{2}{3(3+1)}}
\end{array}\right)$$

$$=\left(2.38,3.44,4.51\right)$$

4. NUMERICAL EXAMPLE: THE SELECTION OF WAGONS FOR THE INTERNAL TRANSPORT OF A LOGISTICS COMPANY

In this section we showed application of TrWGPHA for solving real world problems. The case study used in this paper is adopted from the paper Stevic *et al* (2017). The problem is formulated as a multi-criteria decision model with eight criteria (Table 1) and eight alternatives.

Table 1. *The criteria defined for the selection of the wagon*

	Criteria	Characteristics and meaning of the criteria
C_1	Price of the wagon	The price of the second-hand wagon is the value expressed in monetary units
C_2	Maintenance conditions	The maintenance conditions include the ease of maintaining the wagon, the possibility of personal maintenance, and the cost of maintaining the wagon, etc.
C_3	Exploitation time	Since the wagons are second-hand, their age and the time they spent in use can play a role in their selection.
C_4	Load capacity	Load capacity (bearing capacity) is a value expressed in tonnes i.e., the total mass that it is possible to place inside the wagon.
C_5	Manipulative convenience	Manipulative convenience covers the ease of maneuverability by means of loading vehicles, in this case forklifts, and the possibility or impossibility of a forklift completely entering a wagon.
C_6	Time of last revision	This is the time passed since the last regular inspection of the wagon.
C_7	State of the bandages and flanges of the wheels	This is the quality and amount of wear and tear on the bandages and flanges of the wheels.
C_8	Ecological factor	The ecological factor includes the influence of the wagon on the environment, for example, noise produced by a wagon that can affect the psycho-physical condition of employees.

Rough initial decision making matrix used in original study (Stevic *et al.*, 2017) is transformed to fuzzy initial decision making matrix. The mean values of fuzzy numbers were obtained as the arithmetic mean of the left and right boundaries of the rough numbers used in the original study. Fuzzy initial decision making matrix is showed in the Table 2.

Table 2. *Fuzzy initial decision making*

Alt.	C1	C2	C3	…	C7	C8
A1	(1.22,1.67, 2.11)	(2.39,2.67, 2.95)	(4.74,6, 7.26)		(4.53,5.33, 6.12)	(5.89,6.34, 6.78)
A2	(4.74,6, 7.26)	(4.78,5.65, 6.51)	(4.4,5, 5.6)		(4.78,5.65, 6.51)	(4.78,5.65, 6.51)
A3	(8.39,8.67, 8.95)	(7.17,7.97, 8.77)	(4.06,5.26, 6.46)		(2.53,3.33, 4.12)	(1.49,2.36, 3.22)
A4	(1.89,2.34, 2.78)	(5.88,6.68, 7.47)	(4.78,5.65, 6.51)		(5.12,6.3, 7.47)	(7.89,8.34, 8.78)
A5	(1.6,3.14, 4.67)	(2.74,4, 5.26)	(6,7, 8)	…	(6.53,7.33, 8.12)	(4.37,5.9, 7.42)
A6	(6.39,6.67, 6.95)	(5.5,6, 6.5)	(3.88,4.68, 5.47)		(2.53,3.71, 4.88)	(1.99,3.39, 4.78)
A7	(3.5,4, 4.5)	(3.78,4.34, 4.89)	(4.78,5.65, 6.51)		(3.22,3.67, 4.11)	(3.64,4.68, 5.72)
A8	(2.32,4.38, 6.44)	(3.2,5, 6.8)	(3.99,5.39, 6.78)		(5.64,6.68, 7.72)	(5.49,6.36, 7.22)

In a similar way we obtain fuzzy weights of the criteria, Table 3.

Table 3. *Fuzzy weights of the criteria*

Criteria	Trinagular fuzzy numebrs
w_1	(0.171, 0.174, 0.178)
w_2	(0.186, 0.188, 0.19)
w_3	(0.094, 0.096, 0.099)
w_4	(0.236, 0.237, 0.239)
w_5	(0.119, 0.12, 0.12)
w_6	(0.063, 0.072, 0.081)
w_7	(0.053, 0.054, 0.055)
w_8	(0.043, 0.045, 0.047)

In the following steps, using criteria weights (Table 3) and Equation (18) the final defuzzified values of the criteria functions of the alternatives were obtained and ranked: *Q(A1)*=0.119, *Q(A2)*=0.130, *Q(A3)*=0.119, *Q(A4)*=0.098, *Q(A5)*=0.0.140, *Q(A6)*=0.106, *Q(A7)*=0.135 and *Q(A8)*=0.153; A8>A5>A7>A2>A3>A1>A6>4.

CONCLUSION

In this paper, we investigate the multi-criteria decision making problems with TrNs. The paper presents a new model (TrWGPHA model) for decision making, which is verified on the selection of wagons for carrying out the internal transport of a paper manufacturing company. One of the contributions of this

paper is the new TrWGPHA model that enables the objective aggregation of values of the initial decision matrix with full consideration of the imprecision and subjectivity that prevail during decision making. Another significant contribution of this paper is the development of the new fuzzy PA and HA models which contribute to the advancement of the literature that considers the theoretical and practical application of multi-criteria techniques. The proposed models allow the evaluation of alternatives despite the imprecision and lack of quantitative information in the decision-making process.

By applying fuzzy numbers in combination with TrWGPHA, imprecision in group decision making is taken into account and more objective results are obtained than with crisp approaches. Further research directions relate to the application of rough numbers in combination with TrWGPHA and other multi-criteria methods and the attempt to develop new methods that would further enrich this widely applied field.

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A NOVEL INTEGRATED MULTI-CRITERIA DECISION-MAKING MODEL: FUCOM-EDAS-M

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Abstract: Multi-criteria decision-making (MCDM) methods are an extraordinary tool in supporting decision-making in everyday situations. They are used for various purposes, and in this paper, a new integrated MCDM model was formed, combining FUCOM (Full Consistency Method) and EDAS-M (Evaluation method based on the Distance from the Average Solution in the Minkowski space). The aim is to combine the benefits of these two methods, and, above all, reduce subjectivity and solve complicated models with more potential solutions. The model was tested on an example of evaluation and selection of an electric vehicle. The FUCOM method was applied to determine the weighting values of five criteria on the basis of which further evaluation of alternatives was performed. The EDAS-M method was applied in order to rank 12 different potential solutions.

Keywords: FUCOM, EDAS-M, multi-criteria decision-making, electric vehicle
JEL: C44, C52

1. INTRODUCTION

Applying optimization techniques to day-to-day decision-making has become a request on the one hand, and a challenge on the other. Different parameters and factors that may influence decision-making need to be considered and, according to Stojić *et al*. (2018), pre-defined fulfilling certain prerequisites. In addition, a methodology that offers approximately optimal solutions should be applied adequately. This can be concluded from the fact that the implementation of decisions is dependent on several persons and that each problem considered individually has its own specific characteristics, which was observed in the paper (Ruzgys *et al*., 2014). Thus, considering this, it is required to develop new methodologies. Integration of multi-criteria methods is desirable because of the nature of the problems being treated, but also the limitations of particular methods that can identify only the significance of the criteria or the ranking of

alternatives. Therefore, in this paper, the integration of FUCOM and EDAS in Minkowaki space method has been performed. The aim of this paper is to create a novel integrated model that will be available for further application in various fields. In addition to integrating conventional approaches, some of the theories of uncertainty are often combined with MCDM methods for more accurate decision-making (Stanujkić *et al*., 2016; Stević *et al*., 2018; Stanujkić & Karabašević, 2018; Pamučar *et al*., 2018a; Ji *et al*., 2018).

As noted, this paper determines the ranking of alternatives that represent electric vehicles. In addition to considering this type of model, solving similar problems can also be taken into account, e.g. evaluation of internal combustion engines or individual exploitation characteristics that may affect traffic performance (Nunić *et al*., 2019).

In addition to the introduction, the paper is presented throughout several other sections. In the second section, the algorithm of the FUCOM method is briefly shown and its advantages over other existing methods in determining the weighting values of criteria are explained. In addition, the algorithm of EDAS-M method is provided in detail. Section 3 presents the results. The proposed FUCOM-EDAS-M model has been tested on a multi-criteria example consisting of five criteria and 12 alternatives. At the end of the paper, concluding considerations are given with a brief discussion.

2. METHODS

2.1. Full Consistency Method - FUCOM

One of the new methods that is based on the principles of pairwise comparison and validation of results through deviation from maximum consistency is the Full consistency method (FUCOM) (Pamucar *et al*., 2018b). Benefits that are determinative for the application of FUCOM are a small number of pairwise comparisons of criteria (only *n-1* comparison), the ability to validate the results by defining the deviation from maximum consistency (DMC) of comparison and appreciating transitivity in pairwise comparisons of criteria. The FUCOM model also has a subjective influence of a decision-maker on the final values of the weights of criteria. This particularly refers to the first and second steps of FUCOM in which decision-makers rank the criteria according to their personal preferences and perform pairwise comparisons of ranked criteria. However, unlike other subjective models, FUCOM has shown minor deviations in the obtained values of the weights of criteria from optimal values (Pamučar *et al*., 2018b; Nunić, 2018; Zavadskas *et al*. 2018; Noureddine & Ristić, 2018 Božanić *et al*., 2019). Additionally, the methodological procedure of FUCOM eliminates the problem of redundancy of pairwise comparisons of criteria, which exists in some subjective models for determining the weights of criteria.

Assume that there are *n* evaluation criteria in a multi-criteria model that are designated as *wj*, *j* = 1,2, ..., *n*, and that their weight coefficients need to be determined. Subjective models for determining weights based on pairwise comparison of criteria require a decision-maker to determine the degree of impact of the criterion *i* on the criterion *j*. In accordance with the defined settings, Figure 1 presents the FUCOM algorithm (Pamučar *et al*., 2018b).

Figure 1. *Steps of FUCOM methodology*

Algorithm: FUCOM

Input: Expert pairwise comparison of criteria

Output: Optimal values of the weight coefficients of criteria/sub-criteria

Step 1: Expert ranking of criteria/sub-criteria.

Step 2: Determining the vectors of the comparative significance of evaluation criteria.

Step 3: Defining the restrictions of a non-linear optimization model.

Restriction 1: The ratio of the weight coefficients of criteria is equal to the comparative significance among the observed criteria, i.e. $w_k / w_{k+1} = \varphi_{k/(k+1)}$.

Restriction 2: The values of weight coefficients should satisfy the condition of mathematical transitivity, i.e. $\varphi_{k/(k+1)} \otimes \varphi_{(k+1)/(k+2)} = \varphi_{k/(k+2)}$.

Step 4: Defining a model for determining the final values of the weight coefficients of evaluation criteria:

$$\min \chi$$

s.t.

$$\left| \frac{w_{j(k)}}{w_{j(k+1)}} - \varphi_{k/(k+1)} \right| \le \chi, \ \forall j$$

$$\left| \frac{w_{j(k)}}{w_{j(k+2)}} - \varphi_{k/(k+1)} \otimes \varphi_{(k+1)/(k+2)} \right| \le \chi, \ \forall j$$

$$\sum_{j=1}^{n} w_j = 1$$

$$w_j \ge 0, \ \forall j$$

Step 5: Calculating the final values of evaluation criteria/sub-criteria $\left(w_1, w_2, ..., w_n\right)^T$.

2.2. EDAS in Minkowski space EDAS-M method

EDAS method in Minkowski space, called the EDAS-M method is developed in (Zavadskas *et al*., 2019). EDAS-M approach consists of the following steps:

Step 1: Development of MCDM model. Make the selection of appropriate criteria *m* that in the best way describe alternatives *n*.

Step 2: Forming the initial decision-making matrix *X*, as follows:

$$X = \left[x_{ij} \right]_{n \times m} = \begin{bmatrix} x_{11} & x_{12} & \ldots & x_{1m} \\ x_{21} & x_{22} & \ldots & x_{2m} \\ \ldots & \ldots & \ldots & \ldots \\ x_{n1} & x_{n2} & \ldots & x_{nm} \end{bmatrix}. \quad (1)$$

where x_{ij} denotes the performance value of i^{th} alternative on j^{th} criterion.

Step 3: Computation of the average solution according to all criteria using equation (2):

$$AV = \left[AV_j \right]_{1 \times m}. \quad (2)$$

where AV_j is obtained using equation (3):

$$AV_j = \frac{\sum_{i=1}^{n} x_{ij}}{n}. \quad (3)$$

Step 4: Calculate the positive distance from average PDA and the negative distance from average NDA matrix according to the type of criteria (benefit and cost):

$$PDA = \left[PDA_{ij} \right]_{n \times m}. \quad (4)$$

$$NDA = \left[NDA_{ij} \right]_{n \times m}. \quad (5)$$

if j^{th} criterion belongs to benefit group:

$$PDA_{ij} = \frac{\left(x_{ij} - AV_j \right)}{AV_j}. \quad (6)$$

$$NDA_{ij} = \frac{\left(AV_j - x_{ij} \right)}{AV_j}. \quad (7)$$

and if j^{th} criterion pertains to cost group:

$$PDA_{ij} = \frac{\left(AV_j - x_{ij} \right)}{AV_j}. \quad (8)$$

$$NDA_{ij} = \frac{\left(x_{ij} - AV_j \right)}{AV_j}. \quad (9)$$

where PDA_{ij} and NDA_{ij} denote the positive and negative distance of i^{th} alternative from the average solution in terms of j^{th} criterion, respectively. These equations are different when compared to the conventional EDAS method because PDA_{ij} and NDA_{ij} could be negative.

Step 5: Determination of the weighted sum of PDA and NDA in Minkowski space for all alternatives, as follows:

$$SP_i = d_i \left| \sum_{j=1}^{m} k_{ij} \left| w_j PDA_{ij} \right|^m \right|^{1/m} . \quad (10)$$

where

$$k_{ij} = 1 \, if \; PDA_{ij} \geq 0 \; and \; k_{ij} = -1 \, if \; PDA_{ij} < 0 \; .$$

$$d_j = 1 \quad if \quad \sum_{j=1}^{m} k_{ij} \left| w_j PDA_{ij} \right|^m \geq 0 \; and$$

$$d_j = -1 \quad if \quad \sum_{j=1}^{m} k_{ij} \left| w_j PDA_{ij} \right|^m < 0$$

$$SN_i = d_i \left| \sum_{j=1}^{m} k_{ij} \left| w_j NDA_{ij} \right|^m \right|^{1/m} . \quad (11)$$

$$k_{ij} = 1 \, if \; NDA_{ij} \geq 0 \; and \; k_{ij} = -1 \, if \; NDA_{ij} < 0 \; .$$

$$d_j = 1 \quad if \quad \sum_{j=1}^{m} k_{ij} \left| w_j NDA_{ij} \right|^m \geq 0 \; and$$

$$d_j = -1 \quad if \quad \sum_{j=1}^{m} k_{ij} \left| w_j NDA_{ij} \right|^m < 0$$

$\sum_{j=1}^{m} k_{ij} \left| w_j NDA_{ij} \right|^m$ *and* $\sum_{j=1}^{m} k_{ij} \left| w_j NDA_{ij} \right|^m$ could be negative, also. w_j is the weight of j^{th} criterion.

Step 6: Normalize the values of *SP* and *SN* for all alternatives, shown as follows:

$$NSP_i = \frac{SP_i}{\max SP_i} . \quad (12)$$

$$NSN_i = 1 - \frac{SN_i}{\max SN_i}. \quad (13)$$

Step 7: Calculate the appraisal score *AS* for all other options using equation (14):

$$AS_i = \frac{NSP_i + NSN_i}{2}. \quad (14)$$

In conventional EDAS method appraisal score AS can be 0≤1, while in this EDAS-M method can be lower than zero and higher than one.

Step 8: Rank the alternatives according to the decreasing values of appraisal score *AS*. The choice with the highest AS value is the best among the potential options.

3. NUMERICAL EXAMPLE

To evaluate a novel integrated FUCOM-EDAS-M model, a study on the evaluation and selection of electric vehicles presented in (Biswas *et al*., 2019) was selected. In the original study, the authors used an objective method to determine the importance of criteria (Criteria Importance Through Intercriteria Correlation – CRITIC), and to rank alternatives, they used the CoCoSo method developed by Yazdani *et al*. (2018).

The considered alternatives are the following:

- BMW i3,
- Chevy Bolt,
- Chevy Spark,
- Fiat 500e,
- Ford Focus Electric,
- Mitsubishi i-MiEV,
- Nissan leaf,
- Fisker Emotion,
- Tesla Model S,
- VW eGolf,
- Tesla Original Roadster and
- Tesla.

The criteria for evaluating the electric vehicles are:

- C_1 - combined fuel economy,
- C_2 - battery range,
- C_3 - top speed on flat road,
- C_4 - accelerating time and
- C_5 - vehicle price.

Out of five criteria, the first, the second and the third belongs to benefit type, while the fourth and fifth belongs to cost criteria. Basically, there are several conflicting criteria, which is confirmed by the following: Consumer decisions to purchase electric vehicles are influenced by several complex criteria, such as costs/benefits, performance, appeal/status, risk, psychographics, and demographics (Higgins *et al*., 2012).

The initial matrix showing the values of alternatives according to each individual criterion is shown in Table 1. It is important to note that the decision is made on the basis of quantitative criteria, i.e. the criteria that have clearly expressed numerical values.

The implementation of the MCDM approach in the field of evaluating the performance of electric vehicles, adequate locations for a charging station, design, public infrastructure for electric vehicles, etc. are just a few examples related to this field (Donateo *et al*., 2008; Guo & Zhao, 2015; Xu *et al*., 2017; Liu & Wei, 2018; Palevičius *et al.,* 2018).

Table 1. *Initial decision-making matrix*

	C_1	C_2	C_3	C_4	C_5
A_1	137	81	93	7.2	42400
A_2	119	238	91	7	37495
A_3	119	82	90	8	21375
A_4	122	87	88	9	31800
A_5	110	100	84	10	36630
A_6	112	126	81	15	22995
A_7	129	151	90	6.3	30680
A_8	100	400	125	6.3	129000
A_9	107	315	120	2.3	68000
A_{10}	126	125	102	9.2	28995
A_{11}	99	245	130	3.7	109000
A_{12}	93	256	120	3.8	88000

In solving this problem, it is first necessary to determine the importance and impact of the criteria on the selection of alternatives. Accordingly, the ranking from the most significant to the least significant was performed first, followed by a comparison of the criteria, as shown in Table 2.

Table 2. *Comparison of the criteria in the FUCOM method*

C_5	C_3	C_1	C_2	C_4
1	1.25	1.4	1.55	1.6

The procedure for determining the significance of the criteria is as follows:
First, the comparative priority of the criteria is determined:

$$\varphi_{C_5/C_3} = 1.25/1 = 1.25; \quad \varphi_{C_3/C_1} = 1.4/1.25 = 1.12;$$
$$\varphi_{C_1/C_2} = 1.55/1.4 = 1.11; \quad \varphi_{C_2/C_4} = 1.60/1.55 = 1.03$$

In the next step, the final values of the weight coefficients were calculated and they should meet the two conditions:
Condition (1):

$$w_5 / w_3 = 1.25; \quad w_3 / w_1 = 1.12; \quad w_1 / w_2 = 1.11; \quad w_2 / w_4 = 1.03,;$$

and Condition (2):

$$\varphi_{C_5/C_2} = 1.25 * 1.12 = 1.40; \quad \varphi_{C_3/C_2} = 1.12 * 1.11 = 1.24;$$
$$\varphi_{C_1/C_4} = 1.11 * 1.03 = 1.14$$

Thence it follows:

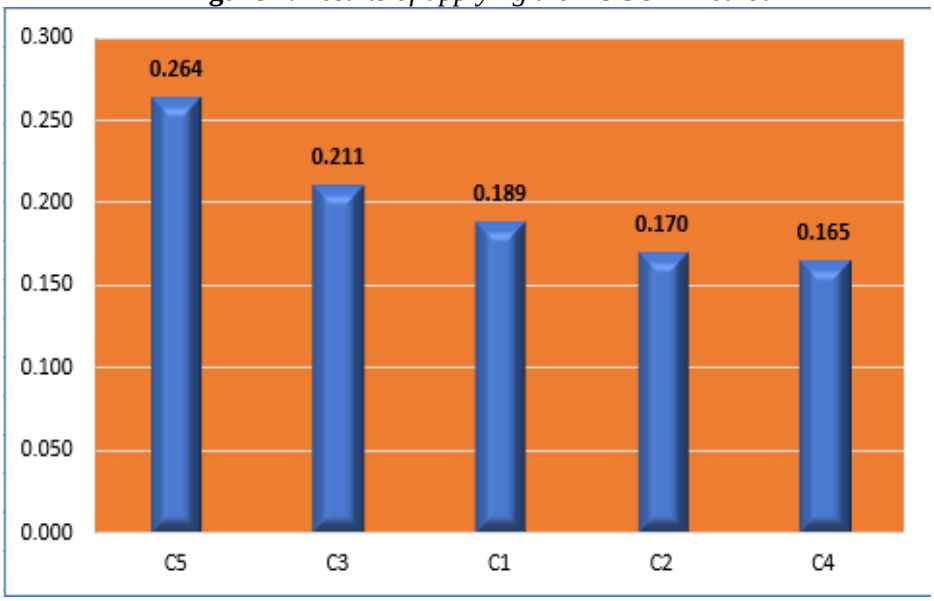
$$w_5 / w_2 = 1.40; \quad w_3 / w_2 = 1.24; \quad w_1 / w_4 = 1.14$$

The final model based on which the final values of the criteria are obtained is presented as follows:

$$\min \chi$$
$$s.t. \begin{cases} \left|\frac{w_5}{w_3} - 1.25\right| = \chi, \ \left|\frac{w_3}{w_1} - 1.12\right| = \chi, \left|\frac{w_1}{w_2} - 1.11\right| = \chi, \ \left|\frac{w_2}{w_4} - 1.03\right| \\ \left|\frac{w_5}{w_2} - 1.40\right| = \chi, \left|\frac{w_3}{w_2} - 1.24\right| = \chi, \left|\frac{w_1}{w_4} - 1.14\right| \chi \\ \sum_{j=1}^{5} w_j = 1, \ w_j \geq 0, \forall j \end{cases}$$

Subsequently, using the Lingo 17 software, the following model is obtained with the weights of the criteria shown in Figure 2.

Figure 2. *Results of applying the FUCOM method*



As can be seen in Figure 2, the most important criterion is vehicle price, which is understandable in a way. It should be emphasized that the significance of other criteria is not drastically lower than the best, i.e. the most significant criterion.

The first step of EDAS-M approach is the forming of MCDM model by choosing the essential criteria which describe potential solutions. In the second step, the initial decision matrix is developed (Table 1), while, in the third step, the average solution according to all criteria is:

$$AV = \begin{bmatrix} 114.4 \\ 183.8 \\ 101.2 \\ 7.3 \\ 53864.2 \end{bmatrix}$$

Step 4: *PDA* is obtained using equation (6) for benefit criteria and applying equation (9) for cost criteria, which is shown in Table 2.

Table 2. *Positive distance from average (PDA) matrix*

PDA	C_1	C_2	C_3	C_4	C_5
A_1	0.197	-0.559	-0.081	0.016	0.213
A_2	0.040	0.295	-0.100	0.043	0.304
A_3	0.040	-0.554	-0.110	-0.093	0.603
A_4	0.066	-0.527	-0.130	-0.230	0.410
A_5	-0.039	-0.456	-0.170	-0.367	0.320
A_6	-0.021	-0.315	-0.199	-1.050	0.573
A_7	0.127	-0.179	-0.110	0.139	0.430
A_8	-0.126	1.176	0.236	0.139	-1.395
A_9	-0.065	0.714	0.186	0.686	-0.262
A_{10}	0.101	-0.320	0.008	-0.257	0.462
A_{11}	-0.135	0.333	0.285	0.494	-1.024
A_{12}	-0.187	0.393	0.186	0.481	-0.634

An example of PDA calculation for benefit criteria:

$$PDA_{11} = \frac{137 - 114.4}{114.4} = 0.197$$

and for cost criteria:

$$PDA_{44} = \frac{7.3 - 9}{7.3} = -0.233$$

NDA is obtained using equation (7) for benefit criteria and applying equations (9) for cost criteria, as it is shown in Table 3.

Table 3. *Positive distance from average (NDA) matrix*

NDA	C_1	C_2	C_3	C_4	C_5
A_1	-0.197	0.559	0.081	-0.016	-0.213
A_2	-0.040	-0.295	0.100	-0.043	-0.304
A_3	-0.040	0.554	0.110	0.093	-0.603
A_4	-0.066	0.527	0.130	0.230	-0.410
A_5	0.039	0.456	0.170	0.367	-0.320
A_6	0.021	0.315	0.199	1.050	-0.573
A_7	-0.127	0.179	0.110	-0.139	-0.430
A_8	0.126	-1.176	-0.236	-0.139	1.395
A_9	0.065	-0.714	-0.186	-0.686	0.262
A_{10}	-0.101	0.320	-0.008	0.257	-0.462
A_{11}	0.135	-0.333	-0.285	-0.494	1.024
A12	0.187	-0.393	-0.186	-0.481	0.634

An example of PDA calculation for benefit criteria:

$$PDA_{11} = \frac{114.4 - 137}{114.4} = -0.197,$$

and for cost criteria: $PDA_{44} = \frac{9 - 7.3}{7.3} = 0.233$

Step 5: Tables 4 and 6 show the weighted sum of *PDA* and *NDA* as it was determined in Minkowski space for all alternatives:

Table 4. *The weighted sum of PDA in Minkowski space*

	C_1	C_2	C_3	C_4	C_5
A_1	7.22E-08	-7.78E-06	-1.43E-09	1.26E-13	5.60E-07
A_2	2.49E-11	3.15E-07	-4.29E-09	1.86E-11	3.32E-06
A_3	2.49E-11	-7.41E-06	-6.85E-09	-8.69E-10	1.02E-04
A_4	3.08E-10	-5.76E-06	-1.56E-08	-7.88E-08	1.48E-05
A_5	-2.07E-11	-2.80E-06	-5.88E-08	-8.11E-07	4.30E-06
A_6	-1.01E-12	-4.38E-07	-1.32E-07	-1.56E-04	7.93E-05
A_7	8.11E-09	-2.58E-08	-6.85E-09	6.33E-09	1.89E-05
A_8	-7.66E-09	3.19E-04	3.03E-07	6.33E-09	-6.77E-03
A_9	-2.76E-10	2.63E-05	9.35E-08	1.85E-05	-1.60E-06
A_{10}	2.56E-09	-4.77E-07	1.59E-14	-1.38E-07	2.69E-05
A_{11}	-1.07E-08	5.79E-07	7.87E-07	3.61E-06	-1.44E-03
A12	-5.54E-08	1.32E-06	9.35E-08	3.14E-06	-1.31E-04

$k_{ij}(PDA)$ is shown in Table 5, while $k_{ij}(NDA)$ is shown in Table 7.

Table 5. *Values of* $k_{ij}(PDA)$

kij	C_1	C_2	C_3	C_4	C_5
A_1	1.00	-1.00	-1.00	1.00	1.00
A_2	1.00	1.00	-1.00	1.00	1.00
A_3	1.00	-1.00	-1.00	-1.00	1.00
A_4	1.00	-1.00	-1.00	-1.00	1.00
A_5	-1.00	-1.00	-1.00	-1.00	1.00
A_6	-1.00	-1.00	-1.00	-1.00	1.00
A_7	1.00	-1.00	-1.00	1.00	1.00
A_8	-1.00	1.00	1.00	1.00	-1.00
A_9	-1.00	1.00	1.00	1.00	-1.00
A_{10}	1.00	-1.00	1.00	-1.00	1.00
A_{11}	-1.00	1.00	1.00	1.00	-1.00
A_{12}	-1.00	1.00	1.00	1.00	-1.00

The elements of the weighted sum of PDA in Minkowski space matrix are obtained in the following way:

As the first is need to get $k_{ij}\left|w_j PDA_{ij}\right|^m$ for example:

$$k_{11}\left|w_1 PDA_{11}\right|^m = 1\times\left|0.189\times 0.197\right|^5 = 7.22E-08$$

After previously calculation, all $k_{ij}\left|w_j PDA_{ij}\right|^m$ is need to summing of the respective values. For example, for alternative A_1:

$$A_1 = (7.22E-08)+(-7.78E-06)+(-1.43E-09)+$$
$$(1.26E-13)+(5.60E-07) = 7.15E-06$$

After previously computing and determining d_i

$$A_1 = \left[-1.00, 1.00, 1.00, 1.00, 1.00, -1.00, 1.00, -1.00, 1.00, 1.00, -1.00, -1.00\right]$$

the values of SP_i are obtained as follows:

$$SP_1 = -1.00\times\left|-7.15E-06\right|^{1/5} = -0.093$$

All calculations should be performed in the same way for *SN*.

Table 6. *The weighted sum of NDA in Minkowski space*

	C_1	C_2	C_3	C_4	C_5
A_1	-7.22E-08	7.78E-06	1.43E-09	-1.26E-13	-5.60E-07
A_2	-2.49E-11	-3.15E-07	4.29E-09	-1.86E-11	-3.32E-06
A_3	-2.49E-11	7.41E-06	6.85E-09	8.69E-10	-1.02E-04
A_4	-3.08E-10	5.76E-06	1.56E-08	7.88E-08	-1.48E-05
A_5	2.07E-11	2.80E-06	5.88E-08	8.11E-07	-4.30E-06
A_6	1.01E-12	4.38E-07	1.32E-07	1.56E-04	-7.93E-05
A_7	-8.11E-09	2.58E-08	6.85E-09	-6.33E-09	-1.89E-05
A_8	7.66E-09	-3.19E-04	-3.03E-07	-6.33E-09	6.77E-03
A_9	2.76E-10	-2.63E-05	-9.35E-08	-1.85E-05	1.60E-06
A_{10}	-2.56E-09	4.77E-07	-1.59E-14	1.38E-07	-2.69E-05
A_{11}	1.07E-08	-5.79E-07	-7.87E-07	-3.61E-06	1.44E-03
A12	5.54E-08	-1.32E-06	-9.35E-08	-3.14E-06	1.31E-04

$k_{ij}(NDA)$ is contrary than previously shown $k_{ij}(PDA)$.

Table 7. Values of $k_{ij}(NDA)$

kij	C_1	C_2	C_3	C_4	C_5
A_1	-1.00	1.00	1.00	-1.00	-1.00
A_2	-1.00	-1.00	1.00	-1.00	-1.00
A_3	-1.00	1.00	1.00	1.00	-1.00
A_4	-1.00	1.00	1.00	1.00	-1.00
A_5	1.00	1.00	1.00	1.00	-1.00
A_6	1.00	1.00	1.00	1.00	-1.00
A_7	-1.00	1.00	1.00	-1.00	-1.00
A_8	1.00	-1.00	-1.00	-1.00	1.00
A_9	1.00	-1.00	-1.00	-1.00	1.00
A_{10}	-1.00	1.00	-1.00	1.00	-1.00
A_{11}	1.00	-1.00	-1.00	-1.00	1.00
A_{12}	1.00	-1.00	-1.00	-1.00	1.00

For example if $k_{11}(PDA) = 1$ then $k_{11}(NDA) = -1$.

Step 6: Normalized values of *SP* and *SN* for all alternatives are obtained using equations (12) and (13), while *AS* is obtained using equation (14).

Table 8 shows the results of the EDAS-M method.

Table 8. Results of integrated FUCOM-EDAS-M model

	NSPI	NSNI	ASI	RANK
A_1	-0.596	0.744	0.074	**8**
A_2	0.521	1.224	0.872	**6**
A_3	1.000	1.430	1.215	**1**
A_4	0.623	1.268	0.946	**5**
A_5	0.367	1.158	0.762	**7**
A_6	-0.960	0.587	-0.186	**9**
A_7	0.724	1.312	1.018	**4**
A_8	-2.325	0.000	-1.163	**12**
A_9	0.855	1.368	1.111	**2**
A_{10}	0.773	1.333	1.053	**3**
A_{11}	-1.722	0.260	-0.731	**11**
A_{12}	-1.059	0.544	-0.257	**10**

The results obtained show that the third alternative, i.e. an electric vehicle, is the best according to the ranking criteria and their importance. The second best solution is the ninth alternative, while in the third position is the tenth alternative. The eighth alternative is in the last position of the ranking.

CONCLUSION

In this paper, the integration of the FUCOM method, which provides approximately complete consistency in determining the significance of criteria, and the EDAS in Minkowski space method has been performed. The integration of these two MCDM methods has been performed for the first time in this paper for the evaluation of electric vehicles, which is one of the contributions of the study. This model can be used for complex multi-criteria problems in which criteria, i.e. their importance, can play an important role in making a final decision. The implementation of such MCDM models in the field of application and development of electric vehicles is expected to be increasing. This is supported by the fact that electric vehicles are increasingly used in both passenger and freight transport. In addition, directions for future research may focus on integrating the EDAS-M method with other uncertainty theories, such as a fuzzy, rough, or neutrosophic set.

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AN MCDM ASSESSMENT OF ACHIEVING THE 12TH GOAL OF THE 2030 AGENDA

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Abstract: The responsible consumption of natural resources has become a critical issue because the unrenewable resource base could be exhausted in future decades. In order of enabling sustainable development, the General Assembly adopted the *2030 Agenda for Sustainable Developmen*t that involves 17 Sustainable Development Goals (SDG) and 169 targets pointed to the different aspects of production and living. In this paper, we try to discover how far get the countries in Southern Europe regarding the 12th SDG – *Responsible consumption and production*. The assessment of the progress of the given countries is performed relative to the five indicators. The Entropy method is used for the determination of the criteria significance while the final ranking of the countries is done by application of the EDAS method.

Keywords: 2030 Agenda, 12th SDG, Entropy, EDAS, Southern Europe, natural resources, consumption
JEL: C44, Q29, Q39

1. INTRODUCTION

Industrial development has led to increased consumption of natural resources. Especially endangered are unrenewable natural resources because industrial production is mainly based on its utilization. Besides, the pressure on the environment grows which results in its serious damage and climate changes. The problem of unplanned and exaggerated consumption of natural resources that jeopardize future production, as well as the existence of humans, become an important topic in international debates. People, their activities and choices could seriously affect, positively or negatively, the environment and could contribute or hinder the achieving of sustainable development in all aspects (Jackson, 2014). Although, there could be noted the increasing interest of the researchers for the questions about sustainability (Dobrovolskienė *et al.*, 2019).

In order of achieving the sustainable development, the General Assembly accepted the *2030 Agenda for Sustainable Development* (in further text denoted as 2030 Agenda) which is directed to the improvement of the state of the planet and bringing the well-being to the people, especially in undeveloped parts of the world (https://www.un.org/development/desa/disabilities/envision2030.html). This Agenda contains 17 Sustainable Development Goals (SDG) directed to the different fields connected to sustainable development. Each of the SDGs involves the appropriate number of targets and indicators which enables monitoring of accomplishment in the process of achieving a certain goal. The *12th SDG* named *Responsible consumption and production* is particularly important regarding achieving a higher level of responsible using of the resources.

The application of the 2030 Agenda requires the overcoming of various policy and scientific obstacles (Terama *et al.*, 2016). The existence of the quantitative targets ensures a possibility for resolving these issues and increasing the ability of the action plans to achieve the decoupling of resource use and economic growth (Nash, 2009). The policy-makers need quantitative indicators that will help them in making guidelines for national industries pointed to the responsible consumption. With that aim, Wagner and Wellmer (2009) proposed a four-level hierarchy of natural resources as a base for the development of a resource efficiency indicator. Bringezu et al. (2016) concluded that sustainable natural resource consumption requires an appropriate government and management that relies on the scientific indicators and peace of information.

The SDGs are defined from the global aspect but which of them will be a priority in a particular country depends on the problems that the country is faced with (Salvia *et al.*, 2019). Although the 169 targets support the 17 goals, some of the targets are still ambiguous and complex for measuring (Biermann *et al.*, 2017). Therefore, Hoekstra *et al.* (2017) proposed the IPAT equation as an aid in the monitoring of the progress towards 6th SDG. Collste *et al.* (2017) developed an iSDG model to provide a real representation of real-world development. Pogge and Sengupta (2016) assessed the SDGs from the perspective of human rights. In order of the progress assessment regarding certain goals, the SDG composite index is introduced and Diaz - Sarachaga *et al.* (2018) elaborated in their paper does this index is a representative measure of improvement in achieving the SDGs. Besides the mentioned, remains the question of how we will measure our progress towards SDGs relative to the other countries easily and comprehensively. With that aim, in this paper, we proposed the application of the Multiple-Criteria Decision-Making (MCDM).

MCDM represents a part of the operational research and management science which methods gain significant popularity in the last three decades (Popovic *et al.*, 2019). The authors developed many MCDM methods which are used for

resolving various real-world decision-making problems. An adequate overview of the MCDM methods could be found in the paper of Zavadskas *et al.* (2014) and Gavade (2014). By introducing the proper extensions of the MCDM methods the uncertainty and vagueness of the environment are acknowledged and involved in the decision-making process (for example Stanujkić & Meidutė-Kavaliauskienė, 2018; Liao *et al*., 2018).

The main intention of this paper is to give the rank of the countries from Southern Europe relative to the 12th SDG - *Responsible consumption and production* and for that purpose, the Entropy and EDAS methods are used. The reason for evaluating the countries from this part of Europe is because the Republic of Serbia is situated there. It is a signatory of every significant convention pointed to the achieving of the sustainable development and preservation of the environment and natural resources and we want to define its position towards achieving the 12th SDG four years after introducing the 2030 Agenda. The mentioned MCDM methods represent a useful aid in this evaluation process which enables achieving the primary goal: defining the position of the Republic of Serbia amongst the other countries from Southern Europe in an easy and comprehensive way. With that aim the rest of the paper is organized as follows: in section 2 the used methodology is explained; the case study is presented in section 3; and et the end the conclusion is given.

2. METHODOLOGY

The problem of defining the rank of the Southern Europe countries relative to the 12th SDG will be resolved by applying the Entropy and EDAS methods, as we stated previously. The Entropy method will be used for defining the significance of the considered criteria, while the EDAS method will be used for the final assessment and ranking. In the further text, both methods will be explained in detail.

2.1. Entropy method

Shannon (1948, 1964) proposed the Entropy method, which quickly becomes very popular and widely used in various fields because of its simplicity and reliability. Besides the other MCDM methods popular for determination of the criteria weights such as: Analytic Hierarchy Process - AHP (Saaty, 1980), Step-wise Weight Assessment Ratio Analysis - SWARA (Keršuliene *et al.*, 2010) and PIvot Pairwise RElative Criteria Importance Assessment - PIPRECIA (Stanujkic *et al.*, 2017), authors applied the Entropy method as well (Wang & Lee, 2009; Gou *et al.*, 2017). Defining the criteria significance is performed by using the following Equation:

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{n} \left(1 - e_j\right)}, \quad (1)$$

where $j = 1,..., n.$

The output entropy e_j of the j_{th} factor is calculated as:

$$e_j = -\frac{1}{\ln(m)} \sum_{j=1}^{n} r_{ij} \ln\left(r_{ij}\right), \quad (2)$$

where $j = 1,..., n.$

The total sum of the obtained criteria weights should satisfy the term: $\sum_{j=1}^{n} w_j = 1$.

2.2. EDAS method

The Evaluation Based on Distance from Average Solution - EDAS is introduced by Keshavarz Ghorabaee *et al*. (2015), and represents a relatively novel MCDM technique. The guiding idea of the EDAS is reflected through the introducing of two distance measures: the Positive Distance from Average (PDA) and Negative Distance from Average (NDA). Additionally, the assessment of the alternatives is performed relative to higher values of the PDA and lower values of the NDA.

Until now, the EDAS method is used for the facilitation of the decision-making process in various fields. For example, Karabasevic *et al.* (2018) used it in the case of personnel selection in the IT industry. This method was, also, useful in creating the model for the selection of the adequate architectural shapes of residential houses for single-families (Juodagalvienė *et al.*, 2017). Recently, the authors have developed the extensions of the EDAS method to appreciate the vagueness of the environment to a greater extent. These extensions are used in the evaluation process in different fields and we will mention some of them. The selection of the site for disposal of the solid waste is performed by applying the intuintionistic fuzzy EDAS (Kahraman *et al.*, 2017). Stanujkic *et al.* (2017) proposed the extension of the EDAS method by involving the interval grey numbers. Kutlu Gündoğdu *et al.* (2018) applied a fuzzy EDAS method in the hospital selection while Karaşan *et al.* (2019) assessed the social responsibility projects by using the interval-valued neutrosophtic EDAS technique.

For the purpose of this paper, we will apply the EDAS method that is based on the using of crisp numbers. The computational procedure of the EDAS method, that relies on that one presented in the paper of Karabasevic *et al.* (2018), can be precisely presented as follows:

***Step* 1.** First perform the selection of the available alternatives, the evaluation criteria and form the decision-making matrix *X*, shown as follows:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{12} & x_{22} & \cdots & x_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ x_{1n} & x_{2n} & \cdots & x_{mn} \end{bmatrix} \tag{3}$$

where x_{ij} represents the performance rating of the alternative *i* on the criterion *j*.

***Step* 2.** Define the average solution according to all criteria, shown as follows:

$$x_j^* = (x_1, x_2, ..., x_n), \tag{4}$$

where

$$x_j^* = \frac{\sum_{i=1}^{m} x_{ij}}{m}. \tag{5}$$

***Step* 3.** Compute the positive distance from average d_{ij}^+ and the negative distance from average d_{ij}^-, according to the type of criteria (benefit and cost), in the following way:

$$d_{ij}^+ = \begin{cases} \dfrac{\max(0, (x_{ij} - x_j^*))}{x_j^*}; & j \in \Omega_{\max} \\ \dfrac{\max(0, (x_j^* - x_{ij}))}{x_j^*}; & j \in \Omega_{\min} \end{cases}, \tag{6}$$

$$d_{ij}^- = \begin{cases} \dfrac{\max(0, (x_j^* - x_{ij}))}{x_j^*}; & j \in \Omega_{\max} \\ \dfrac{\max(0, (x_{ij} - x_j^*))}{x_j^*}; & j \in \Omega_{\min} \end{cases}, \tag{7}$$

where $\Omega_{\max}$ and $\Omega_{\min}$ denotes the set of the benefit criteria and the cost criteria, respectively.

***Step* 4.** Determine the weighted sum of PDA, Q_i^+, and the weighted sum of NDA, Q_i^-, for all alternatives, by using the following Eqs.:

$$Q_i^+ = \sum_{j=1}^{n} w_j d_{ij}^+, \tag{8}$$

$$Q_i^- = \sum_{j=1}^{n} w_j d_{ij}^-. \tag{9}$$

***Step* 5.** Normalize the values of the weighted sum of the PDA and the weighted sum of the NDA for all alternatives, as follows:

$$S_i^+ = \frac{Q_i^+}{\max\limits_i Q_i^+}, \tag{10}$$

$$S_i^- = 1 - \frac{Q_i^-}{\max\limits_i Q_i^-}, \tag{11}$$

where S_i^+ and S_i^- denote the normalized weighted sum of the PDA and the NDA, respectively.

***Step* 6.** Calculate the appraisal score S_i for all alternatives, as follows:

$$S_i = \frac{1}{2}(S_i^+ + S_i^-). \tag{12}$$

***Step* 7.** The alternatives should be ranked according to the decreasing values of the appraisal score. The alternative with the highest S_i is the best choice among the considered alternatives.

3. A CASE STUDY

3.1. Data

The crucial intention of the Agenda 2030 that was adopted by all United Nations Member States in 2015 is to ensure the continual improvement of the conditions on the planet in the next fifteen years. The main targets are: decreasing the inequality, improve the health and education, enhance the economic growth and all that with preservation of the environment and natural resources (https://sustainabledevelopment.un.org/sdgs). All these intentions are summarized in the 17 goals that are represented in **Table 1**.

Table 1. *17 SDGs*

Goal number	Name
1	No poverty
2	Zero hunger
3	Good health and well-being
4	Quality education
5	Gender equality
6	Clean water and sanitation
7	Affordable and clean energy
8	Decent work and economic growth
9	Industry, innovation, and infrastructure
10	Reduced inequality
11	Sustainable cities and communities
12	Responsible consumption and production
13	Climate action
14	Life below water
15	Life on land
16	Peace and justice strong institutions
17	Partnerships to achieve the goal

Source: https://www.un.org/sustainabledevelopment/sustainable-development-goals/

As **Table 1** shows each goal treats a particular problem that the modern world is facing. But, the common denominator of them all is that they are pointed to the preservation and enhancement of the conditions under which people live. In order of adopting the mentioned list of goals countries worldwide conducted activities relative to the prioritization of given goals regarding their particular problems. For example, the Republic of Serbia performed the mapping of the strategic framework connected to the goals of sustainable development in the 2030 Agenda (https://rsjp.gov.rs/wp-content/uploads/2017/11/Agenda-UN-2030.pdf).

As we stated previously, each goal is elaborated in the set of appropriate targets. In order of monitoring the improvement towards the mentioned goals and targets, a set of indicators is developed. **Table 2** shows the indicators for 12th SDG and the targets are omitted because of the length of the paper.

Table 2. *Indicators of the12th SDG*

Number	Indicator
12.1.1	Number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or a target into national policies
12.2.1	Material footprint, material footprint per capita, and material footprint per GDP
12.2.2	Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP
12.3.1	(a) Food loss index and (b) food waste index
12.4.1	Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting the information as required by each relevant agreement
12.4.2	Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment
12.5.1	National recycling rate, tons of material recycled
12.6.1	Number of companies publishing sustainability reports
12.7.1	Number of countries implementing sustainable public procurement policies and action plans
12.8.1	The extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; (d) student assessment
12.a.1	Amount of support to developing countries on research and development for sustainable consumption and production and environmentally sound technologies
12.b.1	Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools
12.c.1	Amount of fossil-fuel subsidies per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels

Source: https://unstats.un.org/sdgs/indicators/indicators-list/

Only for the marked indicators exist the data and for that reason only they will be involved in further analysis.

3.2. Application of the proposed methodology

Table 3 presents the input data for the countries from Southern Europe without Andorra because for that country we could not found the complete data. The evaluation procedure will be based on the 5 indicators because the information connected to the others is not currently available.

Table 3. *12th SDG selected indicators for the countries from Southern Europe excluding Andorra for 2010*

		C_1	C_2	C_3	C_4	C_5
		Material footprint per capita	Material footprint per unit of GDP	Domestic material consumption per capita	Domestic material consumption per unit of GDP	International agreements on hazardous waste
		tonne/per capita	kg/US$	tonnes per person per year	kg/US$	number of agreements
		min	min	min	min	max
A_1	Albania	8.25	2.49	8.26	2.5	4
A_2	Bosnia and Herzegovina	7.52	2.23	7.9	2.4	4
A_3	Croatia	12.97	1.21	9.66	0.9	4
A_4	Greece	28.43	1.3	14.43	0.66	4
A_5	Italy	19.18	0.64	10.93	0.36	4
A_6	Malta	19.82	1.19	12.74	0.77	4
A_7	Montenegro	21.61	4.78	4.37	0.97	4
A_8	Portugal	22	1.15	18.24	0.95	4
A_9	San Marino	104.52	1.76	10.32	0.17	1
A_{10}	Serbia	14.36	4.63	10.69	3.45	4
A_{11}	Slovenia	22.49	1.17	16.76	0.87	4
A_{12}	Spain	23.28	0.88	13.14	0.5	4
A_{13}	Northern Macedonia	10.37	2.86	8.53	2.36	4

Source: https://sdg-tracker.org/sustainable-consumption-production

We determined the weights of criteria by applying the Entropy method. The results are obtained by using Eqs. (1) and (2) and they are presented in **Table 4**.

Table 4. *The criteria weights*

Criteria	w_j
C_1	0.3707
C_2	0.2156
C_3	0.0636
C_4	0.3138
C_5	0.0364

Source: Author's calculations

The obtained result shows that the greatest significance has the criterion C_1 - *Material footprint per capita* while the least significant is criterion C_5 - *International agreements on hazardous waste*.

After that, the positive distance from the average and negative distance from the average are calculated by applying the Eqs, (6) and (7). In **Table 5** the results for the positive distance from the average are presented.

Table 5. *The positive distance from the average -* d_{ij}^{+}

	C_1	C_2	C_3	C_4	C_5
A_1	0.6593	0.0000	0.2644	0.0000	0.0612
A_2	0.6895	0.0000	0.2964	0.0000	0.0612
A_3	0.4644	0.4017	0.1397	0.3060	0.0612
A_4	0.0000	0.3572	0.0000	0.4911	0.0612
A_5	0.2079	0.6835	0.0266	0.7224	0.0612
A_6	0.1815	0.4116	0.0000	0.4063	0.0612
A_7	0.1076	0.0000	0.6108	0.2521	0.0612
A_8	0.0915	0.4313	0.0000	0.2675	0.0612
A_9	0.0000	0.1297	0.0809	0.8689	0.0000
A_{10}	0.4070	0.0000	0.0480	0.0000	0.0612
A_{11}	0.0713	0.4215	0.0000	0.3292	0.0612
A_{12}	0.0386	0.5649	0.0000	0.6145	0.0612
A_{13}	0.5718	0.0000	0.2403	0.0000	0.0612

Source: Author's calculations

Table 6 represents the results for the negative distance from the average.

Table 6. *The negative distance from the average -* d_{ij}^{-}

	C_1	C_2	C_3	C_4	C_5
A_1	0.0000	0.2313	0.0000	0.9276	0.0000
A_2	0.0000	0.1027	0.0000	0.8505	0.0000
A_3	0.0000	0.0000	0.0000	0.0000	0.0000
A_4	0.1740	0.0000	0.2851	0.0000	0.0000
A_5	0.0000	0.0000	0.0000	0.0000	0.0000
A_6	0.0000	0.0000	0.1346	0.0000	0.0000
A_7	0.0000	1.3636	0.0000	0.0000	0.0000
A_8	0.0000	0.0000	0.6244	0.0000	0.0000
A_9	3.3163	0.0000	0.0000	0.0000	0.7347
A_{10}	0.0000	1.2895	0.0000	1.6601	0.0000
A_{11}	0.0000	0.0000	0.4926	0.0000	0.0000
A_{12}	0.0000	0.0000	0.1702	0.0000	0.0000
A_{13}	0.0000	0.4142	0.0000	0.8197	0.0000

Source: Author's calculations

Eqs. (8) and (9) are applied for computation of the weighted sums of PDA and NDA for considered alternatives. Then, the normalized weighted sum of the PDA and NDA are obtained by using Eqs. (10) and (11). Finally, the appraisal scores S_i is obtained by using Eq. (12) (**Table 7**).

Table 7. *The weighted and the normalized weighted sums of PDA and NDA*

	Q_i^+	Q_i^-	S_i^+	S_i^-	S_i
A_1	0.2634	0.0485	0.5789	0.9322	0.7556
A_2	0.2766	0.0375	0.6080	0.9475	0.7778
A_3	0.3659	0.0000	0.8041	1.0000	0.9020
A_4	0.2333	0.1270	0.5128	0.8224	0.6676
A_5	0.4550	0.0000	1.0000	1.0000	1.0000
A_6	0.2857	0.0422	0.6279	0.9409	0.7844
A_7	0.1600	0.0867	0.3517	0.8788	0.6152
A_8	0.2131	0.1959	0.4682	0.7260	0.5971
A_9	0.3057	0.7149	0.6719	0.0000	0.3360
A_{10}	0.1561	0.1424	0.3431	0.8008	0.5720
A_{11}	0.2228	0.1546	0.4896	0.7838	0.6367
A_{12}	0.3311	0.0534	0.7277	0.9253	0.8265
A_{13}	0.2294	0.0562	0.5043	0.9214	0.7128

Source: Author's calculations

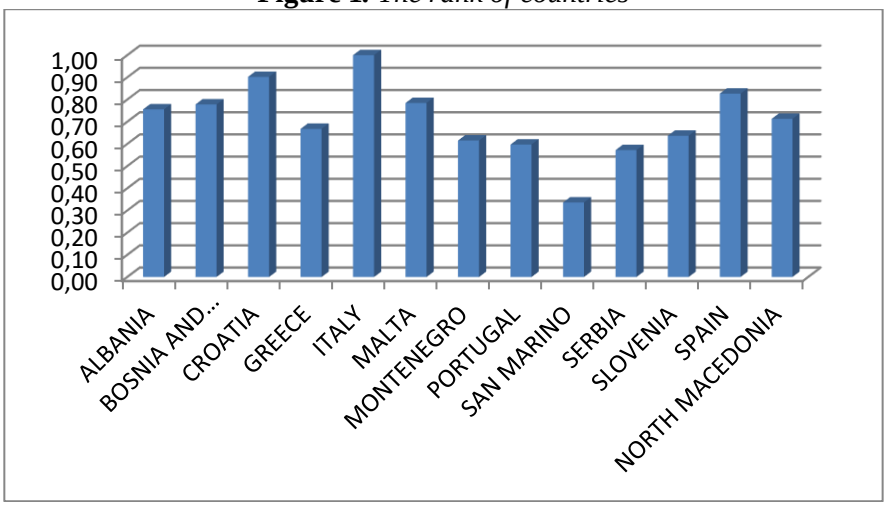
The overall ranking order of the considered countries is presented in **Table 8** and depicted in **Figure 1**.

Table 8. *The final rank of countries*

Country	S_i	Rank
A_1	0.7556	**6**
A_2	0.7778	**5**
A_3	0.9020	**2**
A_4	0.6676	**8**
A_5	1.0000	**1**
A_6	0.7844	**4**
A_7	0.6152	**10**
A_8	0.5971	**11**
A_9	0.3360	**13**
A_{10}	0.5720	**12**
A_{11}	0.6367	**9**
A_{12}	0.8265	**3**
A_{13}	0.7128	**7**

Source: Author's calculations

Figure 1. *The rank of countries*



Source: Author's calculations

Obtained results show that the most successful country regarding the achieving of the 12th SDG is Italy while in the last place is San Marino.

CONCLUSION

Sustainability issues have come in the center of the interest of the scientists and governments, recently. This results in the creating of many strategies and agendas pointed towards achieving sustainable development in many aspects and in 2015 General Assembly adopted the *2030 Agenda for Sustainable Development*. This 2030 Agenda contains 17 crucial goals and each of them is elaborated in a particular number of targets. In order of enabling the monitoring of progress towards given goals and targets, the set of indicators relative to each goal is formed. Unfortunately, some of the indicators are still unavailable because the data about them is still not gathered.

The very intriguing question is how to measure the progress of a country in comparison with other countries in an easy way. In order of achieving that in this paper we proposed an MCDM approach based on the application of the Entropy and EDAS methods. Entropy is used for determining the significance of the evaluation criteria and the key reason for that is reflected through its objectiveness because it does not depend on the standpoint of a decision-maker. The final assessment of the considered countries and their ranking is performed by applying the EDAS method. Even though the EDAS method has been recently proposed, it is used for the facilitation of the decision-making process in various fields and we considered that it will be convenient for applying in our case, too.

Our research attention was point to the assessment of the progress of the countries from Southern Europe towards the 12th SDG goal. Particularly, we want to examine the position of the Republic of Serbia, which is classified as a country in Southern Europe, relative to the responsible production and consumption of natural resources. The final results show that the leading country according to achieving this goal is Italy, while the last place takes San Marino. Unfortunately, the Republic of Serbia is on the twelve position which is the penultimate place. This indicates that the Republic of Serbia should invest a lot of effort towards riching the considered goal.

The proposed methodology enabled a successful ranking of the considered countries in an easy way and show full potential in this case. The main shortage of this paper is that the procedure is based on the application of the crisp numbers. Introduction of the fuzzy, grey or neutrosophic numbers will provide the involving of the uncertainty and vagueness of the environment in the proper degree. Besides, the more complete picture of the achievements of the countries would be obtained in the case when we have the data about the greater number of indicators relative to a certain goal. Also, ranking based on the assessment of the achievement of all 17 goals will more clearly indicate which country has better results connected to a certain goal, and which has the best performance of all.

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SELECTION OF OPTIMAL SOFTWARE DEVELOPMENT METHODOLOGY BASED ON WEIGHTED AGGREGATED SUM PRODUCT ASSESSMENT METHOD

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Abstract: The software development methodology covers the complete software life cycle. It involves the production of quality and reliable software in a systematic, controlled and efficient manner using formal methods for specification, evaluation, analysis and design, implementation, testing, and maintenance. Today, software is used in all domains of education. From primary and secondary schools to higher education institutions are using specialist software packages intended for research. The aim of this manuscript is a selection of the software development methodology based on multiple-criteria decision-making methods. PIPRECIA method is applied for defining the weights of the criteria, whereas WASPAS method is applied for the ranking of alternatives. The application of the proposed approach, as well as its efficiency and effectiveness, are shown in the conducted case study.

Keywords: Software, Software development methodology, MCDM, WASPAS
JEL: D81, C44

1. INTRODUCTION

The software development methodology covers the complete software life cycle. It involves the production of quality and reliable software in a systematic, controlled and efficient manner using formal methods for specification, evaluation, analysis and design, implementation, testing, and maintenance. Today, software is used in all domains of education. From primary and secondary schools to higher education institutions are using specialist software packages intended for research.

Manger (2012) states that software product is a collection of computer programs and related documentation, created precisely for the reason of being sold. It can

be developed for a specific user (customized product) or generally for the market (generic product). Today's software includes the necessity that he must be of good quality. More specifically, a software product is expected to be characterized by the following quality attributes: a) Maintenance; b) Reliability and security; c) Efficiency; d) Usability.

Thus, the software represents a series of commands that are stored in the computer's memory. It is executed on hardware and is required for proper operation and functioning of a computer system. According to the purpose one of the most common software division is into two groups: a) System software: all programs, software packages, etc. intended for the functioning of a computer system are belonging to system software; b) Application software: all programs, software packages, etc. intended to solve specific problems and tasks of computer system users are belonging to application software (Tomašević, 2012).

The pace of change in the software development industry is still high. People continue to push the boundaries of known techniques and practices to develop as efficient and effective software as possible. Software development lifecycle models and business decision models contribute to controlling product development in different ways.

Software products are among the most complex systems made by man. Therefore their development requires the use of techniques and processes that can be successfully scaled up to very large applications while satisfying demands for size, performance and security, all within the time and budget constraints. The complexity of large software systems is overcome by the use of higher-level abstraction structures, such as software architecture.

Thus, a set of activities that are related to the "initialization, design, realization and sale of software products and managing all the resources that are related to that product" is called software engineering which is of crucial importance to software development (Steward, 1987).

Today, decisions are made daily and are one of the most important elements of management activities. With globalization and increasing business dynamics, changes have been made in the decision-making process, so decision-making has become much more demanding and complex. Multiple-Criteria Decision-Making (MCDM) represents the process of selecting one alternative from a set of available alternatives or, in some cases, ranking alternatives based on a predefined set of specific criteria that most often have different significance. Justification for the application of the MCDM methods is relevant approach to making decisions and the adoption of sustainable solutions (Stanujkić *et al*., 2019a; Stanujkic *et al*., 2019b; Karabašević & Maksimović, 2018; Stanujkić *et al*., 2017b).

Therefore, the main aim of this manuscript is to present an approach for the selection of software development methodology based on MCDM methods. For the defining weights of the criteria, PIPRECIA method is applied, whereas for the purpose of the ranking of alternatives WASPAS method is applied.

2. THEORETICAL BACKGROUND

Nowadays, software engineering is receiving increasing attention in software development. Software engineering is a systematic approach to the development, exploitation, maintenance, and replacement of software products. Software engineering is a technological and management discipline that deals with the systematic production and maintenance of software products, which should be developed on time and at an estimated cost (Mead, 2009).

Characteristics of software engineering are (Buckley, 1987): a) modeling as the basis of design (object-connection model, process model, data model); b) methods of analysis, synthesis, and identification are used; c) division into levels, related to the phases of the software product life cycle and the project phase; d) interdisciplinarity and user involvement; d) project organization; e) validation and verification of results, quality assurance, presentation of results, documentation.

Because of all of the above, software engineering requires the use of both analytical and descriptive tools that have been developed within the computer sciences, along with the rigorous approach that engineering disciplines bring to achieving adequate reliability and security, all through the teamwork of software engineers working in a cohesive environment. At today's level of software engineering development, an organization's ability to handle software development in this way is precisely measurable and ranges from level 1 where software processes are unpredictable to level 5, where software processes are optimized.

The software development model is selected depending on the nature of the project and the application, the technical orientation of the people who will participate in the development, the methods and tools that will be used in the development, the methods of control as well as the products that are required. The primary goal of model creation is to provide software products that meet user requirements.

Depending on the importance of particular stages and activities of software development and the forms of organization and development management, as well as the experience of employees and the nature of the product, there are (Balaji & Murugaiyan, 2012; Martin, 2002):

a) Sequential software development model, the so-called *waterfall*;

b) Iterative and incremental model of software development;
c) Agile development model.

The purpose of the SWEBOK project is to characterize the content of software engineering as a discipline, as well as to differentiate software engineering from other disciplines such as computer science, project management, computer engineering, etc. According to the SWEBOK project, software engineering methods can be divided into three areas: a) heuristic methods relating to methods based on the informal approach; b) formal methods based on a mathematical approach; and c) prototyping methods relating to methods based on different types of prototyping (Antović *et al*., 2008; Stanojević *et al*., 2006).

Each model of the software development process uses a requirement specification as input and a delivered product as an output. Over the years, many such models have been proposed. Below, some of the most popular will be discussed in order to better understand their similarities and differences.

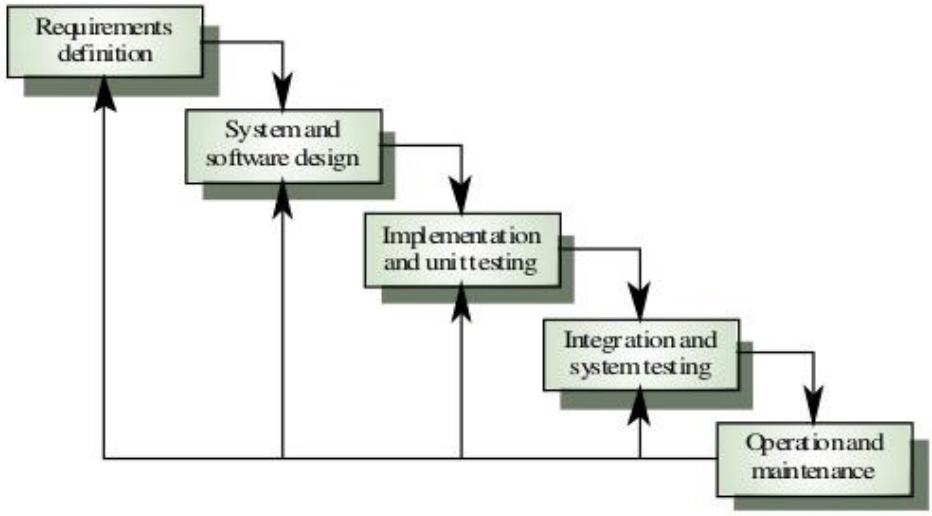
2.1. The waterfall model

One of the first proposed is a waterfall model. The waterfall model implies that it is necessary that one phase of the development must be fully completed before the beginning of the next one (Royce, 1970).

The waterfall model is very useful as an aid in expressing what the software development team needs to do. Its simplicity makes it easy to provide explanations to those unfamiliar with the software development process as it explicitly indicates among the steps necessary to begin the next phase. Many other more complex models represent a "beautified" waterfall model, through the inclusion of feedbacks and activities (Balaji & Murugaiyan, 2012). The biggest problem with the waterfall model is that it does not reflect the actual way in which the code evolves. Except perhaps for the very clear problems, the software is usually developed through a number of iterations. Software is often used to solve a problem that has never been resolved before, or whose solution must be improved to reflect changes that have occurred in the business or work environment (Pfleeger & Atlee, 1998).

Although this model has been used for many years in the production of many quality systems, it does not mean that no problems occur. In recent years, the model has been criticized for its rigidity and inflexible procedure.

Figure 1. *Waterfall model*



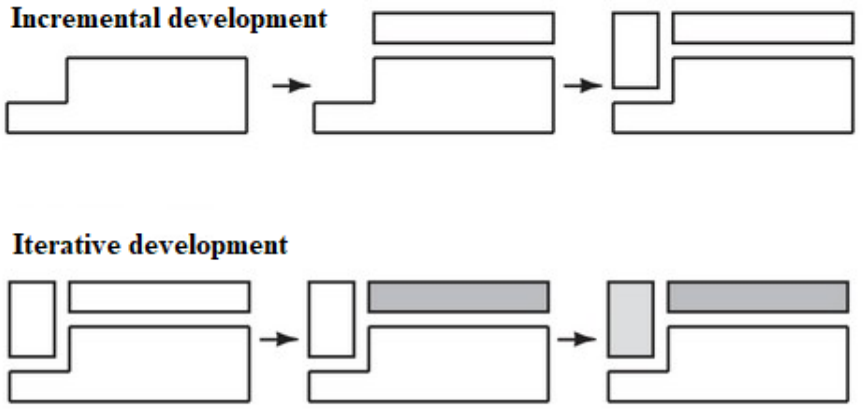
Source: https://www.slideshare.net/Ehtesham17/waterfall-model-in-software-engineering

2.2. The iterative and incremental model

The problems encountered in the waterfall model led to the need for a new method of system development that would provide quick results, which would require less initial information and offer more flexibility.

When iterative development is applied, the project is divided into smaller parts. This allows the development team to demonstrate results early in the process and to receive valuable feedback from system users. Often, each iteration is actually one mini-waterfall with feedback from one phase that provides vital information for the next phase. In iterative development, iteration is delivered immediately, at the very beginning, and then the functions of each subsystem are changed, in each new version. In incremental development, the system as specified in the requirement specification is subdivided into subsystems by functions. Versions are defined initially as small, functional subsystems, and then new features are added to each new version (Larman, & Basili, 2003).

Figure 2. *Incremental and iterative development*



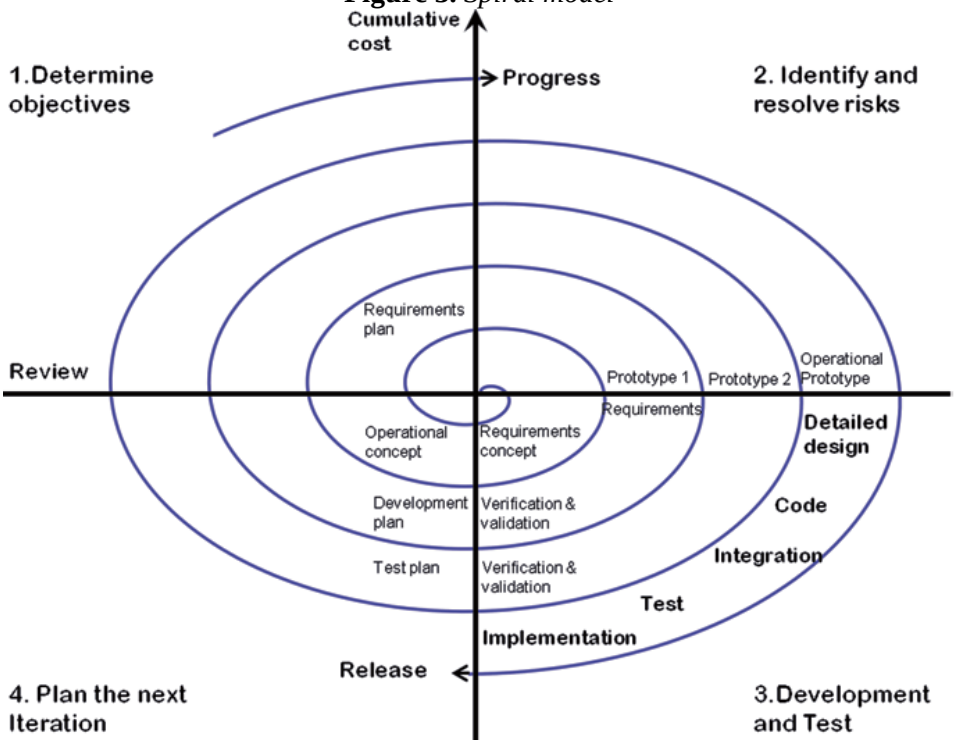
Source: http://www.link-university.com/lekcija/Fazni-razvoj-i-spiralni-model/2620

2.3. The spiral model

Boehm (1988) observed the development of software in light of the risks involved, suggesting that the spiral model can combine development activities with risk management, in order to be smaller and easier to control. This model is designed to include the best features of the waterfall model and introduces a new component - the risk assessment. The term "spiral" is used to describe the process that follows the development of the system.

The spiral model, shown in Figure 3, in some ways is similar to the iterative development shown in Figure 2. Starting with the requirements and initial development plan (including budget, constraints and alternatives in terms of staff, design and development environment), this process introduces a risk assessment step and a prototype alternatives, before producing a "working principles" document, to describe the functioning of the system at a high level of abstraction. From that document, a set of requests is defined and monitored to verify the completeness and consistency of the request. Therefore, the principle of operation is the product of the first iteration, while the requirements are the main product of the second iteration. In the third iteration, system development produces the design, while the fourth iteration enables testing (Fliger *et al*., 2006).

Figure 3. *Spiral model*



Source: Cowley (2014)

In each iteration, the risk analysis identifies different variants in terms of requirements and constraints, while prototyping verifies the feasibility or desirability of selecting the appropriate variant. After identifying the risks, project managers must decide how to eliminate or minimize them. To avoid the risk of choosing interfaces that would prevent productive use of the new system, designers can prototype both interfaces and test them in order to determine which is preferable, or even include both interfaces in the project so users can, after logging in, select interface. Restrictions such as budget and delivery time help in choosing a risk management strategy (Neill & Laplante, 2003).

2.4. The agile methods

Agile methodologies emerged in the late 90s when a group of software engineers concluded that previous approaches and methodologies for software development were not suitable in a turbulent environment and that it was not possible to bind and achieve firm delivery times for software solutions and customer satisfaction. They met and through mutual exchange of opinions came to the basic principles of agile methodologies, which they wrote down in the so-called Agile Manifesto (Jovanović *et al*., 2016).

Kilibarda *et al*. (2016) find that agile methodologies differ from traditional ones in that they require the development of software products through shorter development cycles. With its completion, it is possible to deliver one piece of a software product to the client and make the necessary changes with it, in order to reach the final result faster and more efficiently.

In the practice of implementing agile methodologies for software product development, a number of methods are proposed and used today. The most famous are Scrum, Extreme Programming (XP), Crystal Clear, DSDM, and more. The Scrum method is one of the most popular and in practice the most used method of agile software development management.

2.4.1 SCRUM methodology

This method is based on the basic principles that characterize the agile approach and is convenient in practice because it is very easy to use. This method suggests that software development work takes place in shorter cycles called sprints, followed by ongoing consultations with the client, and that, after a certain cycle, analysis and review will be carried out and, if necessary, the desired and necessary changes will be made. This includes mandatory meetings before and after each sprint, in order to consider whether everything was done accordingly to the requirements and if it is necessary to introduce some changes. In a particular situation, it is possible to go back and implement a specific sprint according to new requirements (Jovanović *et al*., 2016; Pichler, 2010).

Development cycles - sprints are time intervals that can last one month, usually lasting two or more weeks. The software development team using the SCRUM method has special authority in terms of organizing and operating, as well as the special member or product owner that has certain authorization and responsibilities regarding the work of the development team and delivering the desired results to the client. In addition to team members working on software development, the SCRUM methodology envisages two specific roles related to team operations. These are the product owner and SCRUM master (moderator or mediator) (Jovanović *et al*., 2016).

One of the most commonly used and researched methods is SCRUM, which describes an iterative development process with the gradual delivery of value. SCRUM methodology can only reach its full potential if all elements are well defined with fully dedicated teams.

3. METHODOLOGY

Weighted aggregates sum product assessment (WASPAS) method was developed by Zavadskas *et al*. (2012). The WASPAS method represents a unique combination of two MCDM approaches weighted sum (WS) method and weighted product (WP) method.

In order to cope with a wider range of problems, the WASPAS method has many extensions, such as: WASPAS-G (Zavadskas *et al*., 2015), WASPAS-IFIV (Zavadskas *et al*., 2014), WASPAS-SVNS (Baušys & Juodagalvienė, 2017), WASPAS-IFN (Stanujkic & Karabasevic, 2018); WASPAS-R (Stojic *et al*., 2018).

Also, until now WASPAS is applied for solving the most diverse problems, such as: manufacturing decision making (Chakraborty *et al*., 2014), construction site selection (Turskis *et al*., 2015), personnel selection (Karabasevic *et al*., 2016; Urosevic *et al*., 2016), website selection (Stanujkic & Karabasevic, 2018), and so on.

The computational procedure of WASPAS method can be precisely presented as follows (Karabasevic *et al*., 2016; Urosevic *et al*., 2016):

Step 1. Determine the optimal performance rating for each criterion. In this step, the optimal performance ratings are calculated as follows:

$$x_{0j} = \begin{cases} \max\limits_{i} x_{ij}; & j \in \Omega_{\max} \\ \min\limits_{i} x_{ij}; & j \in \Omega_{\min} \end{cases}, \tag{1}$$

where x_{0j} denotes the optimal performance rating of *j*-th criterion, $\Omega_{\max}$ denotes the benefit criteria, i.e. the higher the values are, the better it is; and $\Omega_{\min}$ denotes the set of cost criteria, i.e. the lower the values are, the better it is, *m* denotes number of alternatives; *i* = 0, 1, ..., *m*; and *n* denotes number of criteria, , *j* = 0, 1, ..., *n*.

Step 2. Construct the normalized decision matrix. The normalized performance ratings are calculated as follows:

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{x_{0j}}; & j \in \Omega_{\max} \\ \dfrac{x_{0j}}{x_{ij}}; & j \in \Omega_{\min} \end{cases}, \tag{2}$$

where r_{ij} denotes the normalized performance rating of *i*-th alternative in relation to the *j*-th criterion.

Step 3. Calculate the relative importance of i-th alternative, based on WS method. The relative importance of *i*-th alternative, based on WS method, is calculated as follows:

$$Q_i^{(1)} = \sum_{j=1}^{n} w_j \, r_{ij} \,, \tag{3}$$

where $Q_i^{(1)}$ denotes the relative importance of *i*-th alternative in relation to the *j*-th criterion, based on WS method.

Step 4. Calculate the relative importance of i-th alternative, based on WP method (Madić, 2014). The relative importance of *i*-th alternative, based on WP method, is calculated as follows:

$$Q_i^{(2)} = \prod_{j=1}^{n} r_{ij}^{\,w_j} \tag{4}$$

where $Q_i^{(2)}$ denotes the relative importance of *i*-th alternative in relation to the *j*-th criterion, , based on WP method.

Step 5. Calculate total relative importance, for each alternative. The total relative importance, or more precisely the joint generalized criterion of weighted aggregation of additive and multiplicative methods is calculated as follows:

$$Q_i = 0.5Q_i^{(1)} + 0.5Q_i^{(2)} = 0.5\sum_{j=1}^{n} w_j \, r_{ij} + 0.5\prod_{j=1}^{n} r_{ij}^{\,w_j} \tag{5}$$

In order to have increased ranking accuracy and effectiveness of the decision making process, in WASPAS method, a more generalized equation for determining the total relative importance of *i*-th alternative is developed as below:

$$Q_i = \lambda Q_i^{(1)} + (1-\lambda)Q_i^{(2)} = \lambda\sum_{j=1}^{n} w_j \, r_{ij} + (1-\lambda)\prod_{j=1}^{n} r_{ij}^{\,w_j} \tag{6}$$

4. CASE STUDY OF THE SELECTION OF SOFTWARE DEVELOPMENT METHODOLOGY

This section will present a case study of the selection of software development methodology based on the use of PIPRECIA and WASPAS methods.

Based on the literature review, alternatives that will be evaluated are as follows: Waterfall methodology – A_1; Iterative and incremental methodology – A_2; Spiral methodology – A_3; and SCRUM methodology – A_4.

Pivot Pairwise Relative Criteria Importance Assessment method (PIPRECIA) method is developed by Stanujkic *et al*. (2017a) and is used for the determination of the weights of the criteria. Based on the research carried by Mahapatra and Goswami (2015), in this manuscript following criteria were determined, namely: Requirement analysis – C_1; Status of the development team – C_2; User's participation – C_3; and Project type and associated risk – C_4.

Step 1. Determination of weights of criteria

Responses and assigned weights of the evaluated criteria obtained from the three Decision Makers (DMs) by applying PIPRECIA method are shown in Table 1-3, whereas in Table 4 are shown group weights.

Table 1. *Weights of the criteria obtained from the first of the three DMs*

	Criteria	s_j	k_j	q_j	w_j
C_1	Requirement analysis		1	1	0.29
C_2	Status of the development team	0.85	1.15	0.87	0.25
C_3	User's participation	0.85	1.15	0.76	0.22
C_4	Project type and associated risk	1.1	0.9	0.84	0.24
				3.47	1.00

Source: Author's calculations

Table 2. *Weights of the criteria obtained from the second of the three DMs*

	Criteria	s_j	k_j	q_j	w_j
C_1	Requirement analysis		1	1	0.28
C_2	Status of the development team	0.89	1.11	0.90	0.26
C_3	User's participation	0.9	1.1	0.82	0.23
C_4	Project type and associated risk	0.98	1.02	0.80	0.23
				3.52	1.00

Source: Author's calculations

Table 3. *Weights of the criteria obtained from the third of the three DMs*

	Criteria	s_j	k_j	q_j	w_j
C_1	Requirement analysis		1	1	0.32
C_2	Status of the development team	0.7	1.3	0.77	0.24
C_3	User's participation	0.9	1.1	0.70	0.22
C_4	Project type and associated risk	1	1	0.70	0.22
				3.17	1.00

Source: Author's calculations

The group weights of the criteria based on the stances of the three DMs are shown in Table 4.

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

	Criteria	w_j^1	w_j^2	w_j^3	w_j^*	w_j
C_1	Requirement analysis	0.289	0.284	0.316	0.296	0.296
C_2	Status of the development team	0.251	0.256	0.243	0.250	0.250
C_3	User's participation	0.218	0.232	0.221	0.224	0.224
C_4	Project type and associated risk	0.242	0.228	0.221	0.230	0.230
					0.999	1.000

Source: Author's calculations

Step 2. Ranking of alternatives

Based on the ratings obtained from the three *DMs*, group ratings are calculated as follows:

$$x_{ij} = \left(\prod_{k=1}^{3} x_{ij}^{k} \right)^{1/3}, \tag{7}$$

The group ratings of the four evaluated alternatives obtained from the three DMs are shown in Table 5.

Table 5. *The initial decision-making matrix*

Criteria Alternatives	C_1	C_2	C_3	C_4
w_j	0.296	0.250	0.224	0.230
A_1	3.33	3.00	2.67	2.33
A_2	2.67	2.67	2.67	3.33
A_3	3.67	3.67	3.00	4.00
A_4	5.00	4.67	4.67	4.67

Source: Author's calculations

By applying Eq. (2), a normalized decision matrix has been formed. The normalized decision matrix, as well as the weights of the criteria are shown in Table 6.

Table 6. *The normalized decision matrix and the weight of the criteria*

Criteria Alternatives	C_1	C_2	C_3	C_4
w_j	0.296	0.250	0.224	0.230
A_1	0.67	0.60	0.53	0.47
A_2	0.53	0.53	0.53	0.67
A_3	0.73	0.73	0.60	0.80
A_4	1.00	0.93	0.93	0.93

Source: Author's calculations

The relative importance of the evaluated alternatives, based on weighted sum (WS) method and weighted product (WP) are shown in Table 7.

Table 7. *The relative and total importance of the alternatives*

	$Q_i^{(1)}$	$Q_i^{(2)}$	Q_i	**Rank**
A_1	0.29	0.07	0.36	**3**
A_2	0.28	0.07	0.35	**4**
A_3	0.36	0.09	0.45	**2**
A_4	0.48	0.12	0.60	**1**

Source: Author's calculations

Data from the Table 7 show us that alternative designated as A_4 has the highest total importance in terms of evaluated criteria.

CONCLUSION

The pace of change in the software development industry is still high. People continue to push the limits of known techniques and practices to develop the most efficient and effective software. Software development lifecycle models and business decision models contribute to controlling product development in different ways.

A particular software development model can significantly affect various software product-related issues. If the model fails to fully meet the requirements, it will certainly affect the end product. Often a major reason for the failure of software development is the lack of good methodology or the implementation of inadequate. Also, a common barrier to successful software development is the misunderstanding and failure to meet user requirements. Continuous communication with the client is implied in agile methodologies, and such

omissions are much harder to come by. Certainly, the ultimate goal, for both sides, is applicable software.

The proposed PIPRECIA-WASPAS approach has successfully responded to the requirements in terms of selection of the of software development methodology. The conducted case study has proved the applicability, ease of use and effectiveness of the proposed approach. Based on the conducted case study, alternative designated as A_4 has the highest total importance in terms of evaluated criteria. Therefore, SCRUM methodology is the most convenient by the stances of the DMs.

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BRANDING IN ORGANIZATIONS: PROMOTIONAL ACTIVITIES IN THE BRANDING PROCESS

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Abstract: Within the framework of this paper, branding will be presented from a theoretical standpoint and from the aspect of the conducted research study. The motivation for this type of analysis is certainly the undoubted significance of a brand the driver of the success of contemporary business doing, on the basis of which organizations are also separated from competition. The key goal of the research is to examine the interdependence of the practices of product and service branding with an assessment of the significance of individual factors. The research was conducted on a sample of 163 respondents from the organizations which the respondents are employed in. The assessments of the quality of the brand were cross-matched with the assessment of the significance of individual factors. The research results indicate the fact that the quality of the organizations' marketing activities significantly influences product/service branding, which depends on numerous factors from the environment.

Key words: brand, branding, consumer loyalty, brand promotion, factors influencing branding.
JEL: M37, M31

1. INTRODUCTION

A brand is nothing but a set of perceptions that are initiated by communication and an experience. A brand symbolizes what differentiates a certain product or company on the market. As highlighted by Kotler and Pfoertsch (2007), a brand signifies the quality of a product or service that satisfies consumers, and the building of a strong, recognizable, well-positioned brand on the market is one of the basic functions of marketing. Pursuant to that, not only does a brand place an accent on quality, but it also promotes identity and underlines the values of a unique culture through the transmission of the messages, products and services created by such a culture (Byrnes, 2009). The value of a brand for the consumer is significantly determined by the experience he has with a brand, including communication messages connected with the brand that he initiates not only

based on the attributes of the brand, but also on the basis of his total experience in the purchasing and brand use process (Veljković & Đorđević, 2010). All of that is indicative of the fact that it is not only sufficient for a brand to be built, but it also needs to be well-managed in order for it to survive in the market arena and keep on developing. The goal of brand management is to build the name of the product/service that will have a special long-term meaning in the consumer's awareness (Ognjanović, 2017, p. 242). Brand awareness plays a significant role on the occasion of buying a product or service, and it may have control over consumers' risk assessment and their safety in connection with a decision on buying (Malik *et al.*, 2013). So, successful brand management will reflect on consumer loyalty. Loyal consumers will keep coming back to their favorite brand and will be buying it again and again because they have recognized it. Recognition happens thanks to branding (Claessens, 2011, p. 106), and branding is a process by means of which companies differentiate their offer in relation to competition (Jobber & Fahy, 2006). The organization will benefit from it, i.e. business doing will be improved in the final instance. That is a strategic question and the goal is to create and increase the value of a brand both for the consumer and for the enterprise (Veljković, 2010). For that reason, marketing, brand management and branding can rightly be said to be of the key significance for companies' success in the future as well.

The basic goal of the research study presented in the paper is focused on the analysis and understanding of branding practices, as well as the factors that influence the branding of products or services from the organizations' point of view. The goal of the paper also relates to the examination of the quality of an organization's promotional activities, as well as the degree of the presence of the traditional versus electronic promotion of the brand of an organization. The paper can be useful for the interested professional and scientific public with the aim of improving business doing, as well as in the achievement of better financial results, all thanks to branding and brand management.

2. LITERATURE REVIEW

2.1. Notional and Conceptual Determinations

In marketing, a brand is a symbol representing a set of all information connected with a firm, product or service. A brand can also be defined as a promise made to the consumer, comprising a set of a product's features for the buyer, relevant for him to satisfy his needs (Armstrong & Kotler, 2014). The success of a brand primarily depends on what potential consumers and buyers think of it, not on what a marketing team think of it. Wood (2000, p. 662) considers a brand to be a set of all mental associations people have with stimuli from the environment. Brand awareness is the strength of the presence of a brand in the consumer's mind (Ross, 2006). It is not only sufficient to have the best and the most quality product, the most favorable price, a top-ranked promotion or the best distribution

network, but the most important thing is how much and what an average consumer in the street knows and thinks of a product. Then, the consumer practically tests the quality (Miletić *et al.,* 2017) of that product by his own choice, which has increasingly been present in the contemporary era. Simultaneously, a brand is the intangible asset of the company that has a certain value (Krstić *et al*., 2013, p. 14). A brand is considered to be a promise (Kotler & Pfoertsch (2006)), a guarantee or an agreement with the manufacturer and symbolically represents a quality mark (Varela *et al.,* 2010). In support of this thesis, Zehir *et al.* (2011) point out that full trust contributes to both purchase loyalty and loyal attitudes, i.e. the brands that are trusted are also bought more frequently, and buyers are more dedicated to them as well.

Competitive advantage in industrial products arises from the system of brand building and brand management in industrial enterprises (Babčanová *et al.*, 2012). Not all products, however, can be unified through models, systems, analyses, or categories (Akçura *et al.,* 2004). Evan apart from the fact that the literature on the brand is voluminous and that there are numerous research studies in this context, yet, according De Chernatory and Segal-Horn (2001), the brands of physically tangible products are dominantly studied, i.e. research studies related to the service brand are neglected. According to Berry (2000), the service brand represents an unconditional promise of the future satisfaction of the user. Services are differently treated and are less tangible, and differently from products, they are much more dependent on the persons providing them. So, Bobocea *et al.* (2016) highlight, for example, that the labor force qualification is significant when speaking about health services. A good example of a big influence of those providing services is also found in tourism. For that reason, too, tourist services and their branding are specific (Brzaković, A., & Brzaković, T., 2018). In support of that, when speaking about brand loyalty in tourism, Ivanova (2017, p. 208) points out the extreme price vulnerability, i.e. the fact that tourists will very easily renounce a brand and redirect themselves, for example, to another tourism agency with lower prices.

The value of a brand represents the value added that, said conditionally, is given to products and services as a gift (Kotler & Keller, 2006). In the literature, the value of a brand is approached from two standpoints: from the consumer's perspective and from the perspective of the company, i.e. organization. As the paper is focused on the latter concept, then we should certainly point out the fact that, amongst the key benefits an organization may have from the existence of th brand, the following benefits can be singled out (Filipović & Kostić-Stanković, 2007): a benefit from the price (which contributes to profitability); loyalty to the mark (which decreases a threat of price competition); growth (which leads to the development of new products, and barriers to the penetration of the competition (it is more difficult for competitors to increase their share in that market). For a long time now, products have ceased to only satisfy their functional value; they speak more about the companies that create them and the people who use them,

about their lifestyle, cultural characteristics, beliefs and values (Cvijanović *et al.*, 2018). Pursuant to that, we come to branding through the value of a brand. Branding is aimed at highlighting certain comparative advantages in relation to the competition that would make the end user to opt for that product or service, not the one similar to it (Khan & Mufti, 2007). Consumers' decisions in that respect are based either on their clear observation of differences between brands or on the influence of something that may only be important for them, which Keller (2013) calls the intangible image. Branding is extremely important for marketing strategies. The significance exactly arises from the fact that the brand influences the value of those products/services. A very illustrative explanation says that the majority of top-ranked managers do not observe symbols, brands, names… simply as sugar icing, but rather as the baker's yeast contributing to the rising of the cake (Kocić, 1998). In brand management, the identity construct has become popular. Many companies build and manage the identity ensuring that the brand identity expresses exactly a set of values, possibilities and sales propositions (Heding *et al.*, 2009, p. 48). A brand represents the recognition of values, i.e. the observation of the identity of a certain product (Olins, 2002; Lowery & Shrum, 2007).

2.2. Brandedness of Products/Services

Chronologically observed, in the domain of the brandedness of products/services, it is first needed to identify whether an organization brands its products or services or not. The success of (local and global) brands can depend on the characteristics of the product category (Farias, 2015). Apart from that, the product lifecycle can also be important. McKuiston (2004) suggests that, for industrial products, branding is a multidimensional concept which does not only include the manner in which buyers look at a physical product, but also the logistics, customer support, corporate image and policy accompanying that product. Apart from the already mentioned specificities of service branding, the specificity of branding in financial services (Keller, 2013, pp. 32-36), for example, or in services belonging to the telecommunications domain (Clark, 2009), can also be added at this point. In companies operating in these fields, a greater level of investing in branding and financial advertising are emphasized.
Kotler *et al.* (2014, p. 328) also categorize the logotype, i.e. the trademark, which create recognizability, into and among the drivers of the market value and initial identity of a brand (Grinsven & Das, 2016). The trademark is a legally protected mark or part of the mark of a product which is exclusively used by the concerned enterprise. Apart from the quality of a brand, the quality of the design of a trademark, which is the key element in building the user's perception of a brand according to Schmitt and Simonson (1997), is also very much significant. Organizations should pay attention to the esthetic design of a trademark, because it may increase dedication to a brand (Park *et al.*, 2013; Machado *et al.*, 2018).
Beside the determination of the existence of a brand and a trademark, as well as their quality, the next important question relates to the recognition of a brand

outside the borders of one country. The supposition that a brand will go beyond the domestic frameworks onto foreign markets implies the internationalization of business operations. One of the effects of such internationalization is a better status and image of a company (Aničić *et al.*, 2016). Also, where some product originates from may be significant at this point, i.e. the country of origin of some product is also important (Rabrenović, 2016). Based on the conducted research study, Šapić *et al.* (2018) came to a conclusion that it might be a very relevant criterion influencing consumer behavior and contributing to the creation of their loyalty.

2.3. Using Traditional and Electronic Brand Promotion in Organizations

Although necessary, the traditional integrated marketing communications concept is losing its significance due to changed conditions of business doing, in respect of both efficiency and effectiveness. This concept is materialized in the means and techniques of mass and direct communications. The appearance of new concepts is a result of the action of global trends and the aspiration of business entities to achieve, preserve or improve their competitive position and the position in the consumer's awareness (Matović *et al.*, 2015). With the challenges imposed by new media, change of the media and the divided attention of the consumer, an optimal integration of marketing communications is generated (Batra & Keller, 2016). Integrated marketing communications (IMC) are defined as a cross-functional process of the creation and cherishing of profitable relationships with clients and other stakeholders by means of strategic control. That process ensures that all forms of communication and messages are carefully interconnected (Sellahvarzi *et al.*, 2014). Integrated marketing communications can also be said to be the means the company uses to inform, persuade and remind consumers, either directly or indirectly, of the products and/or services they sell (Diaconu *et al.*, 2016), and also to be becoming the most visible and the most sensitive marketing tool (Duralia, 2018). It is very important that novel trends with respect to information technologies should also be transferred to the education system, particularly so the higher education system. Innovations in the technologies domain which are permanently conducted should also be applied in branding (Brzaković, T., & Brzaković, A., 2018). According to a research study by Krstić and Djurdjević (2017), it is very important for organizations to know how to use the media, i.e. select the right platform for the promotion of products/services and brand management. For example, *Youtube* has its own role in some products (such as: cosmetic preparations, culinary recipes, as well as the brands promoting a lifestyle). It is also needed to know that, although being extremely popular, *Facebook* is not sacrosanct when the implementation of a branding strategy is concerned.

Possible outcomes of the saturation with traditional media have made marketers redirect their means towards new and less burdened media. The Internet, which represents an interactive media very successfully used in marketing, is one such

media. Interactive marketing requires two-way communication. Differently from one-way communication, two-way communication implies activities by means of which a concrete seller directly addresses the target consumer so as to receive a measurable answer from him (Jevtić & Zelenović, 2015, p. 19). More than it has ever been the case before, Internet marketing facilitates the reception of those positive pieces of information. All that, however, can be sublimated so that, apart from lower costs, it also encompasses a series of other benefits, namely: an increase in brand recognizability, the improvement of brand loyalty, greater possibilities of attracting new clients, i.e. consumers, greater brand authorizations, an increase in the number of visitors on the company's website, a better insight into what people think of the brand and a series of other benefits. Those also include micro-targeting, which makes products closer to target groups through an interactive relationship.

2.4. Significance of Individual Factors for Branding

Given the fact that brands are ever-increasingly observed as the key points of differentiation and sustainable competitive advantages (Mudambi, 2002), then inevitably the importance of tradition in the business doing of an organization also imposes when branding is in question. A brand's previous reputation and the building of a greater value of the brand over time based on it (Cravens & Piercy, 2006) are also the significant factors that influence branding. However, as is noticed by Rahmani *et al.* (2012), in order for it not to be a short-term tool and in order for it to be characterized by goods and the brand, brand managers should apply it with long-term goals, because buyers recognize superficial activities of a low quality. Instead of offering sale promotion, managers should be investing in the development of the market value of a brand (Vukotić *et al.*, 2013). In that case, the fact that propaganda is a monologue before an audience, not a dialogue with them, should be minded (Kotler & Keler, 2006, p. 555).Apart from the name of a brand, slogans also represent efficient elements of branding (Lowery & Shrum, 2007). Claessens (2011, p. 106) points out the fact that a brand connects, associates with a logo and typical brand colors and slogans. In recent years, there has been an intensified interest in understanding the mutual influence of consumers and the culture of a brand (McCracken, 2009). As Dević *et al.* (2014, p. 228) point out, for example, there are certain authors who, based on research studies carried out, state the fact that cultural and linguistic differences between states at a global level require an acceptable standardization or a thorough adaptation of the names of corporate or manufacturing brands on international markets.

Thus, for example, according to a study carried out by Flint *et al.* (2016), managers in the field are the most important when the regional positioning of brands is in question. However, it is not only managers who are important in the branding process, but all employees are also important. When employees believe in the brand, then they are also loyal to the organization creating that particular

brand. Special significance in branding may also be attributed to internal communication, which should be efficient and energetic (Bendapudi, N., & Bendapudi, V., 2005).

3. RESEARCH RESULTS

3.1. Description of the Sample and the Distribution of the Organizations

The primary research study was conducted based on the survey questionnaire on a sample of 163 respondents from the organizations in which the respondents are employed in Serbia. The examination was carried out through the in-person distribution of the questionnaires in Belgrade and by sending them via email. The research study was done in the period of three months (April, May, and June) in 2018. The survey questionnaire consists of several groups of questions. In the distribution of the organizations in relation to the activity performed, the dominant one is the service activity (about 60%) in comparison with the manufacturing (about 20%) and the mixed (about 20%) ones. Given the significance of the activity as the basic factor predetermining the business operations of the organization, the other characteristics of the organizations are analyzed in relation to the activity of the organization.The distribution of the organizations according to the number of the employees in the sample shows somewhat more significant share of the organizations with a larger number of the employees (over 50), but the distribution of the sample is generally balanced in relation to this characteristic and stable in relation to the activity performed by the enterprise. Observed as per the length of the time period of the business operations of the organization, the dominant ones are those operating in a period shorter than 25 years, particularly so in the organizations performing the mixed activity. A distribution like this is expected bearing in mind the fact that the majority of the organizations in private ownership started doing business after the social-political changes of the late 1980s, as opposed to the school institutions and public enterprises, which prevail in the structure of the organizations operating in a period longer than 25 years.

When the distribution of the organizations according to the geographical span of their respective business operations, it is possible to notice a greater share of the organizations operating at both the international and the regional levels in the structure of the organizations of manufacturing activities in relation to the service ones, in which the local and national levels dominate. A distribution like this is also expected given the fact that manufacturing organizations are export-oriented, whereas service organizations, which, for example, also include schools, prevailingly operate at the local or the national level.

3.2. Brandedness of the Organization's Products/Services

The attitudes the respondents expressed towards the brandedness of the organization they work in are included in the next group of the questions: Your organization has branded products/services? Your organization's products/services have a certain trademark? The quality of your organization's brand? The quality of the design of the trademark of your products/services? The recognizability of your products/services beyond the borders of your country?

The modalities of the answer(s) to the first two questions are of a nominal character (Yes, No, or I don't know), whereas the modalities of the answer(s) to the other questions are of ordinal nature (from 1, for the lowest grade, to 5, for the highest grade). Because of that, in the case of the first two questions, the distribution of the organizations is presented in relation to the observed characteristic, whereas in the other cases, the average is presented as the measure of the central tendency of the value of the observed characteristic. The results of the research study have shown that the organizations included in the sample brand their products, i.e. they use a certain trademark for the visual distinction of their products. More than a half of the observed organizations in the sample brand their products or services. Observed as per the activity, it is possible to note that, in the service activity, the share of the organizations not branding their products/services is somewhat greater in relation to the manufacturing and mixed activities. On the other hand, using a trademark is generally more present and present in a balanced way between the organizations of different activities. The starting assumption in this research question was that the quality of promotional activities influences the branding of products/services. Table 1 shows the average grades for the quality of the organization's brand. The grades for the quality of the brand and the quality of the design are high, whereas international recognizability is somewhat more poorly graded, but still above the median of the measurement scale (the measurement scale 1-5, the median 3). Observed as per activities, it is possible to notice that the mixed-activity organizations have on average the highest, and the service ones the lowest grades for the quality of the brand. This difference is particularly pronounced in international recognizability, which is in accordance with the established fact that service organizations are for a larger part oriented towards domestic and local business doing. Based on these findings, it can be pointed out that the differences in the organizations' characteristics significantly influence the difference in the branding and quality of the brand of products/services.

Table 1. *The average grade for the quality of the brand*

	Manufacturing and service activities	Manufacturing activity	Service activity
The quality of your organization's brand	4.2258	3.7667	3.6947
The quality of the design of the trademark of your products/services	3.9032	4.1071	3.6737
The recognizability of your products/services beyond the borders of our country	3.7742	3.6207	3.1064
Total	3.968	3.832	3.492

Source: Authors' calculation

3.3. Traditional and Electronic Brand Promotion and Its Use in Organizations

The next research question relying on the prior is the intensification of the significance of the electronic way of promoting the organization's brand. In fact, that was the starting premise in the examination of the degree of the presence of the traditional versus electronic branding of the organizations. The respondents' attitudes towards the contemporary promotional activities of the organizations where they are employed are encompassed by the next group of the questions: In your organization, promotional movies are occasionally and/or regularly uploaded to *YouTube* with the aim of promoting the brand; Your organization applies some form of mobile marketing (mobile applications, SMS marketing) in order to promote the brand; Your organization occasionally and/or regularly advertises on the Internet and in other media, thus promoting its brand. Brand promotion via promotional movies and through mobile marketing is moderately present. Only slightly more than a half of the organizations practice promotion via movies, whereas promotion through mobile marketing is even practiced by less than a half of the surveyed organizations. Observed as per the activity, promotion via movies is but slightly less present in the service organizations, whereas promotion through mobile marketing is balanced.

In relation to promotional movies and mobile marketing, brand promotion via the Internet and in other media is significantly more present – about 70% of the organizations in the sample practice this promotion system. A correlation of forces like this between movies and mobile marketing is expected given the fact that making movies or developing mobile applications is a more complex type of promotion, pursuant to which fact the same requires higher implementation costs as well.It is interesting to establish a fact that, differently from the previous analyzed characteristics, where the manufacturing organizations mainly demonstrated more frequent promotion and the higher grades for the quality of the brand, advertising on the Internet and in other media is more frequently present in the service organizations. The use of traditional and digital marketing activities in brand promotion is graded on the basis of a choice between these

two forms. Table 2 presents a comparison of the average grades for these two very important characteristics. It can be noticed that there are differences in the grades, observed as per the activity, between the service, manufacturing and mixed organizations. The mixed-activity organizations have the highest grades on average, whereas the manufacturing-activity organizations have the lowest grades. Also, the traditional marketing activities record higher grades for all the three groups of the organizations, which implies that the organizations included in the sample still give greater significance to traditional marketing activities.

Table 2. *The descriptive statistics of the marketing activities: traditional vs. online*

	Manufacturing and service activity	**Manufacturing activity**	**Service activity**
The level of the traditional marketing activities in your organization in respect of brand promotion (TV, radio, flyer-based promotion, billboards etc.	3.8065	2.8966	3.2447
The level of *online* promotion in your organization in respect of brand promotion (*Facebook, Web* site, *Twitter* etc.)	3.72	2.56	2.9136
Total	3.76325	2.7283	3.07915

Source: Authors' calculation

3.4. Significance of the Individual Factors for Branding

The central research question relates to whether products/services branding depends on numerous factors or not. In order to perceive it in an easier way, a framework division into internal and external factors was made so as to enable the generalization of the conclusions. Differently from the previous groups of the questions that measured the practices of branding and the promotional activities practiced by the organizations in the sample, the last group of the questions is aimed at the examination of the attitudes towards the individual significance of the factors in the branding process in a general sense. The respondents were rating the significance of each one of the 20 offered factors (Table 3) on a scale from 1 (insignificant) to 5 (quite significant).

Table 3. *The individual grades for the significance of the factors for branding*

	Manufacturing and service activity	**Manufacturing activity**	**Service activity**
The length of the operation of the organization	**4.4839**	**4.2667**	**4.3723**
Prior reputation	**4.2667**	**4.3333**	**4.3548**
Traditional marketing (TV, radio, flyer-based promotion, billboards, etc.)	*3.871*	*3.6207*	*3.6774*
Online marketing (Facebook, web site, Twitter etc.)	*4.1667*	*3.4483*	*3.5806*
A good trademark (logo)	4.3333	4.2069	4.1383
The colors used	4.2258	4.0333	3.8723

The dissimilarity of the trademark in relation to the competition	4.2581	4.2	4.0538
A good name	**4.4516**	**4.4**	**4.4105**
A good promotional slogan	4.0968	4.1333	3.8696
The country of origin of a product/service	4.2903	4.1379	3.5319
The quality of a product/service	**4.3667**	**4.3333**	**4.3043**
The organization's business culture	4.0323	4.2	4.2043
Consumer sophistication	4.0667	4.1	3.734
The price for the product	4.0667	4.1786	3.9787
The level of competence of the employees to adequately promote the brand	4.0667	4.2667	3.9263
The support of the state/local self-governments in brand promotion	*3.7667*	*3.3793*	*3.2903*
The competition and its activities	*4*	*3.6667*	*3.6737*
Who buyers and users are	4.2333	4.2143	3.9247
The economic branch of the operation of the organization	4.1613	4.1034	3.9457
The organization's sociocultural environment	3.9677	4	3.8043
The average	4.1586	4.0611	3.932

Source: Authors' calculation

All the factors are, on average, rated above the value of the median, which implies that the respondents consider each one of these factors to be significant or quite significant for branding. Among the factors, those connected with the very characteristics of the organization (the length of the operation, reputation, a good name, the quality of the product) are prominent (**bold**) with respect to their significance, whereas the least significant (*italic*) are those of external nature (the support of the state, the activities carried out by the competition), as well as the marketing channels, which are among the factors that have received the lowest grades. It has already been pointed out that the organizations included in the sample still attribute greater significance to the traditional marketing activities, irrespective of the fact that there is an ever-increasing significance of digital marketing in world proportions. The significance of the individual factors is mainly rated in a balanced way, when observed in relation to the activity of the organization, which reflects through the balance of the average grades. It is also interesting to mention the fact that the mixed-activity organizations systematically attribute somewhat greater significance to the aforementioned factors that are generally given the lowest grades for significance.

The first step was the analysis of the respondents' attitudes towards the general significance of certain factors and their influence on branding. The descriptive analysis has already indicated that the average values of the grade for significance are greater than the median. In the second step, the significance of the factors for branding was analyzed so as to reduce them from the level of the general attitudes to the level of significance in the context of the branding of the very organizations where the respondents are employed. Given the fact that the previous analysis indicated that the respondents considered each one of the

offered factors to be significant to a certain extent, the analysis was expected to indicate the existence of a positive correlation. The following three characteristics were selected as the key dependent variables describing the quality of the brand at the level of the organization: The quality of your organization's brand; The quality of the design of the trademark of your products/services; The recognizability of your products/services beyond the borders of our country.

The results of the correlation analysis based on the *Spearman* coefficients are presented in Table 4. In this case, too, only the subsample of the organizations providing services was used.

Table 4. *Spearman correlation coefficient*

		The quality of your organization's brand	**The quality of the design of the trademark of your products/services**	**The recognizability of your products/services beyond the borders of our country**	**Total signif. correl.**
The length of the operation of the organization	Correlation Coefficient	.245**	.186*	.187*	3
	Sig. (2-tailed)	0.002	0.021	0.021	
	N	155	153	153	
Prior reputation	Correlation Coefficient	.257**	.305**	.169*	3
	Sig. (2-tailed)	0.001	0	0.037	
	N	154	152	153	
Traditional marketing (TV, radio, flyer-based promotion, billboards, etc.)	Correlation Coefficient	.423**	.492**	.333**	3
	Sig. (2-tailed)	0	0	0	
	N	154	153	153	
Online marketing (Facebook, web site, Twitter etc.)	Correlation Coefficient	.430**	.410**	.260**	3
	Sig. (2-tailed)	0	0	0.001	
	N	153	152	153	
A good trademark (logo)	Correlation Coefficient	.473**	.575**	.375**	3
	Sig. (2-tailed)	0	0	0	
	N	154	153	153	
The colors used	Correlation Coefficient	.468**	.669**	.341**	3
	Sig. (2-tailed)	0	0	0	
	N	156	154	154	
The dissimilarity of the trademark in relation to the	Correlation Coefficient	.459**	.613**	.304**	3
	Sig. (2-tailed)	0	0	0	

competition	N	154	152	152	
A good name	Correlation Coefficient	.374**	.515**	.271**	3
	Sig. (2-tailed)	0	0	0.001	
	N	156	154	154	
A good promotional slogan	Correlation Coefficient	.470**	.606**	.360**	3
	Sig. (2-tailed)	0	0	0	
	N	154	152	152	
The country of origin of a product/service	Correlation Coefficient	.412**	.571**	.379**	3
	Sig. (2-tailed)	0	0	0	
	N	154	153	153	
The quality of a product/service	Correlation Coefficient	.468**	.489**	.255**	3
	Sig. (2-tailed)	0	0	0.002	
	N	151	149	149	
The organization's business culture	Correlation Coefficient	.366**	.449**	.233**	3
	Sig. (2-tailed)	0	0	0.004	
	N	154	152	152	
Consumer sophistication	Correlation Coefficient	.435**	.538**	.375**	3
	Sig. (2-tailed)	0	0	0	
	N	155	153	153	
The price for the product	Correlation Coefficient	.402**	.406**	.225**	3
	Sig. (2-tailed)	0	0	0.006	
	N	152	150	150	
The level of competence of the employees to adequately promote the brand	Correlation Coefficient	.485**	.480**	.361**	3
	Sig. (2-tailed)	0	0	0	
	N	155	153	153	
The support of the state/local self-governments in brand promotion	Correlation Coefficient	.304**	.270**	.269**	2
	Sig. (2-tailed)	0	0.001	0.001	
	N	152	150	150	
The competition and its activities	Correlation Coefficient	.407**	.434**	.310**	3
	Sig. (2-tailed)	0	0	0	
	N	155	153	153	
Who buyers and users are	Correlation Coefficient	.441**	.452**	.289**	3

	Sig. (2-tailed)	0	0	0	
	N	151	149	149	
The economic branch of the operation of the organization	Correlation Coefficient	.409**	.485**	.334**	3
	Sig. (2-tailed)	0	0	0	
	N	153	151	151	
The organization's sociocultural environment	Correlation Coefficient	.340**	.425**	.285**	3
	Sig. (2-tailed)	0	0	0	
	N	151	149	149	
Total significant correlations		20	20	20	

Note: ** 0.01 significance, *0.05 significance

Source: Authors' calculation

In Table 4, the grades for the brand of the organization in the columns are cross-matched with the grade for the significance of the individual factors; so, three fields: the value of the correlation coefficient, the p-value, and the number of the observations are shown for each combination of the cross-matching. At the end of the right-hand side and at the bottom of the Table, the number of the correlation coefficients for which statistical significance has been confirmed are summed up. The analysis of the correlation coefficients indicates that all of the 60 correlation coefficients are statistically significant, and the absolute majority are significant at the level of 1%. Generally observed, the largest number of the correlations are statistically significant. Observed as per the value of the correlation coefficients, it is noticeable that the correlation is more pronounced between the significance factors and the quality of the brand, or the quality of the trademark. Irrespective of the slightly lower values of the correlations between the factors and international recognizability, however, they are all statistically significant. Taking into consideration all those results of the analysis, it can be concluded that there is the significance of the numerous factors that influence the branding of products/services.

CONCLUSION

Based on the results obtained, it can be pointed out that the fact that more than a half of the observed organizations in the sample brand their products or services is very encouraging. Observed as per the activity, the share of the organizations not branding their services is slightly bigger in the service activity in relation to the manufacturing and mixed activities. Apart from the fact that the specificities of service branding are pointed out and partly explained, this could be the subject matter of a new and additional research study with the aim of finding out the cause for the fact that branding in service organizations is not present to a greater extent.

On the other hand, using a trademark is generally more present and present in a balanced way among the organizations of different activities. Also, observed from the activity aspect, it is noticeable that the mixed-activity organizations have on average the highest grades for the quality of the brand, whereas the service ones are attributed the lowest grades in that respect. This difference is particularly pronounced in international recognizability, which is in accordance with the established fact that service organizations are, for a larger part, oriented towards domestic and local business doing. Bearing this very fact in mind, we can apostrophize that differences in the characteristics of organizations significantly influence the differences in the branding and the quality of the brand of products/services.

Also, based on the research study, a fact can be established that, differently from the previously analyzed characteristics, where the manufacturing organizations mainly demonstrated more frequent promotion and received the higher grades for the quality of the brand, advertising on the Internet and in other media is more frequently present in the service organizations. With respect to the choice between traditional and electronic marketing, the organizations included in the sample still ascribe more significance to traditional marketing activities, irrespective of the fact that there is an ever-increasing significance of digital marketing in world proportions. This could be the subject matter of a new analysis of what the cause for the branding practices like these is.

In connection with the research results related to the significance of the individual factors for branding, those related to the vey characteristics of the organization (the length of the operation, reputation, a good name, the quality of a product) can be singled out amongst the most important ones, whereas the least significant are those of external nature (the support of the state, the activities carried out by the competition), as well as the marketing channels, which are also amongst the factors rated the lowest. That branding enabled by the Internet is insufficiently valued has been confirmed. All the factors that are less significant could certainly be additionally analyzed in order to discover the reasons for their lesser importance. At the same time, all the recommendations for further research studies can also represent the limitations of this research study. Should the size of the sample be the assumption for its width, then a greater depth of the analysis that might be achieved in the future also imposes as a new research task, beside the need for a wider, greater sample.

Finally, the correlation between the quality of the brand, the quality of the design of the trademark and recognizability beyond the borders, on the one hand, and the significance of the individual factors (a total of 20 such factors), on the other, was being researched. The correlation is more pronounced between the significance individual factors and the quality of the brand, or the quality of the trademark, with somewhat lower values of the correlation between those factors

and international recognizability. The complete results of the analysis show that there is significance pertaining to the numerous factors that influence products/services branding. Based on all of the foregoing, it can be concluded that product/service branding depends on numerous factors, as well as the internal and external environment of the business organization.

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CAS APPROACH AND DEVELOPMENT OF INNOVATIVE ECOSYSTEMS IN SERBIA

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Abstract: While traditional approach looks at the innovation as "complicated" system with predictable interactions and tendency to equilibrium state, we support the new approach to innovations as "complex" system with unpredictable interactions and potential for disequilibrium. Aiming to improve Serbian innovative capacity, we propose a complex adaptive systems approach to development of innovative ecosystem as opposed to traditional institutional approach. Further, we propose the modification of employment contracts, enabling the innovative employee to participate in innovation related benefits, in line with the Incomplete Contract Theory. The strategy is to facilitate regular and repetitive stakeholder meetings based on few principles: self-organization vs. hierarchy, bottom-up vs top-down initiatives and agile approach. The underlying idea is that stakeholders need a facilitator and key challenge is to achieve facilitator's neutrality. Finally, the outcome is a smart innovative ecosystem – cost effective and self-sustainable solution to facilitate iterative process of stakeholder interactions.

Keywords: innovation, research, innovative ecosystem, Serbia.
JEL: O31, O32, O33, O38

1. INTRODUCTION

In order to address the inadequate domestic institutional support capacity and regulatory framework to support innovative initiatives and companies in Serbia, we propose the new approach and objective of this paper is to describe our approach emphasizing three points: (1) Objective - what we propose to do? Introduce a complex adaptive systems (CAS) approach to development of complex innovative ecosystem as opposed to traditional institutional approach; (2) Outcome and strategy - what we expect to achieve and how? Find a cost effective and self-sustainable solution to facilitate iterative process of stakeholder interactions, understanding that participant interests keep changing and that we need to recognize Serbian specificities in terms of culture and social context of economic migrations; (3) Framework - what is the framework that we propose? Proposed framework is based on the assumption that key success factor

is the ability to facilitate the interactions of participants, understand and process system inputs (stakeholder interests, legal framework, government incentives) and provide contextual understanding of inputs and participant reactions.

Participating stakeholders need a facilitator and key challenge is to achieve facilitator's neutrality. The Government of Serbia (GoS) must be included, but facilitator(s) should be politically independent from the GoS, like the Central Bank Governor and Head of Fiscal Council; facilitation should be in a spirit of moving responsibilities from the GoS towards enterprises.

2. THE COMPLEX ADAPTIVE SYSTEMS (CAS) APPROACH

2.1. Standard approach vs. new approach

We believe that traditional approach and conventional logic based on the assumption that mixing the right ingredients (stakeholders) will produce desired effects (innovations) are linear and simplistic and do not work well or at in the context of systems that are fundamentally complex, such as innovations. Further, unstoppable economic migrations of young educated people from Serbia into the developed countries of the European Union bring additional level of uncertainty. Maksimović & Stamatović (2018) confirm that "migrations are constant" (p.546). Jovičić & Stamatović (2018) argue that "government of any European country where salaries are lower compared to nearby countries cannot stop the economic migration. Serbian employees will migrate from Serbia searching for a higher salary". Consequently, the Serbian labour market is complex. One cannot estimate future workforce based on the number of students expected to graduate because 90% of them could emigrate. Finally, monitoring of non-complex system is based on the ability to define an ideal future state of the system and measure discrepancies between current and desired status in order to propose corrective measures. Balance scorecard is a good example of monitoring technique that is suitable for non-complex, but cannot be applied to complex systems. One may easily define scorecard targets for indicators of profit, GDP and employment where logic is – the more, the better. The same holds for student grading on any educational level. Target is the maximal value/grade and more is better. Key issue with monitoring the complex systems is that targets are not applicable.

On the other side, complexity theory does not assume ideal state and is mainly focused on set of iterative and repetitive actions aiming to assess the present and check what can be changed. While traditional approach looks at the innovation as "complicated" system with predictable interactions and tendency to equilibrium state, we believe that new approach to innovations as "complex" system with unpredictable interactions and potential for disequilibrium is more appropriate.

Key differences in strategy and management themes between complicated and complex systems are summarized by Bate (2015) in Table 1 (p.52).

Table 2. *Complicated vs. Complex (Strategy and Management Themes)*

Leadership focused on COMPLICATED	#	**Leadership focused on COMPLEX**
STRATEGY Theme (where to play and how to win)		
Allocated resources to deliver a solution.	1	Allocated resources to answer a question.
"Best practices" based on what has worked.	2	Next practices based on what could work better.
Grand designs.	3	Emergence.
Inspiration from the specific.	4	Inspiration from the abstract/ patterns.
Learnt behavior.	5	Learn, unlearn, and learn.
Playing and winning the game.	6	Changing the game.
Primary perspective on the parts.	7	Primary perspective on the whole.
The business as a machine.	8	Human and behavioral factors.
MANAGEMENT Theme		
Assuring an outcome.	9	Sensing feedback from actions.
As-is and to-be plans.	10	Vision, "next state" plans and agile execution.
Rules and determinism.	11	Simple checklist/guiding principles.
Command and control.	12	Influence, enable and empower.
Consequence of decision.	13	Consequence of the sum of decisions.
Internally focused first.	14	Externally focused first.
Promoting stability and predictability.	15	Promoting agility and adaptability.
Working with known data.	16	Seeking out new data.

Source: Bate (2015).

In other words, building a new house is complicated, but once you build the first - one can use the same logic for all of them. On the other side, motivation of a company to engage with the startup is complex, as each combination is a new game, and one success does not guarantee that same logic will be successful in the future.

2.2. Incomplete contacts

Hart & Moore (1998) argue that complex legal issues related to intellectual property rights need to be treated on case by case basis – which requires repetitive interactions and negotiations. This article led to Hart being awarded

the 2016 Nobel Prize in Economics for his work on the Incomplete Contracts Theory. From one side, company and employees have opposite interests when it comes to innovations, as benefit should be split into two participants – company and employees. The more benefits one participant grabs for himself, the less remains to the other participant. From the other side, most of mainstream theories and corporate practices look at this relationship as a partnership, taking the oversimplified and romantic approach to the topic.

The romantic character of this approach may be illustrated by the common practice of intracompany competitions where employees propose and demonstrate innovative ideas while best teams get the symbolic awards. Company spins the reality by promoting the innovative spirit among employees, hoping that employees will eventually feel rewarded if their team performs well, leading to unexpected consequences – employee should be satisfied by the fact that company will take all benefits from his/her idea. The irony lies in the fact that some employees actually accept this evidently unfair game. If an employee proposes a feasible idea and his team presentation ends up winning one of first three places on the intracompany innovative competition, the employees (members of best three teams) are rewarded by the intellectual recognition that is proportional to the loss of benefits. The members of the best team get the most intellectual satisfaction by being recognized as the best team within the company, while they effectively suffer the maximum loss of benefits they could potentially get if they (alone or with the help of venture capital) launched the startup based on the awarded idea/innovation.

The hypocrisy of this approach originates from the contract itself. Most of contracts take all the innovation related benefits from the employee and transfer all 100% to the company. The legal justification is simple and stipulated in a single line stating that employees are rewarded by the salary, while company holds the intellectual property rights on products and processes. One does not need to be the legal expert to see the obvious fact that contract which takes all (100%) benefits from one side (employee) and transfers them all (100%) to the other side (company) does not represent a partnership (contrary to dominant approach in the scientific literature). The company strategy is based on the force and standard legal practice – in order to start working, employee must firstly sign the work contract with the company, which provides the legal basis for the company to "grab" all innovation related benefits from the employee and transfers them to the company. The employee strategy is based on the need to be recognized by colleagues. Employees really do want/need the recognition for their performance and are genuinely proud to be ranked among top three in the intracompany innovative competitions. It is evident that specific kind of happiness due to performance recognition within the company really exists and that it is fairly strong.

The key issue with the corporate policy related to internal innovations is the inability of the company (mainly the legal experts in company law and labour law which define the rights and obligations in the employee contracts) to see that modern employee contracts do not promote the innovative spirit among employees. The implication of the Hart & Moore (1998) theory of incomplete contracts to the intracompany innovation policy is that unfair contracts will have negative effect i.e. decrease the interest of employees to create breakthrough innovations. Hart looks at the relationship between two contractual counterparties from various perspectives, such as financial compensation, participation in the profit, allocation of the control rights, ownership and management, and investigates the causes for potential conflicts. The incomplete contract theory introduces two new notions - incomplete contract and residual control rights aiming to explain the source causes for the conflict of contractual parties. One of consequences of the incomplete contract is a decrease in the interest for innovations. Solution would be to create a new better contract or amend the existing incomplete contract. In this context, the application of the incomplete contract theory to the labour law should lead to the modification of standard employee contracts, enabling the innovative employee to participate in innovation related benefits. To put it simple – he/she should not work only for the salary.

2.3. Issues with standard approach

Standard approach is a corporate driven method of cooperation between corporations and startups where key vehicle is an incubator – corporations select and help startups by financing in-house incubators and accelerators for several years. The conventional corporate incubator model has failed to produce expected outcomes. According to Nesta (2018), “many companies, such as Qantas, Intel, Qualcomm and Citrix, to name a few, have abandoned or downsized their accelerator programs, or else shifted to third-party managed accelerators” (p.18). According to Arthur D. Little & MMV (2019), “only 31% of corporates considered their collaboration activities successful”. According to Eagar *et al*. (2019), “the main causes of failure are: (a) lack of major impact on growth, (b) misaligned or unclear objectives, (c) long times required to scale up, (d) inadequate resourcing, (e) lack of a systematic approach, (f) cultural mismatch and (g) lack of a home” (p.41).

Lack of major impact on growth: The paradox originates from the disproportion between the size of the multinational company’s business and incubators/startup business. From one side, global company operations are on the scale of USD billions. From the other side, incubator/startup operations operate on the scale of USD millions. Even if incubator/startup brings the expected profit, this will represent a tiny contribution to global company’s results. For that reason, the top management of global companies in inherently not motivated to devote enough time to incubators, regardless of them being profitable and innovative.

Misaligned or unclear objectives: The paradox originates from the global trend to copy/paste solutions applied by relevant peers including the top competitors. This strategy of copying the competitor may work in a complicated but does not work in a complex environment. For example, the fact that one incubator/startup has produced desired outcome for one pharmaceutical company in Serbia, cannot easily be copied by competitors i.e. some other pharmaceutical company. Successful creation of a new medicine for blood disease does not guarantee the competitors to reach the similar success with the new medicine for bones. Consequently, if a global company launches a new incubator/startup project just to copy the competitors without the "clear strategic rationale", this effort is likely to fail. On top of it, those copy/paste initiatives are linked with the lack of interest for the incubator by the top management. This is caused by the fact that rationale for such an incubator is often not clearly defined. Consequently, top management is not in the position to align company objectives to unclearly defined incubator/startup objectives. This misalignment decreases the chance of success.

Long times required to scale up: The paradox originates from the disproportion between the time perspective favorited by the multinational company's top management and time required by an incubators/startup to achieve the scale. From one side, top management of the global company is focused on short-term goals defined and measured in one to two years. From the other side, the incubators time to scale-up is measured in terms of 4-5 years. Consequently, top management often prematurely cancels incubator/startup projects (after one to two years), not letting them the chance to organically grow and scale-up. The shareholders' interests overweight the incubator's interests. Such environment naturally leads to inherent premature canceling of the project i.e. to the closing of incubators/startups.

Inadequate resourcing: The paradox originates from the disproportion between the funding assumptions assumed by the multinational company's top management and funding required by an incubators/startup to achieve the scale-up and commercialization. From one side, top management of the global company looks at the funding of incubators as a bullet investment that should be mainly focused on the initial phase "scout, screen and validate potential start-ups". From the other side, incubators/startups need additional funding throughout the innovation lifecycle especially "at the scale-up and commercialization stages, when start-ups themselves often lack the right capabilities and experience". Consequently, the startups experience lack of funding from the internal resources i.e. corporates as a significant stopper to the success of the project in later stages. Apparently, corporates top management is less experienced in the management of startups compared to venture capitalists, which is understandable taking into account the difference between global

company – which uses established mechanisms in the scale-up phase, and a startup – which does not have established channels and thus requires significant additional funding.

Lack of a systematic approach: The paradox originates from the disproportion between the management approach of multinational company's top management and management approach required by an incubators/startup to achieve the scale-up and commercialization. From one side, top management of the global company looks at the management of incubators as a new business that consists of multiple and different products, without the systematic approach. This unsystematic approach is based on the correct assumption that various startups are essentially and fundamentally different in their nature. From the other side, incubators/startups do need a systematic/unified approach to management of some specific phases, especially those that "ensure early de-risking and fast-enough speed to scale". Consequently, the startups experience the lack of systematic approach in critical phases of a product scale-up.

Cultural mismatch: The paradox originates from the disproportion between one/more areas of culture assumed by the multinational company's top management and culture required by an incubators/startup to achieve the scale-up and commercialization. From one side, top management of the global company is risk averse and focused on process oriented established businesses. From the other side, incubators/startups by default represent the risky business, very likely to fail. Consequently, the company top management inherently looks at the incubators as potential loss i.e. threat and this attitude creates a barrier to the development of incubators.

Lack of a home: The paradox originates from the disproportion between interests of managers of the existing products and managers of new products created in by incubators/startups. From one side, top management of the global company looks at the existing products/brands as a proven revenue source. Further, they look at the new brands as a "risk that could cannibalize existing business". From the other side, new products/brands created by incubators/startups need to be "absorbed into the business" and this appears to be the key issue in real life. Top managers tend to favorite existing profitable products and hesitate to give an opportunity to the new product, fearing from the failure of new business. The managers of new product are usually not powerful enough compared to the managers of existing products. Consequently, the interest of existing products will prevail, and this lack of home i.e. lack of established and powerful top manager behind the new product represents a barrier for further development of products created by incubators.

2.4. Strategy for the new approach

New approach aims to compensate for the identified issues with the standard approach – where corporations finance the incubators/startups. Before we propose the solution i.e. define the new approach, we need to emphasize the dynamic nature of temporary solutions for each single startup. Aiming to take into the account the changes in global and local environment which affect the position of participants in the innovative ecosystem, we need to setup the rules on how, where and how often those participants i.e. stakeholders are supposed to meet in order to re-negotiate the terms of the cooperation. Ecosystem needs a facilitator - not a boss/regulator. We need to build a framework for most productive interaction of stakeholders based on following key principles: (a) self-organization vs. hierarchy, (b) bottom-up vs top-down initiatives, (c) agile approach, and (d) include all stakeholders.

Self-organization vs. hierarchy: Instead of focusing on right ingredients, the focus should be on stimulating the non-hierarchical relations and interactions without the central control, as opposed to traditional hierarchical approach. In this area, we see the key role of international development agencies: United States Agency for International Development (USAID), Swiss Agency for Development and Cooperation (SDC), Italian Agency for Development Cooperation (ICE) and French Agency for Development (AFD) in helping the GoS to decide how to facilitate the self-organization of stakeholders in the innovative ecosystem and subsequent emergence of complex system of multiple interactions. We assume that development agencies do have a practical experience with recent solutions introduced in comparable countries. The logical step would be to use this knowledge.

Bottom-up vs top-down initiatives: Responses to environment are derived from spontaneous combination of top-down and bottom-up initiatives as opposed to traditional top-down approach to development of innovation systems and opposed to Serbian cultural environment where traditional approach is dominant, except for the IT sector. According to Jucevičus & Grumadaite (2015), "The concept of smart development takes into account the complex dynamic nature of the system and is based on promoting the productive self-organization rather than imposing the top-bottom linear solutions" (p.126).

Agile approach: According to Beaumont *et al*. (2017), "study on breakthrough innovation revealed that leading companies expect their share of revenue from breakthrough, as opposed to incremental innovation to double over the next five years" (p.26). We see that most organizations struggle to deliver breakthrough innovations systematically because they are late in introducing "agile" approaches as opposed to standard engineer "waterfall" methods of project management. According to Beaumont *et al*. (2017), "research reveals that companies that have successfully added agile methods to their toolboxes, and

tailor their innovation approaches by the type of innovation, perform significantly better than those that stick to a single, waterfall approach" (p.27).

Software industry is an exception. One needs to look at how non-software product-based companies can apply "agile", as well as "non-agile", methods in a complementary way. We see two areas where "agile" may be applied: to manage iterative interactions of system participants and to manage product/innovation development in all stages - not just in the initial one. Fortunately, "agile" is heavily used in international IT companies that have development centers in Belgrade/Serbia and it would make sense to use this knowledge to develop the agile framework for participant interactions. For example, Fidelity National Information Services Inc. (FIS) with 400 employees in Belgrade and 52,000 worldwide recognizes the value of "agile". It would be wise and cost effective to use local FIS expertize in the application of the agile methodology in the IT industry.

Include all stakeholders: According to Kolk *et al*. (2017), "there is growing evidence that breakthrough innovations are more likely when less obvious partners get together: even five years ago, who would have thought that Wells Fargo, a bank, would be developing new loan facilities to students together with Amazon, which was originally an e-commerce company" (p.12). All stakeholders are welcome and required to participate in the process of iterative negotiations. Stakeholder roles remain the same as in the traditional approach to innovative ecosystems. To use an analogy: ingredients are same - how we mix them is what matters. Universities & research centers bridge experts with entrepreneurs. Support organizations provide legal support, IT support, real estate and what is most important – the mentorship. Corporations provide real life experience, distribution channels, clients and money. Venture capital and banks provide money. Government & municipality provide incentives, International organizations (European Union and D.G. Research) facilitate regional cooperation (startupeuropeclub.eu). Media raises awareness of current activities/opportunities. Think tanks suggest appropriate strategical approaches. Development agencies (such as the USAID) provide the technical assistance based upon relevant experience in other relevant countries as well as mentorship/guidance towards new approaches.

2.5. New approach - the next generation corporate incubator

The objective of the new approach is to modify the existing practice of incubators financed by corporates aiming to compensate for the identified issues. From one side, the old approach to the management of innovative incubators has been focused on running the experiments on multiple potential products with the objective to create multiple proofs of concepts i.e. focus has been on moving multiple products to the proof of concept stage. From the other side, the new approach introduces the new objective – to deliver one properly scaled-up

innovative product i.e. create new business of scale. The new approach to creating the innovative product in the incubator (incubator vehicle) is focused on delivering one new scaled-up innovative product, instead of multiple proofs of concept.

According to Eagar *et al*. (2019), "companies succeed in new approach are using five steps: (a) sharpen objectives, (b) adopt an incubation vehicle designed to deliver at scale, (c) use multiple partner engagement tools in an integrated way, (d) go beyond proof of concept (PoC) before integrating into the business, (e) focus heavily on the mainstreaming phase" (p.44).

Sharpen objectives: The underlying idea is that we need to precisely define concrete objectives, milestones and challenges at the beginning of the project. From one side, less successful innovative incubators/startups spend less time on the analysis of the current market gaps. Consequently, the vision and strategic objectives are less concretely specified. Those unclear objectives tend to correlate with the less successful innovative startups. For example, following objective is not concrete enough – introduce mobile applications to automatize the process of scheduling the appointments to service providers (hair salons, dentists, doctors). From the other side, more successful innovative incubators/startups spend more time on the analysis of current market gaps. Consequently, the strategy is more precisely defines in terms of which problems are expected to be solved and how is this expected to be done. For example, the objective of creating the application for scheduling the appointments to service providers should be elaborated in details: which service providers (all or some specific – doctors only) should be addressed, what are the specificities of the local market in terms of local currency payments, what are minimal technical requirements for the cell phone in that should run the application, etc. Further, agreed objectives need to be supported by cross functional top management, not only by management in the research and development department. Objectives need to be accepted by incubator management that will be responsible for the project implementation. Finally, progress measurement should be more focused on objectives in terms of processes i.e. reached milestones, and less focused on profitability indicators.

Adopt an incubation vehicle designed to deliver at scale: Next generation incubators are focused to create "scaled-up and de risked businesses in non-core areas, instead of (or in addition to) conventional start-up incubators". There are three key differences between vehicles of conventional start-up incubators and Next generation incubators: Nextgen incubators tend to launch and scale-up one product or service while conventional incubators are designed to produce multiple proofs of concept. Nextgen incubators are managed by one delivery team that is expected to take full responsibility for all goals and manage all relevant processes, while conventional incubators are managed by multiple

teams responsible for achieving individual goals and managing the individual processes. Nextgen incubators use an agile approach to development of new product/services which enables faster speed to launch (one to two years), while conventional incubators use waterfall approach which usually takes more time to launch (three to four years).

Further, two methods of management are applicable. Nextgen incubators may be run internally – by corporation managers and externally – by external consultants. From one side, if incubator is managed internally, the incubator management will have independence i.e. less pressure from the corporate management, while some normal level of monitoring will remain to exists. From the other side, incubator may be managed by external third party – consultants. The advantage of external model is in the speed and agility provided by the relatively independent incubator management. From the other side, the disadvantage is the costly and slow transition of the new product from the incubator back into the corporation.

Use multiple partner engagement tools in an integrated way: The underlying idea is that start-up incubator/accelerator is not the only available innovative tool/vehicle. The best results are accomplished by companies that simultaneously use additional tools/vehicles such as corporate venturing, entrepreneur programs and internal research and development teams. From one side, less successful companies use different tools/vehicles for separate i.e. different tasks. From the other side, more successful companies use multiple tools/vehicles simultaneously for one same task, i.e. they try to fix one issue with the use of different tools in an interconnected way.

Go beyond proof of concept (PoC) before integrating into the business: The underlying idea is that it is not enough to bring the innovation to the PoC stage. In order to increase the chance of success, it is preferable to bring the innovation to the next step beyond the PoC, which effectively means to adopt the "build/ operate/transfer" approach. Thus, the nextgen incubators tend to move the product into the testing and operationalize it (scale-up phase) before it is mainstreamed (integrated into the mainstream business).

Focus heavily on the mainstreaming phase: The underlying idea is that new product/business has to be mainstreamed i.e. integrated into mainstream operations, and this may be done on two ways. From one side, most of companies attach the new product to one of existing business units. The advantage of this approach is that it is cost effective. The disadvantage is that this often leads to "dilution – watering down the products/services of the new business so they fit more easily into existing operations and/or brands". From the other side, the preferred approach is to spend time and money to structure and implement the appropriate transitioning/mainstreaming. The advantage of this

approach is in the fact that it creates the appropriate structure and governance for the new business.

2.6. Serbian specificities

According to Jovičić *et al*. (2018), "in recent years, we observe that global tech companies (GTCs) tend to relocate tech resources from developed countries (DCs) towards less developed countries (LDCs). In response, local tech companies (LTCs) emerge in LDCs. Relocation of the software production from DCs into LDCs has modified the global environment" (p. 44). Key opportunity is the fact that developed countries have agreed to relocate the production in the tech/IT sector to less developed countries, such as Serbia. Moreover, due to lower salaries compared to other countries in the region, Serbia has comparative advantage in attracting foreign direct investments in the IT sector, which creates the opportunity to use global IT companies to finance IT incubators in Serbia. Key strength is the motivation of young people in Serbia to study IT oriented faculties, that is exactly the opposite of their peers in developed countries of the European Union. Key weakness of the Serbian innovative ecosystem are economic migrations of educated workforce from Serbia into developed countries of the European Union.

The dual tax treatment of the employees further disturbs the Serbian labour market. Djokić *et al*. (2019) elaborate on the legal treatment of the workforce and explain the differences between two models: "agency model, based on consulting services contracts, treats the workforce as entrepreneurs, and the classical model, based on employee contracts, treats workforce as employees. A key deficiency of the agency model is that the income of IT experts comes at the expense of decreased income of the state budget".

In order to compensate for the losses caused by the economic migration, the GoS should strategically invest more in the areas where young educated people are less likely to emigrate, such as IT sector. GoS has done a lot (network of science & technology parks, the innovation fund for education; plan to incorporate national & the regional innovation initiatives). Hanić & Stamatović (2013) stipulate that "among all the market factors of production, the labor market in Serbia is the least developed, very particular and complex". In the context of the complexity of labor market, key issue with existing incubators in Serbia is the fact that participants from the Universities and institutes are not transparently selected. Instead of employing young doctoral students in appropriate areas, the serbian practice is more inclined towards the engagement of university professors that see that positon as a side job, not the primary source of income. This practice is not sustainable, and Andevski *et al*. (2012) confirm that "there is a low general awareness about sustainable development" (p. 1614). The above malpractice in Serbia is caused by the wrong general perception that if that only prerequisite for innovations is enough funding, i.e. if global companies provide

enough financing for incubators/startups – the innovations will automatically appear. According to Lukinović *et al*. (2017), financial component is required, but it will not bring the competitive advantage without the creative human factor. Moreover, Lukinović *et al*. (2017), argue that business cooperation of domestic and foreign companies is not appropriately supported by Serbian institutions. Stamatović *et al*. (2012) suggest that "local authorities in many municipalities are not sufficiently involved. The economy is seen as something that is decided at the central level" (p. 156).

In that context, we believe that Serbian innovative practice should be modified to empower the corporates and decrease the influence of the GoS in that particular instance, that is the selection of experts. On the other side, GoS should keep the role of regulator i.e. monitor the activitis of global companies and their compliance with positive regulations. According to Jovičić *et al*. (2019) "Government has the legal power to enforce obligatory norms, monitor and control the corporations, and prescribe penalties for those that do not comply with the law. The government interest should prevail and corporations are expected to adjust accordingly" (p. 26). Jovičić *et al*. (2019) suggest that "state/government is expected to act as a regulator and use the legislative power to affect the company activities" (p. 27). Regulator should have the unbiased approach and should have relatively stronger influence and power compared to global corporations. Stamatović & Jovičić (2019) suggest that "the head of Central bank has a political support of the government and is in political terms positioned higher compared to the head of any commercial bank" (p. 306). We believe that best way to take ownership of the project is to include and empower all local stakeholders. Although market is superior regulator compared to Government, GoS representatives need to participate in this process. The key challenge is to help the facilitator to keep integrity and remain unbiased.

CONCLUSION

We have initiated our analysis by defining two approaches to innovations, the traditional approach that looks at the innovation as "complicated" system with predictable interactions and tendency to equilibrium state, and new approach to innovations as "complex" system with unpredictable interactions and potential for disequilibrium. We have summarized key differences between complicated and complex systems. Firstly, complicated systems are focused on "best practices" based on what has worked, and complex systems are focused on "next practices" based on what could work better. Further, management of complicated systems is focused on assuring an outcome, and management of complex systems is focused on sensing feedback from actions. Finally, management of complicated systems is internally focused on promoting stability and predictability, while management of complex systems is externally focused on promoting agility and adaptability.

Further, we have explained why employees are not motivated to create breakthrough innovations. The main reason seems to be the modern corporate policy which transfers all benefits from the innovations to a corporation, leaving innovative employees unmotivated to participate in such unfair game. Theory of incomplete contracts provides an explanation for the observed fact that unfair contracts have negative effect i.e. decrease the interest of employees to create breakthrough innovations.

We have commented on the main causes of failure of the standard approach, identified by Eagar *et al*. (2019), where corporations select and help startups by financing in-house incubators and accelerators: (a) lack of major impact on growth, (b) misaligned or unclear objectives, (c) long times required to scale up, (d) inadequate resourcing, (e) lack of a systematic approach, (f) cultural mismatch and (g) lack of a home".

We have commented on the key principles on how, where and how often are participants i.e. stakeholders supposed to meet in order to re-negotiate the terms of the cooperation: (a) self-organization vs. hierarchy, (b) bottom-up vs top-down initiatives, (c) agile approach, and (d) include all stakeholders.

We have elaborated the new approach to innovations. Innovation efforts on the corporate level will remain to depend on cooperation with start-ups. The underlying idea is that standard approach focused on running experiments in peripheral business areas need to be improved in terms of scaling-up new businesses. The improvement of the standard model of start-up corporate incubators - which creates incremental solutions (orders of magnitude smaller compared to the core business), leads towards the new approaches to break-through innovation where successful companies apply new/next-generation approaches/vehicles for start-up incubators in order to produce scaled up businesses. New approach suggests that new generation incubators/startups need to define more concrete objectives, deliver scaled-up businesses, use multiple engagement tools/vehicles simultaneously, adopt Build Operate Transfer instead proof of concept approach, and focus heavily on the mainstreaming phase.
Finally, in terms of Serbian specificities, we have identified the economic migrations of educated workforce as key weakness and proposed a practical measure to compensate for the losses caused by this migration. The key proposed measure is to identify areas in which young educated people are less likely to emigrate, such as IT sector, and to strategically invest more in areas with lower emigration compared to areas with higher emigration.

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EXAMINATION OF THE INFLUENCE OF THE BALANCED SCORECARD ON THE SUCCESS OF BUSINESS OPERATIONS IN ORGANIZATIONS

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Abstract: The Balanced Scorecard (BSC) represents a contemporary strategic management system, which can be used to balance and align everyday business activities of an organization with a corporate strategy. So, the BSC represents an instrument, i.e. methodology for transforming organizational strategic goals into performance indicators. Measuring the performances of an organization is an important process of measuring the progress the organization has been making in the context of achieving preset goals. The application of the BSC management system is important in formulating a strategy, especially so in carrying out a strategy into operational actions. In order for an organization to do business successfully, it is exceptionally important that it should be capable of measuring the parameters of the successfulness of its business operations. Organizations are as successful as they are able to better measure their performances and assess their work, as well as the effects they achieve. For the reason of the said, the goal of the paper is to examine the influence of the BSC on the success of the business operations of organizations.

Keywords: Balanced Scorecard, business strategy, business excellence, organization
JEL: L10, M21

1. INTRODUCTION

In today's contemporary business and business operations, an organization has the goal not only to survive, but also to win in a market game. Global technological, economic, political, legal, sociocultural and other factors have had an influence on changes being made more quickly, as well as on modelling the management methodology and practice. Certain authors call for a new strategy management theory that would enable development in the field of creative,

proactive strategic deliberations. In today's dynamic networked world, the fact that a whole is greater than the sum of the parts, and that holistic thinking and suchlike approaches should be replaced, or at least supplemented, by analytic ones is increasingly being accepted (Hamel, 1998). Today's environment is becoming more and more dynamic and uncertain. The availability of an ever-increasing number of pieces of information, a simple approach to information, as well as the oversaturation with information, have led to the world reorienting itself from industrial economy to knowledge economy (Drucker, 1998).

Companies in a contemporary environment, whose main feature is a constant and unforeseeable change in competition, must pay additional attention to the time and resources, both financial and of human resources, in order to be capable of measuring success performances in their organization. Such a condition of the contemporary environment has led the organization to the point when, apart from the financial aspects of its business operations, the organization must also monitor other key elements of its performances, where traditional financial indicators are considered as insufficient for the current environment, which makes performance measuring systems much more complex. "Traditional financial indicators were good in the industrial era, but they are outdated in relation to the necessary competences and capacities that today's enterprises have been trying to develop." (Kaplan & Norton, 1992).

Also, due to changes in the character of labor and business doing, there have been changes from labor-intensive towards capital-intensive, all the way to knowledge-tinted intensive labor and business doing, in which we are today, which has led to the key problem management is faced with, i.e. the application of an organization's formulated strategy (Papalexandris *et al*., 2005).

The key problem identified in the traditional models for measuring and managing performances is a pronounced business operations management tendency founded only on financial performances reporting on past events. Such a model for measuring and managing performances is insufficient for a successful implementation of an organization's strategy (Niven, 2002; 2014).

The BSC represents the model that appeared in 1990, when Kaplan and Norton conducted a research study entitled "Measuring Performances in the Organization of the Future", which included 10 organizations, in which new performance measurement methods were being studied. The main reason for which Kaplan and Norton conducted the research study was the belief that performance financial measures were inappropriate for organizations' modern business doing, since the then organizations exclusively used financial measures to manage their business operations based on historical data. Due to all of the mentioned problems and challenges encountered by contemporary organizations, the existing approaches to measuring performances were assessed in a later

research study conducted on a sample of a very small number of the examined organizations as either efficient or very efficient (Kaplan & Norton, 2001).

The BSC model suggested by Kaplan and Norton represents a management tool supporting a successful implementation of corporate strategies. That was discussed and broadly deliberated in practice and in research. Connecting operational and nonfinancial corporate activities with cause chains in the context of a company's long-term strategy, the BSC supports the alignment and management of all corporate activities in accordance with their strategic relevance. A balanced indicator enables us to take into consideration the nonmonetary strategic factors of success that significantly influence the economic success of an organization. Therefore, the BSC is the starting point that also includes ecological and social aspects in the main system of the management of one organization.

This approach is not only a set of performance indicators, but it is much more – the management structure modelling the overall planning, management and control processes. It is also needed to emphasize the fact that there is the alignment of the goals of certain parts and certain employees with the organizational strategy of the company, so the BSC approach is considered as a central and organizational framework for the overall management process.

In relation to its first emergence, the BSC approach has experienced some modifications, which lead to the strategy's yet better integration into the business operations of the organization. This new version of the BSC approach is based on the continuous improvement of the approach and encompasses six phases (Kaplan & Norton, 2008):

1. The development of the strategy based on an internal context, an external context and the existing strategy.
2. To plan a strategy by developing "The Map Strategy".
3. Complying all initiatives with the organizational strategy.
4. Planning operations – the budget and the strategy should be connected with each other.
5. Monitoring and learning – both strategies are reviewed at meetings.
6. Testing and adaptation – whether the strategy is being implemented is checked and necessary modifications are made.

To be more precise, the BSC concept implies a balanced system of measuring the organization's performances, which implies a balance between short- and long-term goals, financial and nonfinancial indicators, the leading indicators, as well as internal and external perspectives of the organization's performances (Kloppenborg & Petrick, 2002).

Therefore, the goal of the paper is to examine the influence of the BSC on the success of the business operations of organizations. For that reason, the paper is structured in the following manner: Section 1 deals with the introductory considerations, whereas Section 2 is literature review. In Section 3, the materials and the methods are presented, whereas Section 4 is a presentation of the results of the research together with the pertaining discussion. Finally, the conclusions are given at the end of the paper.

2. LITERATURE REVIEW

The BSC is successfully used in many institutions throughout the world, such as state units, manufacturing enterprises, service organizations and non-profit companies. Kaplan and Norton understood the requests of contemporary organizations and their need for an efficient implementation of the strategy and the creation of an all-inclusive system of the improvement and management of performances, and they introduced a new management system, i.e. the BSC system. As an all-inclusive framework for the evaluation of performances and the progress of the strategy, the BSC-based management system establishes a balance between short- and long-term goals.

The BSC is a proven framework, which explains and applies the organizational strategy (Niven, 2006). Today, it represents a system of strategic management for managing organizational performances (Brudan, 2010). In its root, this system also has the principle of motivational action – the action of an individual and a group implying their making a contribution to the implementation of the strategy of the organization through their capabilities and knowledge (Nair, 2004).

Today's organizations have understood that 80% of their values are created through intangible assets, including human capital (knowledge and skills of employees), organizational capital (organizational culture and values which regulate it), and intelligence means (sources of information and statistical data), and they no longer carry out a comprehensive assessment of performance by only relying on tangible assets (Kaplan & Norton, 2004).

The BSC is intended for organizations of all sizes and activities. This approach helps organizations find answers to the following questions: a) The consumer's perception?; b) A future focus?; c) A capacity for a continuous improvement of the strategy?; and d) Shareholders' perception.

In order for an organization to do business successfully, it is necessary that it has an adequate business doing strategy in place. A strategy is a general plan of the accomplishment of the mission and goals of an organization through one of the five components in the chain: the mission – the goal – the strategy – the structure- the functioning of the organization. All these components are

interconnected and interdependent, and they have a two-way influence – they influence one another through back, indirect and direct connections.

The defining and implementation of an appropriate strategy is of exceptional significance for an organization. A choice of an appropriate strategy can be made successfully using multicriteria decision-making methods (Popović *et al*., 2019; Urošević *et al*., 2018; Karabašević *et al*., 2018; Karabašević *et al*., 2016; Maksimović *et al*., 2016).

As Kaplan and Norton (2001) assert, a strategy is a hypothesis. The BSC relies on the premise of a strategy as a hypothesis. It enables strategic hypotheses that can be described as a set of cause-and-effect relationships, which are clear and checkable. Strategic hypotheses require the identification of the activities that are the early indicators of the desired outcome. The key to the implementation of a strategy is that everybody in the organization clearly understands the basic hypothesis, brings into compliance resources with hypotheses, test continuously the hypotheses and adapt them to changes in real time.

Strategy-focused organizations use the BSC approach to place a strategy at the heart of their management system. The BSC model makes a simple contribution to the description of a strategy in a consistent and shrewd manner. Prior to its development, managers had not had a generally accepted framework for describing a strategy. They were not able to implement something that was not described well. Such a simple act of describing a strategy through strategic maps and the BSC represents huge progress.

In order for the BSC approach to structure as the composition of the strategic management of a particular organization, Kaplan and Norton highlighted the five principles that should be used for strategically oriented organizations (Belak, 2014): a) the translation of the strategy into performance terms; b) directing the organization towards the strategy; c) the whole procedure for the calculation of costs should be solved through planning and budgeting; d) the translation of the strategy into individual everyday affairs; e) modelling the strategy as a continuous process.

The biggest challenge in the creation of the BSC approach is the selection of indicators, which is pointed out as the necessary identification and development of the key (critical) success factors, and the key (critical) performance indicators pertaining to them.

The key success factors are the approaches of strategically connected actions, a competitive possibility and business outputs, which every firm must achieve or must focus on achieving them so as to be competitive and financially successful.

The success of any performance management program depends on the selection of right key performance indicators (KPI). The selection of appropriate indicates that must be oriented towards a continuous improvement is usually a very complex problem which the success of the implemented KPI depends on. "The gravity of the task in the creation of the BSC model is not in the identification of a sufficient number of performance indicators, but rather in the selection of a very small number of the most important indicators." (Neely, 2002) "The determination of indicators is one of the main obstacles to the effective application of the BSC." (Bryan & Murphy, 2007)

The BSC model presented in the year 1992 by Kaplan and Norton represents a popular system of performance management and it categorizes the goals of an organization into four measurable and operational perspectives: learning and development, the financial perspective, the consumer perspective, and internal business processes (Kaplan & Norton, 1992).

As is mentioned, the BSC approach consists of the measure of financial successfulness, the relationship with buyers, internal business processes, organizational learning and growth. Every business unit within an organization should develop its own BSC measures so that the same reflect the goals and strategies of the organization. Some of those measures will be common to all participants, i.e. units, whereas other ones will be unique for every business unit (Lipe & Salterio, 2000).

3. MATERIALS AND METHODS

The research study was conducted in the period from 15th March 2018 to 30th April 2018. The research study included the respondents in managerial positions (managers and leaders) in the business entities in Serbia. For the need of the research study, a survey questionnaire had specially been created. The sample of the research study is based on the base of 187 correctly filled out survey questionnaires, i.e. 187 respondents. The questionnaire encompassed a sample of 211 respondents; however, there were only 187 correctly completed questionnaires that were taken into further consideration.

The data processing was done by means of the SPSS 23.0 software package. Apart from the basic demographic characteristics, such as the sex, the age, the professional qualification, the respondents also expressed their attitudes by applying a 5-degree Likert Scale (1-absolutely disagree; 2-partly disagree; 3-neutral; 4-partly agree; 5-absolutely agree). The research study is founded on the following assertions/statements that were the subject matter of the evaluation made by the respondents:

- Strategic management integrated plans are available to all the employees of the organization;

- Outcome indicators (quantitative) are clear and unambiguous in the organization's strategic plan;
- In the organization, there is a set of the defined rules and procedures that regulate the resolving of complaints;
- The organization constantly deals with the examination of the user satisfaction with products and services;
- In the organization, there is a system funding the new products and services that are aimed at achieving a shorter period of return on investment;
- In the organization, there is satisfaction with the financial remuneration the employees receive for their work;
- The internal labor processes in the organization are accredited according to the process owner;
- The majority of the process owners in the organization possess the necessary work licenses and certificates;
- The employed in the organization constantly attend trainings, training courses and other professional improvement courses with the aim of developing their knowledge and skills;
- In the organization, the concept of continuous education is in place.

Factor analysis was used for the processing of the data. Factor analysis is one of the most popular multivariant techniques, which has two goals: the identification and understanding of the basic idea, i.e. common characteristics for a larger number of variables, and to confirm the components important for the identification of any phenomenon, namely in the very manner that offers a good ground for the understanding of the most important, essential dimensions or ideas connected with the observed phenomenon.

4. RESULTS AND DISCUSSION

In the continuation of the paper, the results of the research study will be presented with the pertaining discussion.

In the research study, out of the total number of the respondents, the female population has a share of 42.78%, whereas the male population accounts for a 57.22% share. If the structure of the respondents according to the age group is observed, out of the total number of the respondents, a total of 52.94% of them accounts for the respondents at the age of 18 to 30. The age from 31 to 45 accounts for 32.62%, whereas the age of 46 to 60 years of age accounts for 13.90%; the respondents at the age of over 60 account for a less significant share of 0.53%. If the structure of the respondents according to their professional qualifications is observed, the respondents with university education account for as many as 45.99% of the total respondents, and are simultaneously the most dominant group, too. The respondents holding a master's/M.A. diploma account

for 33.16% of the total number of the respondents. The respondents who only have a secondary school account for 10.70% of the total number of the respondents, whereas the respondents with a higher school/college have a 5.35% share in the total number of the respondents; the respondents with the Ph.D. title account for a share of 4.81% of the total number of the respondents.

Table 1. *The descriptive statistics of the influence of the balanced indicators system (Balanced Scorecard – BSC) on the success of business operations in organizations*

	Absolutely disagree	Partly disagree	Neutral	Partly agree	Absolutely agree	Average	Standard deviation
1. Strategic management integrated plans are available to all the employees of the organization	*12.3%*	*18.2%*	*31.0%*	*24.1%*	*14.4%*	*3.10*	*1.221*
2. Outcome indicators (quantitative) are clear and unambiguous in the organization's strategic plan	*1.1%*	*6.4%*	*40.6%*	*25.7%*	*26.2%*	*3.70*	*0.966*
3. In the organization, there is a set of the defined rules and procedures that regulate the resolving of complaints	*1.6%*	*8.6%*	*23.5%*	*34.8%*	*31.6%*	*3.86*	*1.012*
4. The organization constantly deals with the examination of the user satisfaction with products and services	*2.7%*	*8.0%*	*20.9%*	*25.7%*	*42.8%*	*3.98*	*1.097*
5. In the organization, there is a system funding the new products and services that are aimed at achieving a shorter period of return on investment	*3.2%*	*8.6%*	*27.3%*	*29.4%*	*31.6%*	*3.78*	*1.084*
6. In the organization, there is satisfaction with the financial remuneration the employees receive for their work	*4.3%*	*8.6%*	*21.4%*	*34.8%*	*31.0%*	*3.80*	*1.103*
7. The internal labor processes in the organization are accredited according to the process owner	*7.0%*	*8.6%*	*28.9%*	*30.5%*	*25.1%*	*3.58*	*1.158*
8. The majority of the process owners in the organization possess the necessary work licenses and certificates	*7.5%*	*9.1%*	*20.3%*	*40.1%*	*23.0%*	*3.62*	*1.155*
9. The employed in the organization constantly attend trainings, training courses and other professional	*1.6%*	*14.4%*	*19.8%*	*33.2%*	*31.0%*	*3.78*	*1.089*

improvement courses with the aim of developing their knowledge and skills							
10. In the organization, the concept of continuous education is in place	*3.7%*	*10.7%*	*16.6%*	*33.2%*	*35.8%*	*3.87*	*1.130*

Source: Author's own calculations

Table 1 shows the influence of the Balanced Scorecard on the success of business operations in organizations. Somewhat over 70% of the respondents, with the average grade of 3.98 and the standard deviation of 1.097, agree upon the established fact that the organization constantly deals with the examination of user satisfaction with the products and services. Somewhat over 65% of the respondents, with the average grade of 3.87 and the standard deviation of 1.130, agree upon the established fact that in the organization, there is a concept of continuous education in place. More than 50% of the respondents agree upon the other established facts in the table. However, only 35% of the respondents, with the average grade of 3.10 and the standard deviation of 1.221, agree upon the established fact that the strategic management integrated plans are available to all the employees. The respondents' attitudes unambiguously show that the balanced indicators system is significant for the organization and influences the success of its business operations. Yet, one part of the respondents' attitudes that relates to the availability of the strategic management plans show that organizations do not provide all the employees pieces of information about action strategies.

The analysis of the main components of the Balanced Scorecard on the success of business operations in organizations

Table 2. *The descriptive analysis of the variables*

	Average grade	Standard deviation	Number of the analyzed questionnaires
1. Strategic management integrated plans are available to all the employees of the organization	*3.10*	*1.221*	*187*
2. Outcome indicators (quantitative) are clear and unambiguous in the organization's strategic plan	*3.70*	*0.966*	*187*
3. In the organization, there is a set of the defined rules and procedures that regulate the resolving of complaints	*3.86*	*1.012*	*187*
4. The organization constantly deals with the examination of the user satisfaction with products and services	*3.98*	*1.097*	*187*
5. In the organization, there is a system funding the new products and services	*3.78*	*1.084*	*187*

that are aimed at achieving a shorter period of return on investment			
6. In the organization, there is satisfaction with the financial remuneration the employees receive for their work	*3.80*	*1.103*	*187*
7. The internal labor processes in the organization are accredited according to the process owner	*3.58*	*1.158*	*187*
8. The majority of the process owners in the organization possess the necessary work licenses and certificates	*3.62*	*1.155*	*187*
9. The employed in the organization constantly attend trainings, training courses and other professional improvement courses with the aim of developing their knowledge and skills	*3.78*	*1.089*	*187*
10. In the organization, the concept of continuous education is in place	*3.87*	*1.130*	*187*

Source: Author's own calculations

According to Table 2, we can see that the following established facts have the highest average grade when the BSC is in question, namely: The organization constantly deals with the examination of the user satisfaction with products and services; In the organization, the concept of continuous education is in place; In the organization, there is a set of the defined rules and procedures that regulate the resolving of complaints. The dispersion (standard deviation) ranges between 0.9 and 1.2, which is clearly visible from Table 1, so it is concluded that, on the basis of the standard deviation regarding their answers, the respondents are homogenous (Strategic management integrated plans are available to all the employees of the organization; The internal labor processes in the organization are accredited according to the process owner; The majority of the process owners in the organization possess the necessary work licenses and certificates; In the organization, the concept of continuous education is in place; In the organization, there is satisfaction with the financial remuneration the employees receive for their work), whereas this is not the case in the other ones. The total of 187 subjects were analyzed.

Table 3. *The correlation matrix between the variables*

Variables		P_2.1	P_2.2	P_2.3	P_2.4	P_2.5	P_2.6	P_2.7	P_2.8	P_2.9	P2_10
CORRELATION	P_2.1.	*1.000*	*0.355*	*0.177*	*0.138*	*0.269*	*0.115*	*0.236*	*0.222*	*0.288*	*0.322*
	P_2.2.	*0.355*	*1.000*	*0.418*	*0.293*	*0.299*	*0.350*	*0.366*	*0.411*	*0.323*	*0.258*

P_2.3.	*0.177*	*0.418*	*1.000*	*0.569*	*0.432*	*0.452*	*0.327*	*0.244*	*0.337*	*0.397*
P_2.4.	*0.138*	*0.293*	*0.569*	*1.000*	*0.565*	*0.507*	*0.340*	*0.168*	*0.410*	*0.366*
P_2.5.	*0.269*	*0.299*	*0.432*	*0.565*	*1.000*	*0.470*	*0.276*	*0.193*	*0.267*	*0.199*
P_2.6.	*0.115*	*0.350*	*0.452*	*0.507*	*0.470*	*1.000*	*0.316*	*0.302*	*0.441*	*0.401*
P_2.7.	*0.236*	*0.366*	*0.327*	*0.340*	*0.276*	*0.316*	*1.000*	*0.528*	*0.339*	*0.261*
P_2.8.	*0.222*	*0.411*	*0.244*	*0.168*	*0.193*	*0.302*	*0.528*	*1.000*	*0.453*	*0.439*
P_2.9.	*0.288*	*0.323*	*0.337*	*0.410*	*0.267*	*0.441*	*0.339*	*0.453*	*1.000*	*0.718*
P_2.10.	*0.322*	*0.258*	*0.397*	*0.366*	*0.199*	*0.401*	*0.261*	*0.439*	*0.718*	*1.000*

Source: Author's own calculations

In Table 3, the second step is demonstrated, implying a pre-accession test for the analysis of the main components, which is done through checking the correlation between the variables for the BSC. The level of the dependency coefficient amongst the variables exceeds ±0.3 for this analysis.

The methodology of the analysis in the next step leads us to the next analysis, through which we will establish a fact whether the coefficients shown in the previous table are statistically significant or not.

Table 4. *The pass-through tests for the analysis (KMO and Bartlett's test)*

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		*0.794*
Bartlett's Test of Sphericity	Approx. Chi-Square	*671.538*
	df	*45*
	Probability	*0.000*

Source: Author's own calculations

The value of the pass-through test (*Kaiser-Meyer-Olkin Measure of Sampling Adequacy)* is greater than 0.7, but the second pass-through test (*Bartlett's Test of Sphericity)* is also significant at the error level of 0.000. The *Kaiser-Meyer-Olkin Measure of Sampling Adequacy* test confirms that the coefficients are significant for prediction, whereas the *Bartlett* test has confirmed that the coefficients are statistically highly-significant.

After the previous checks, the methodology requires the calculation of the common variation present between the variables through the so-called extracted

variance. The maximum variation tends to one, which means that the values closer to it are of greater significance with respect to the variation with the other variables.

Table 5. *The communality matrix*

Name of the variable	Initial	Extracted variance
1. Strategic management integrated plans are available to all the employees of the organization	*1.000*	*0.422*
2. Outcome indicators (quantitative) are clear and unambiguous in the organization's strategic plan	*1.000*	*0.615*
3. In the organization, there is a set of the defined rules and procedures that regulate the resolving of complaints	*1.000*	*0.596*
4. The organization constantly deals with the examination of the user satisfaction with products and services	*1.000*	*0.744*
5. In the organization, there is a system funding the new products and services that are aimed at achieving a shorter period of return on investment	*1.000*	*0.665*
6. In the organization, there is satisfaction with the financial remuneration the employees receive for their work	*1.000*	*0.592*
7. The internal labor processes in the organization are accredited according to the process owner	*1.000*	*0.537*
8. The majority of the process owners in the organization possess the necessary work licenses and certificates	*1.000*	*0.647*
9. The employed in the organization constantly attend trainings, training courses and other professional improvement courses with the aim of developing their knowledge and skills	*1.000*	*0.808*
10. In the organization, the concept of continuous education is in place	*1.000*	*0.835*

Source: Author's own calculations

There is a common variability between the indicators, explained by absolute variation over the variance.

The purpose of the analysis is to determine the indicators that essentially frequently vary and, in fact, correlate in that manner to a new dimension, which forms a group of the same factors that have an influence on some phenomenon. That further implies the use of a test which will calculate the common variability, i.e. the quantity of the same, by using the Keiser criterion, through which the common variability is extracted, which on its part is declared by a grade greater than one.

Table 6. *The matrix of the rotated components with their saturations*

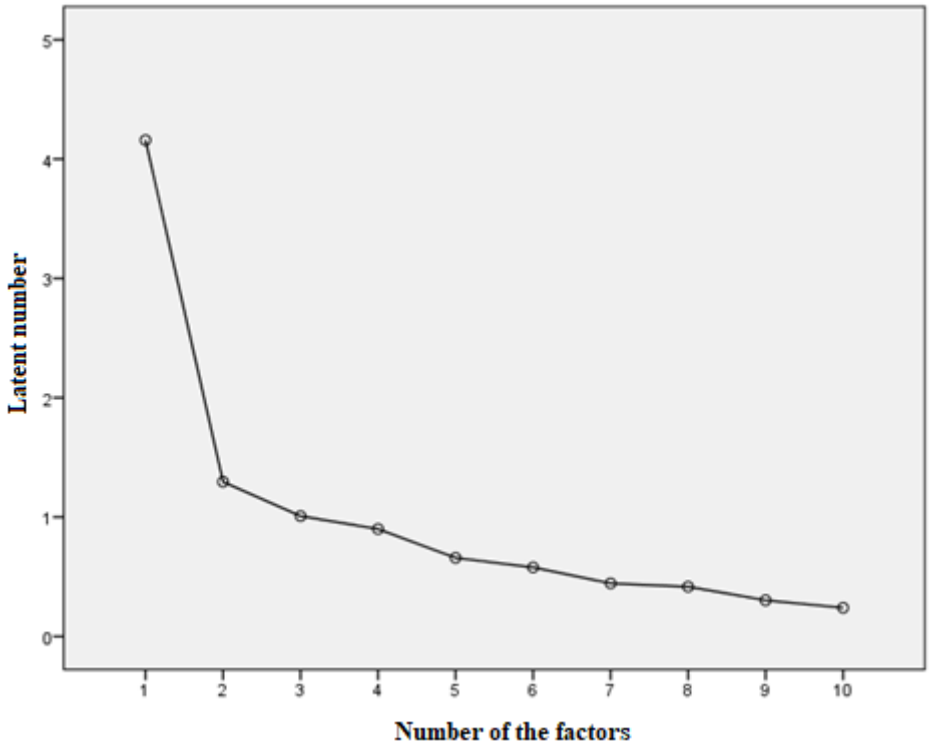
Factor	The basic equivalents of the variance – latent			Extracted summed up variability of the components		
	Total	**% of the variance**	**Cumulative %**	**Total**	**% of the variance**	**Cumulative %**
1	*4.159*	*41.588*	*41.588*	*4.159*	*41.588*	*41.588*
2	*1.296*	*12.955*	*54.543*	*1.296*	*12.955*	*54.543*
3	*1.008*	*10.076*	*64.619*	*1.008*	*10.076*	*64.619*
4	*0.900*	*8.995*	*73.614*			
5	*0.658*	*6.580*	*80.194*			
6	*0.578*	*5.780*	*85.974*			
7	*0.444*	*4.442*	*90.417*			
8	*0.416*	*4.163*	*94.579*			
9	*0.302*	*3.023*	*97.603*			
10	*0.240*	*2.397*	*100.000*			

Source: Author's own calculations

Table 6 shows which indicators are retained in the analysis, and a decision will only be made after the application of the so-called rotation of the factorial space with the aim of making it easier to interpret the results. By applying the rotation of the factorial space, those indicators (factors) that will be retained in the analysis are detected.

The three factors that explain the biggest scope of the variance and simultaneously do not correlate with their own selves are extracted from the previous table. The first factor accounts for the biggest scope of the variance (41.58%), whereas the second (12.95%) and the third (10.07%) are expressed in the percentages of the total variance, which is 64.6% of the explained variability when the BSC is in question. The other variability (35.4%) is explained by some other phenomena. All of the three of them are retained in the analysis, because Keiser's criterion is greater than 1.

Figure 1. *The scatter diagram*



Source: Author's own calculations

Figure 1 shows a diagram of the gradation of the factors, from which it is possible to notice the clear breakpoint after the third component (factor). In the further course of considering the research results, the three components (factors) obtained through the factor analysis are retained and observed as three dimensions, i.e. subscales.

The methodology of the analysis also includes the correlation matrix for the three factors so as to be able to know from the same which of the variables has the highest factorial saturation correlating with the factor – which means closer to one.

Table 7. *The matrix of the rotated components with their saturations*

Name of the variable	Factor 1	Factor 2	Factor 3
1. Strategic management integrated plans are available to all the employees of the organization	*0.054*	*0.637*	*0.116*
2. Outcome indicators (quantitative) are clear and unambiguous in the organization's strategic plan	*0.322*	*0.714*	*0.045*
3. In the organization, there is a set of the defined rules and procedures that regulate the resolving of complaints	*0.712*	*0.220*	*0.200*
4. The organization constantly deals with the examination of the user satisfaction with products and services	*0.831*	*0.061*	*0.226*
5. In the organization, there is a system funding the new products and services that are aimed at achieving a shorter period of return on investment	*0.778*	*0.238*	*-0.046*
6. In the organization, there is satisfaction with the financial remuneration the employees receive for their work	*0.668*	*0.127*	*0.360*
7. The internal labor processes in the organization are accredited according to the process owner	*0.248*	*0.670*	*0.162*
8. The majority of the process owners in the organization possess the necessary work licenses and certificates	*0.014*	*0.657*	*0.463*
9. The employed in the organization constantly attend trainings, training courses and other professional improvement courses with the aim of developing their knowledge and skills	*0.251*	*0.232*	*0.831*
10. In the organization, the concept of continuous education is in place	*0.207*	*0.178*	*0.872*

Source: Author's own calculations

Table 7 shows which variable correlates most with the extracted factor (factorial saturation). The rotation of the factorial space has been performed in order to make the interpretation of the results easier. The following step represents the evaluation and interpretation of the factors, including also the choice of an adequate name. Through factorial saturation, we determine which variables have the most in common with the factor, after which we observe what it is common between them, or what it is they differ from the others, after which the name of the factor is determined.

The highest factorial saturation in Factor 1 is seen in the following variables: The organization constantly deals with the examination of the user satisfaction

with products and services; In the organization, there is a system funding the new products and services that are aimed at achieving a shorter period of return on investment; In the organization, there is a set of the defined rules and procedures that regulate the resolving of complaints; In the organization, there is satisfaction with the financial remuneration the employees receive for their work. Based on the extracted variables and on what is common for that set of the variables, it is concluded that the name of the first factor is STANDARDS OF THE ORGANIZATION.

The highest factorial saturation in Factor 2 is found in the following variables: Outcome indicators (quantitative) are clear and unambiguous in the organization's strategic plan; The internal labor processes in the organization are accredited according to the process owner; The majority of the process owners in the organization possess the necessary work licenses and certificates; Strategic management integrated plans are available to all the employees of the organization. Based on the extracted variables and on what is common for that set of the variables, it is concluded that the name of the second factors is STRATEGIC MANAGEMENT.

The highest factorial saturation in Factor 3 is present in the following variables: In the organization, the concept of continuous education is in place; The employed in the organization constantly attend trainings, training courses and other professional improvement courses with the aim of developing their knowledge and skills. Based on the extracted variables and on what is common for that set of the variables, it is concluded that the name of the third factor is EDUCATION.

CONCLUSION

Every modern organization aspires towards the application of the BSC in its everyday business operations. It is desirable that the BSC, as an adequate system of measuring and improving the overall organizational performances, should be established in organizations, since in that manner and at any moment the organization in which this system is implemented could, based on a set of different indicators that first of all relate to its finance, buyers, internal processes and perspective of innovations and learning, be aware of where it is in relation to its goals. For this reason, the BSC can be said to be an essential instrument of strategic management, which harmonizes, supports and ensures the intercorrelation of the key management processes, directing them towards the defined strategy. The BSC enables strategic goals to be transparent and transformed into goals of all the segments/processes of the organization, as well as all employees. This is a useful system, which in theory allows the inclusion of all important external and internal factors of the successfulness of business operations. Practice has shown that this concept has proven to be useful, but in a large number of cases it experienced a failure, so the decision whether to

introduce the BSC or not must be based on the organization's realistic possibilities and needs. That is especially so with respect to the necessity of quality management at all levels, because the whole system will almost certainly be badly designed and implemented without that necessary condition. The research study has shown that, in organizations, there is a set of defined rules and procedures regulating the resolving of complaints. Organizations constantly deal with the examination of the satisfaction of their users with their products and services. Employees in organizations constantly attend trainings, training courses and other professional improvement courses with the aim of developing their knowledge and skills; there is also the concept of continuous education, so the internal labor processes in the organization are accredited according to the process owner, and the majority of such process owners in the organization possess necessary labor licenses and certificates. In the organization, there is satisfaction with the financial remuneration received by employees for the work they do, since in the organization there is the system which funds new products and services, aimed at a shorter period for return on investment. Strategic management integrated plans are available to all employees in the organization, for which reason outcome indicators are also clear in the organization's strategic plan.

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TRAINING AND WORK SKILLS ACQUISITION IN MODERN BUSINESS

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Abstract: Training helps individuals as well as companies to improve quality, competitiveness and productivity. The function of training should essentially be to provide the experienced advice source, the testing of ideas, encouragement change and to address the issues likely to be prevailing in the future. In order for a company to keep its position in the market and increase competitive advantage, it should be capable of creating new knowledge, as well as relying on the existing ones. Therefore, a continuous training plays a significant role in individual and organisational performance development. The role of the training is not to provide general education, or teach the employees everything; it focuses on the needs of the jobs in the company. First of all, this paper considers an increasing importance of the training. In addition, it analyses training methods, plan and programme, as well as techniques, methods and approach.

Keywords: training, employees, work skills, manager training, training techniques and methods, modern business
JEL: M53,O3, M54

1. INTRODUCTION

In modern, dynamic business environment work force quality is becoming the most difficult factor to be copied and recreated in other companies – what people know, how they use the knowledge, how fast they can learn new things and how motivated they are to invest themselves in better results – it becomes critical for business success. In order for the employees to perform tasks efficiently, it is necessary to carry out their training, improvement and development. The training process transfers new knowledge and skills, it develops new capacities which results in benefits for both the company and the employees since it enables them to achieve personal ambitions. The employees expect the training to provide career advancement and more demanding tasks.

The employees' work place attitude and expectations have changed considerably in the course of time. In modern conditions, a wish for more responsibility and self-actualisation has taken the place of material needs fulfillment.

Understanding the appearance of new employees and demand development, above all, represents the understanding of the changes as a result of the learning process. When we speak of the employee training, we speak not only of individual training, but about group education and development with the aim of being useful for the organisation as well as personnel in specific business mission implementation. If we consider it in the widest sense, values refer to various practical and important issues, such as: decision-making, managerial success, development and organisational changes, as well as the effects of individual system of values on the collective system (Dukić *et al.*, 2010).

Training is a planned effort of the organisation to improve employee performances on the job or somewhere related to the job (Bogićević-Milikić, 2008). Training represents new practical knowledge and skills acquisition necessary for work, leadership, management and organised behaviour according to adopted rules, regulations and standards. Therefore, we can reach a conclusion that it is a process of personal experience acquisition or other experience usage (adoption).

The aim of the training is that the employees adopt knowledge, skills and habits to the best of their abilities. That is why we should have in mind that people differ in the personality traits they possess. These personality traits can influence training success to various degrees. For the organisation, the training goals should be coordinated with the goals of the employees. The training process arises from the organisation plans, mission and objectives, and the personnel training plans are based on them.

2. THE INCREASING SIGNIFICANCE OF PERSONNEL TRAINING AND WORK SKILLS ACQUISITION

Training is a learning process that includes the acquisition of skills, concepts, rules or attitudes in order to increase the employee performance (Byars & Rue, 2007). Unlike education, training refers to limited areas of activity. The training goals are quite specific, clearly defined and thus tend to minimize individual differences.

Training implies systematic development of the behavior set that consists of attitudes, knowledge and skills demanded from an individual in order to complete a task or a job in the appropriate manner (Stevanović & Lojić, 2011).

The changes take place continuously, technical as well as organisational or even the changes in company strategy, and they can cause the knowledge and skills of the employees to become outdated. Employee performance evaluation will point out the areas where the performances are lower than the standards, and that will

be the signal for the company to undertake the measures in order to overcome the problems encountered.

Personnel training is necessary in order to improve the quality system in the companies. The following rules should be acknowledged, respected and conducted by the managers in order for training to reach its point (Popivoda, 2000):

- new jobs ask for new abilities, new abilities ask for new knowledge
- the existing personnel should be trained, not new one
- managers cannot ask the personnel to be trained unless they have been trained themselves
- the company should identify a person in charge of training plan and programme implementation
- certificate of the training completed is kept as a permanent document for each personnel member.

Personnel training is strongly related to other activities in human resource management. On the basis of the information contained in human resource plans, as well as new employees, the training experts define the contents of the training for the new employees. If a company applies high standards in the course of candidate selection for certain jobs through top experts employment, it reduces the need for formal training programmes. On the other hand, efficient training programmes within organisations can reduce the need for external high-skilled expert recruit (Vukotić, 2009).

Organisations provide training for increasing personnel abilities in problem solution and recognition of their need to adjust to the rapid changes characteristic for certain jobs (Urošević *et al.*, 2018). At the same time, development enables personnel to prepare for future jobs successfully. In view of the future oriented development, it includes the learning that can be in no relation to the employee's present job.

In general, decisions in relation to the training – who will take part, what will be learned and how – are made by the organisation rather than the individuals the training is organised for. Training objectives are mainly organisational (for example, increased performances and efficiency) rather than personal aims of the trained personnel. This difference between education and training is evident in complete professional literature/references.

As it has already been mentioned, work skills are acquired through training. For example, entrepreneurs should possess specific skills and knowledge in order to promote entrepreneurship, but they should also improve them. The basic concept of encouraging individuals to start small business is created through the definition of objectives, principles and organisation activity holders directed

towards entrepreneurship development and specific personal traits development encouragement such as creativity, innovation, initiative, independence and responsibility (Vukotić *et al.*, 2013).

Katz (1974) developed skills typology, and it processes three following types in detail:

1) Technical skills – cover three specific groups of skills:
   - Product or service technology knowledge, i. e., knowledge used in the process of product and service creation and design;
   - Organisational skills, i. e., knowledge in business organisation creation;
   - Technical skills in the narrow sense, that is, skills necessary for specific industry operation.
2) Social skills – defined as an ability to work in a group, thus achieving maximum results. Katz also defined leadership skills related to motivation and positive influence skills, and 'network' skills related to business network creation as well as its efficient usage.
3) Conceptual skills – defined as the ability to perceive a company as a whole. They include:
   - Entrepreneurial skills, i. e., the skills of business opportunity comprehension,
   - Administrative skills related to complete and detailed planning and
   - Timely resource relocation directed towards more profitable arrangements.

In his approach, Maier (1965) suggests the following equations:

SKILLS = DISPOSITION (innate abilities) x TRAINING (practice)
PERFORMANCE = SKILLS x ABILITY TO DEMONSTRATE SKILLS

However, completed work depends not only on the skill or ability to perform it, but also on the motivation for the job. It is obvious that employee failure is the result of poor disposition and/or insufficient practice and/or low motivation. As far as the training is concerned, it is more direct in small organisational units, and therefore easier to conduct because all changes in knowledge, abilities, skills, needs and performance improvement are often direct, along with learning in certain organisation. This is the way to help employees in their personal career development. General problem about trainings is a lack of money and time as well as justification of their conduct. We could discuss whether there is enough money or time needed in comparison to large companies because the characteristics of a small company are certain dynamics and vibrancy, opposite to heavy and slow large corporations (Vukotić & Dukić, 2010).

Training applies to the planned attempts to encourage special knowledge, skills and behaviour acquisition necessary for efficient work on a certain job. The

focus of personnel training is an employee's job. In contrast, personnel development includes knowledge, skills and behavior acquisition necessary to improve personnel ability to meet the challenge of various existing or future jobs. For example, workers may need the training that enables them to use computers, electronic mail and other information technology aspects, not necessary related to the specific needs of their current job (Đurica & Đurica, 2009).

2.1. Setting the training goals and training plan

Before the training programme starts, it is necessary to establish the training goal and what the training aims to achieve. Unfortunately, training plans in a lot of organisations have no goals. It seems that the final aim is 'training for the sake of the training itself'. Efficient training goals should establish the outcome for the organisation, department or individual at the end of the training. The results should be described in writing.

Training goals can be established if the following questions are answered (Savović, 2006):

- What principles, facts and concepts should be learnt in the course of the training programme?
- Who should be trained?
- When to conduct the training?
- What is the influence of the training on the organisation and department outcomes, such as: absence from work, reduced cost and increased productivity?
- What is the impact of the training on behaviour and attitude of the trained individuals?

At the same time, Personal Mastery implies that all the employees in the company are reqired to improve themselves since their further knowledge, skills and abilities will make their company better equipped to respond to various market challenges. The company should create the conditions for the employees to experiment, create innovations whereas mistakes are allowed, and the conclusions for business improvement are reached through success and failure analysis as a result of change encouragement in business. Information is central as an input system component (Mašić, 2010).

When certain problems in personnel work and behaviour occur in the organisation, caused by the lack of knowledge and skills, there is a need for training and education. Training and education plan for the employees include the following steps:

1. Training and education needs analysis. The analysis needs to establish whether the training and education is really necessary, and if it is, what type of education or skills are needed. Every job involves specific and strategic

tasks. Improvement is necessary in order to complete them and avoid possible mistakes in their implementation. The type of training or education depends on the task analysis results completed in specific jobs, and therefore it is divided into tasks, the employees are educated to complete each of the tasks.

2. Task analysis. This analysis is performed in order to enable the employees to acquire the skills necessary for successful task completion. It examines a job in details in order to establish the necessary skills. The basic source of offering useful information in this segment of the analysis is certainly job description as well as its detailed specification.
3. Performance analysis. This analysis checks the results and establishes whether they can be improved through training or any other means (e. g. employee relocation to a new job).

Training planning process involves several stages. They are training need identification, training requirements definition, training planning and programming – educational content, methods, techniques, instructors, conveniences and location included, as well as training implementation and evaluation (Ćamilović & Vujić, 2007).

Some of the following methods can determine whether there are some deficiencies in the work or whether training is necessary:

- Performance is checked by a supervisor, colleague or employee
- Employee absence, accidents at work, personnel complaints, damaged goods, customer complaints, product quality, etc
- Work knowledge check, skills, presence
- Attitude evaluation
- Individual diaries kept by an employee on daily basis
- Case studies

After establishing the type of training to be conducted, it is necessary to establish measurable and specific education goals. The instrutor, that is, the person conducting the training should certainly be personnel education oriented.

2.2. Company training and education programme systems

There are three types of programmes necessary for every company in order to survive in the market. They are basic, innovative and the programmes adjusted to the current needs. The basic training and education programmes include overall knowledge necessary for taking over work, that is, managing role. These basic programmes are intended primarily for potential leaders (managers). The innovative programmes contain extended knowledge and innovations in certain fields of work or management included in the basic programme. The training programmes adjusted to the current needs (ad hoc programs) represent a set of specific knowledge in the field related to and influencing quality, management

or successful work in the stated period. In addition to this type of education, there are others, such as: conferences, consulting services, research reports and other types (Vuksanović, 2011).

When new personnel introduction and employment is in question, following the choice of candidates, manager's task is to direct and educate them for their jobs. It implies that new employees receive basic information necessary for doing their business in a satisfactory manner, according to the organisation regulations and goals. The aforementioned task is performed by the employer, and it is exactly a form of new employees socialisation process. The aim of this uninterrupted process is to instil attitudes, standards, values and patterns to new employees, the ones expected by the organisation as well as the 'old' employees in future mutual business. The directing programmes start with an informal and short introduction into business, and it continues through the formal programmes. In both cases the new employee receives job specification in the form of manual with detailed explanations referring to the working hours, performance analysis, payments, vacations as well as a short guide through company facilities. In addition to all these items, it also contains the items related to everyday tasks at certain jobs, personnel policy, company business, safety measures and regulations, as well as company organisation. Successful direction towards specific goals, such as feeling welcome, understanding the organisation the new employees have joined, as well as the introduction to the key factors – organisation policy and procedure. On the basis of the directions, the employee understands how to work, behave and all of that according to the organisation.

2.3. Trainig techniques and methods, and the approaches to training

It is necessary to apply certain training techniques and methods in order to achieve the set goals after establishing the need for training and defining the type of training**.** Some of the method examples and techniques are as follow:

1. On-the-job training. There are several types of on-the-job training, such as giving instructions by the employer (supervisor) or an experienced worker showing how to do the job. Another example of such training could be to put a worker in charge of a job, so as to gain experience or work rotation.
2. Off-the-job training. Off-the-job trainings involve all trainings conducted out of the job (organisation). They are trainings in special training institutions (centers), sometimes trainings in other organisations.
3. Combined trainings. Combined training is a personnel training process where a part of the training is conducted within the organisation, and the other outside the organisation. Training distribution can be performed according to the type of activity or job as the training subject, or training duration.
4. Non-formal learning. This training type has proved to be very successful according to numerous conducted surveys. Also, some of the research

shows that as much as 80 percent of the respondents acquire knowledge much better through non-formal training, performing tasks on the job with colleagues, than in formal trainings.

Personnel training belongs to a very important part of the work in human resource department. Not only that training is necessary in order to complete business effectively and efficiently, but it is also an opportunity for a company to adjust to the environment changes through the personnel training according to the market, service user and organisation requirements. As it has already been pointed out, the training helps both the individuals and organisations to reach their maximum potential, tackle the challenges and achieve specific goals (Wilson, 2007).

Training methods are versatile, and they are applied depending on the activity of the organisation, as well as the goals set by the training. Likewise, training methods and techniques distribution can be classified in several ways. According to another classification, the most common methods are:

1. On-the-job training (OJT). It implies a traditional and very popular type of training consisting of the tasks for the employee performed under the leadership of an experienced person employed on the same job.
2. Job replacement (rotation) consists of planned and time limited replacement of the employee on the training from one to another job related to his job performance.
3. Mentoring and 'apprentice' training represents a very old technique of an apprentice training where individuals are trained on the job with an experienced expert's help. This is the way to link the on-the-job training with the school training. The candidate is enabled to learn from and look up to an exceptionally able and experienced colleague and expert.
4. The goal of simulation is to train a future worker in the conditions identical to those in his job, but they are created in some other place using the identical nevertheless mostly improvised equipment. Only when a candidate has fully mastered the operation mode and conditions as well as equipment, does he start completing the real tasks. This training method is especially used in the conditions distinguished by very sensitive, complicated to use and expensive equipment. A typical example of 'simulation' is a flight simulator in pilot training.
5. Lectures are a classic type of training future candidates for a job, and they are a component in almost all training types. This training type consists in the experts, within or outside the organisation itself, giving lectures on necessary knowledge and skill acquisition in combination with practical examples. The organisation of such lectures often involves universities and institutes with their programs and lecturers. This type of training is most frequently supplemented by the appropriate books or manuals on the subject.

6. Technology-based methods. There is an increasing number of the companies using training methods based on technology. The advantage of these methods is that they are cheaper, accessible and contain a large range of information. About a decade ago, the best-known training methods of this type were: CDs, DVDs, computers, video cassettes, audio cassettes, distance learning, video conferencing, teleconferencing, satellite and cable TV, internet-based training, learning portals (Mašić, 2010). Although some of these methods are outdated, they are still modern training types.

A lot of similarities can be noticed between these two classifications, but certain differences as well. The traditional approach to training can be related to the developed industrial production and traditional organisations. This approach shows that the basic goal of training is the transfer of necessary expert knowledge or the practice of motor skills in order to increase efficiency (fast, accurate and safe work). Nowadays, this approach is still applicable in organisations with short production cycles, as well as in routine business beyond production. This training includes classical teaching in combination with practical work and elementary training. The four-level method is widespread in training for quality. The traditional four-level training model includes:

- Preparation: what level of knowledge is acquired, what are the goals, participant motivation.
- Demonstration: a display of certain work stages by the teacher, comprehension of the participant, task (problem) approach.
- Performance: work assignment imitation until satisfactory performance is achieved.
- Completion: independence rehearsal with success control and the 'trainer's“ help.

The fact that we can state as a lack of the traditional approach to training is surely underdeveloped training related to more complex jobs in production which require planning, communication, organisation, education for changes and development. It is treated as a cost factor that brings neither benefit nor harm. The changes in technology and economy structure caused the companies to invest much more in personnel training in order to succeed in meeting more complex customer requirements, and of course, so as the competition cannot push them out of the market. Due to the turbulent changes, in technology as well as structure, even up to 40 percent of knowledge has become obsolete every year, over 10 percent of jobs have been shut down, and only a small number of new jobs opened. These are the factors that caused the traditional approach to adjust to the changes. The modern concepts offer the answers to the business organisation requirements related to the level of expertise update. Thus, for example, according to the research by Vojnović and Vukotić (2018), 75% of the researched companies had organised personnel training in new program and equipment usage, 73% with the help of specialised companies and 27% of the

companies worked on their own. Modern concepts have a goal of skill development - work skills, solving problem skills, skills for accepting responsibility and cooperation for personnel. Also, this type of concept is necessary for organisations introducing quality system, the ones that want to provide the synergy in engaging the employees and organisational units, training management for personnel motivation and engagement in order to achieve common goals of the organisation, and as such qualified by the connections between individuals and the organisation.

Modern economy demands well-trained, adaptable work force, and thus the education and improvement of the employees as well as managers represent an inseparable part of every successful development policy. The investment into personnel education should not be treated as a consuption type, but a type of investment into extended reproduction because personnel planning and its education is the key issue in every society (Vukotić & Vojnović, 2016).

Organisations provide training for personnel ability increase in problem solution and recognition of the need to adjust to rapid changes characteristic for a job. In general, the decisions referring to the training – who participates, what will be learned and how – are made by the organisation rather than an individual the training is organised for. The goals of the training are most frequently organisational (for example, increased performances and efficiency) rather than personal goals of trained staff. This distinction between education and training is evident in the entire professional literature (Milojević & Milojević, 2013).

2.4. Manager training

In addition to personnel training in practice, a lot of attention is paid to manager improvement. The aim of these programmes is to improve managers' business results through the acquisition of new knowledge and skills. Conditions for organisation results improvement as a whole are also created through the creation of the managers prepared to respond to the challenges in a changing environment. The main ways of knowledge and skill acquisition necessary for a successful manager are: 1) formal development programme and 2) on-the-job development (Vuksanović, 2011, 226).

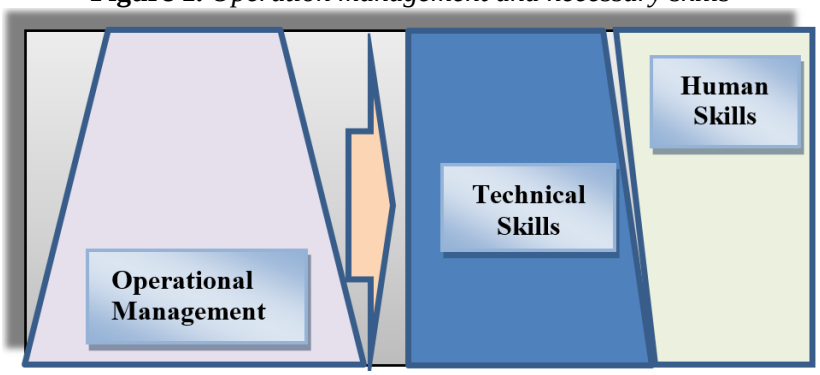
Manager improvement programmes can be organised within the company itself (training, courses, work rotations, professional programmes), but there are also university programs such as MBA in management. The best-known methods in manager training on-the-job are learning at work and on-the-job rotation. The training methods typical mainly for managers are: case study method and management games. In case study method, the manager analyses and solves an interesting problem in the company, discussing his solutions and decisions with other managers in the training. Management games are very interesting and modern, where groups of managers (five per group) compete with each other in

simulated market conditions. Thus, each group decides on expanding into new market, type of product and service, product advertising, funds necessary for all these activities, unaware of the other groups' solutions (Mašić, 2010).

Knowledge necessary for managers in various levels also imply different knowledge and skills. The type of knowledge necessary for managers in higher levels of hierarchy is less needed for operation managers and managers in medium levels, and vice versa. Thus, for example, opposite to the team of specialists he manages, the manager does not need to be a specialist. He should have some knowledge in all areas the people he manages operate in, so that he should have universal knowledge compared to his team.

Top management needs technical knowledge the least, but they mostly need conceptual skills. Human dimension, conceptual skills and less technical knowledge in comparison with operation management are the characteristics of the necessary skills at the medium level of management. Technical knowledge are most needed for operation managers (Figure 1) because their field includes operational activities mainly based on the specific knowledge in technical areas (Stoiljković *et al.*, 2013).

Figure 1. *Operation management and necessary skills*



Source: adapted from – Stoner & Freeman (1989)

Nowadays, organisation structures prevail in the companies where the main characteristics are information technologies usage, independence among individual units that can possibly be dislocated in space, frequently non-hierarchical structure, and the only certain thing is that all the units act according to the same goal. These organisations have a net or neuron structure. Every unit is connected to all units. Physical distance is practically non-existant due to the internet development and multimedia conferences making business easier and reducing necessary time and labor costs. Information system application leads to improvement in: profit, increased income, market share, quality and other business performance increase. In addition to all that, an adaptive subsystem is necessary, with the aim of eliminating unpredictable mistakes. Business

information system multidimensionality and its harmony with increasingly complex business system is necessary for maintaining, and possibly, accelerating the progress and exploitation of the production technology (Vojnović & Vukotić, 2018).

3. RESEARCH

3.1. Methodological framework of the research

The research was conducted with the aim of determining the compatibility degree between training and development of the employees, manifested through various modalities of employees' readiness for changes in business, personality traits, needs for development, as well as the development goals of the organisation. Personnel training and development are very important from the business success aspect. Above all, they depend on the organisation characteristics related to business success and the type of organisation. Personnel development and training depend on social and psychological characteristics of the employees, as well as demography. This paper describes the research conducted on the influence of the personnel training in software application usage.

Research participants knowledge was evaluated through a test before software package application. 86 respondents took part in the research. After the software training, the respondents' knowledge was evaluated once more in a test. The results before and after the training were compared, and the following results were gathered. Progress is determined as a difference in the number of points the respondent scored in the test before and after the training. This fact has already proved the necessity of the permanent training, as well as its significance.

The research questions are:

1. Does the training conducted through software application improve personnel knowledge?
2. What test results in knowledge evaluation after the training did the respondents score depending on: the level of education, work experience and age?

Analysis of the results of the software training impact study was performed using descriptive and comparative statistics of the SPSS software package. Cross-group comparison of numerical features was performed by Student's t-test or analysis of variance (ANOVA) depending on the number of groups compared. The correlation between the variables observed was examined by the Pearson correlation test. A difference or association was considered statistically significant if the probability was $p<0.05$, and highly statistically significant if $p<0.01$.

3.2. Research result analysis

1. Respondent distribution according to gender. There were more men in the research (55%), while there were less women (45%).
2. Respondent distribution according to age. The distribution of respondents according to age showed that most of the staff was between 30 and 40 (74%). There was much less younger staff under 30 (21%). The least of the staff was over 40 (5%).
3. Respondent distribution according to the level of education. The distribution according to the education level showed that most of the staff had secondary education degrees (51%). Less respondents had university degrees (24%), and 18% with lower education degrees. The least of the respondents had higher education degrees (7%).
4. Respondent distribution according to work experience. The distribution of the respondents according to work experience length showed that there were 16% with experience under 5 years. Most of the respondents had 5 to 10 years of work experience (56%). There were 23% of the respondents with 10 to 15 years of experience, and 5% with 15 to 20 years experience.
5. The comparison in test knowledge before and after the training in software packages. The test of the respondents before and after the software package training showed there was highly statistically significant progress in the test after the training. The average success in the test expressed in the number of points was 59.76 before the training, and 73.18 after the training (Table 1). T test for the linked samples showed the difference to be highly statistically significant because statistical probability was p=0.0001.
6. Comparison of success in the test after the training in groups of respondents distributed according to education level. The test after the training in software packages showed that the groups with secondary, higher and university degrees had statistically significantly better result than the group with elementary education (87.33 and 95.83 and 100 points compared to 60.29), as we can see in table 2. Statistical variance analysis test (ANOVA) along with LSD post hoc test showed that the difference is statistically significant because statistical probability was p=0.0001.

Table 1. *Comparing knowledge values in the test before and after the software packages training*

Groups of respondents	**Test results (medium value ± standard deviation)**
Before the training	59.76 ± 23.41
After the training	73.18 ± 23.48
Statistical significance (p)	0.0001

Source: the authors' calculation

Table 2. *Comparing success in the test after the training according to the respondent groups distributed according to education levels*

Respondents according to education levels	Test results after the training (medium value ± standard error)
Elementary	60.29±2.92
Secondary	87.33±0.96
Higher	95.83±1.54
University	100±0
Statistical significance (p)	0.0001

Source: the authors' calculations

7. Comparison of success in the test after the training according to the groups of respondents distributed according to work experience (Table 3). Respondent testing after the software packages training showed that the groups with 5-10 years of experience, 10-15 years, 15-20 years had statistically significantly better results compared to the group with under 5 years of work experience (89.28 and 99.54 and 100 points). Variance analysis statistical test (ANOVA) along with LSD post hoc test showed the difference to be statistically highly significant because the statistical probability was p=0.0001.

Table 3. *Comparison of success in the test after the training in respondent groups distributed according to the work experience length*

Respondents according to work experience length	Results in the test after the training (medium value ± standard error)
Under 5 years	62.05±2.84
5 to 10 years	89.28±1.15
10 to 15 years	99.54±0.45
15 to 20 years	100±0
Statistical significance (p)	0.0001

Source: the authors' calculations

8. Comparison of progress achieved in the training according to education level. The research of respondents' progress after the training showed that the group with university education achieved the least progress compared to the respondents with elementary, secondary and higher education (6.25 compared to 14.62 and 14 and 15.83). Variance analysis statistical test (ANOVA) with LSD post hoc test showed that the difference is statistically highly significant because the statistical probability was p=0.003 (Table 4).

Table 4. *Comparison of the progress achieved by training by education level*

Respondents by education level	Progress in test after training (medium value± standard error)
Elementary	14.62±1.12
Secondary	14±1
Higher	15.83±2.01
University	6.25±1.09
Statistical significance (p)	0.003

The source: the authors' calculations

9. Comparison of progress achieved by training by experience length (Table 5). The progress after the training showed that the group of respondents with under 5 years of experience, and 5-10 years of experience achieved highly statistically significant progress compared to the groups with 10-15 years of experience as well as 15-20 years (14.73 and 13.93 points compared to 19 and 2.5 points). Variance analysis statistical test (ANOVA) with LSD post hoc test showed that the difference is statistically highly significant because the statistical probability was p=0.004.

Table 5. *Comparison of progress achieved by the training by years of experience*

Respondents by years of work experience	Progress in test after training (medium value± standard error)
Under 5 years	14.73±1.05
5 to 10 years	13.93±1.19
10 to 15 years	10.0±1.35
15 to 20 years	2.5±1.44
Statistical significance (p)	0.004

Source: the authors' calculation

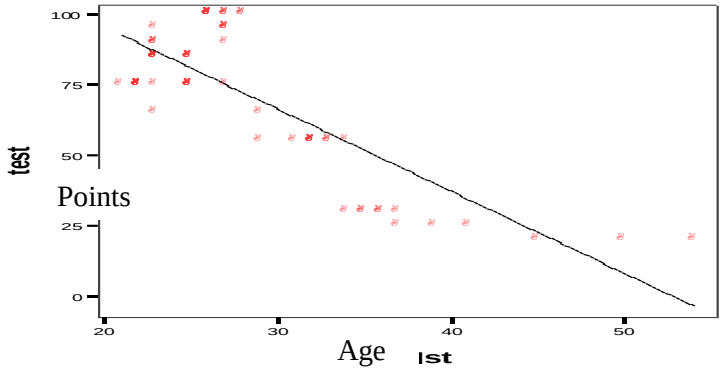
10. The connection between the age and the success in the test. The research of the connection between the age and the success in the test showed that there was a highly statistically significant negative correlation, that is, the number of points in the test decreased with age (Table 6 and Figure 2). The connection was examined by the Pearson's correlation coefficient with r=-0.784 value.

Table 6. *The connection between the age and test success*

Test	The connection between age and test success
Correlation coefficient (r)	-0.784
Statistical significance (p)	0.001

Source: the authors' calculation

Figure 2. *Number of points distribution according to age*



The research conclusions:

1. the research showed that the software training application improved knowledge
2. the respondents with higher and university education had the best results in the knowledge evaluation test after the training
3. in addition to that, the respondents with longer work experience had the best results
4. on the other hand, the respondents with lower education level, with the least experience made the greatest progress, justifying the software usage in the training of these groups
5. younger population had cosiderably better results in the test because they use software packages more easily.

Thus, we can consider the research conducted has provided the answers to the researchers' questions.

CONCLUSION

The intensive and turbulent business environment require continuous changes and adjustments in the business system. The most reliable source of permanent competitive advantage is knowledge in the conditions of uncertainty and risk in high degrees in business processes. Everyday practice proves that modern companies have trained people in all levels. The role of the training is not to provide general education, or teach everything, but it is focused on what's necessary for the company jobs. Therefore, training is an adjustment process of the employees to the conditions of modern business. It is a process that enables the employees to meet the market changes and customer requirements successfully. Educated people have access to vital information, they understand the problems and they are ready to take active part in their solution.

In order to preserve the acquired positions and increase competitive advantage, an organisation should be capable of creating new knowledge, not only to rely on the exploitation of the existing one. In this context, continuous education and employee development have an important role in the performance development. Training refers to the plans in company endeavours to facilitate mastering the job related skills for the employees. These skills include knowledge, skills or behavior as the key for effective business completion. Formerly, training meant solely focusing the employees' learning on mastering the skills necessary for the job, and now it is expanding to create and share knowledge, in order to create intellectual capital. Hence, in addition to the basic skills closely related to doing business, there are also extended skills of technology usage, information exchange among the employees, customer and business comprehension.

The purpose of training is that the employees acquire knowledge, skills and behaviour highlighted in training programmes, applying them in everyday activities. It has been confirmed recently that training should contain more than just basic skills development in order to gain competitive advantage. In addition to training, attention is also paid to manager improvement in practice. The main methods of knowledge and skills acquisition necessary to become a successful manager are: 1) formal development program and 2) on-the-job development. Technical skills are the least important for top managers, but they are the most important for operation managers. Conceptual skills are of no significance for operation managers.

Training achieves, primarily, market competitiveness, because organisations invest in employee education. Therefore, the employees are more motivated to show and prove their own knowledge, resulting in more profit and company identification in the market. To put it briefly, we can reach the conclusion that the training process is performed with the result of effective acquisition of knowledge and experiences in future business.

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ANALYSIS OF MOTIVATIONAL ATTITUDES OF EMPLOYEES IN PUBLIC COMPANIES

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Abstract: Employees with their knowledge, abilities and capabilities represent the most important asset of an organization. Therefore, it is up to the managers to build a system of motivation and rewards that will encourage them to do their best work and thus contribute to the achievement of organizational goals, which increases their commitment to the organization. The aim of this paper is to analyze the motivational attitudes of employees in public companies. The survey was conducted in 2017 on the territory of the Republic of Serbia. The statistical software package SPSS was used for data analysis. The research hypotheses were tested by appropriate statistical analysis methods that include non-parametric analysis techniques and multivariate analysis techniques. The results of the survey are statistically significant, so we have arguments to conclude that socio-demographic factors act as predictors of motivational attitudes of employees in public companies. This paper contributes to the scientific literature and yields original results regarding the motivational attitudes of employees in order to increase the success of the organization itself.

Keywords: public enterprises, human resources, job satisfaction, reward system, motivation, loyalty
JEL: M12, C10, L32, J28

1. INTRODUCTION

Economies of Western Balkans countries, on the pathway to European integration shall depend on enhancing their efficiency and performances in industry, service and know-how. Modernizing production and raising efficiency and competitiveness, accelerating structural changes toward knowledge based services, are the major generators of value added, exports and new jobs (Vapa-Tankosić *et al*., 2013). The results of authors' research on the effects of the use of EU funds in Central European (CEE) countries and the correlation between Happy planet index (HPI) and wellbeing indicator with absorption of EU funds prove the hypothesis that funds are bringing wellbeing in terms of satisfaction of

CEE citizen (Kranjac *et al.*, 2017). One of the key success factors for both private and public companies is the satisfaction of their employees, who, through their knowledge, abilities and capabilities, contribute to the achievement of organizational goals. Public enterprises are enterprises founded by States and carrying out activities of general interest. Pursuant to Article 4 of the Law on Public Enterprises (Official Gazette of the RS, 15/2016) the goals of establishment and operation of public enterprises are: ensuring the permanent performance of activities of general interest and regular satisfaction of the needs of users of products and services; development and promotion of activities of general interest; ensuring the technical and technological and economic unity of the system and the harmonization of its development; gaining profit; and pursuing another statutory interest. The overall behavior of each individual is conditioned by their motives (needs) that give them strength and determine the goals of their activity (Lekić & Erić, 2018). Employees need to be adequately motivated in order to perform their business more efficiently. Motivation is defined as a set of factors that drive and direct people and encourage them to reach a specific goal (Williams, 2011). Motivation can be said to be a governing process that influences people's behavior based on knowing what triggers a particular human behavior. Managers should play a major role in motivating employees to get them to their maximum, using the motivational means provided by the organization (Armstrong & Tayler, 2014). It is up to the managers, through an adequate way of motivation and reward, to encourage employees to achieve organizational goals. It is also up to them to build good employee relationships, a sense of belonging, and a respectful attitude for all employees, as they stimulate innovation, strengthen initiative and enable successful performance of work tasks (Lekić & Rajaković-Mijailović, 2017). Innovation is a process that connects new ideas with new processes and products (Aboelmaged, 2012) and requires organizations to go beyond learning from repetition, defect correction and the desire to reduce process variation. Because employees are crucial to the success of modern organizations, it follows that the basic task facing organizations is to strive and do everything in their power to attract and retain the best people. Specifically, organizations need to determine what kind of employees they want and need for new business conditions. They need to know how they attract employees to work for them, how to keep them loyal.

The results of the survey of the members of the EU Public Administration Network (EUPAN) of representatives of public administration institutions of all EU members, the European Commission as well as of Norway, Switzerland and Serbia (members with observer status) on performance appraisal of civil servants working in central public administration point out that since 2007, increasing professionalization, standardization of performance appraisals across departments and performance appraisal process have occurred (Staroňová, 2017). The results in Serbia show that for employees in public companies, monetary stimulation

and the amount of earnings are indispensable factors of motivation, which is also shown by the results of the research on organizational commitment of employees in commercial banks (Lekić & Vapa-Tankosić, 2018), where employees feel the security in the bank they work in and feel they will be rewarded for the good results of their work, that is, for the achieved results. The finding that remuneration significantly effects job satisfaction has been also confirmed by Lindgren and Paulsson (2008), Taylor (2013), Vosloo *et al.* (2014) and Naji (2014).

In the research of authors Lekić and Vapa-Tankosić (2019), the effectiveness of teamwork of public employees was investigated. Team synergy is a sense of belonging shared by team members. Associate's skills describe team members' training, job competency and flexibility within job descriptions. Innovation involves finding ways to improve productivity and ways of performing work. Quality measures the level of familiarity with customer needs and standards of monitoring their satisfaction. The results showed that the public employees rated synergy with the highest average grade, followed by quality and innovation, and then the associate skills. The correlation between individual teamwork parameters was statistically significant. There are minimal differences in the assessment of individual parameters of teamwork between men and women. Assessment of teamwork parameters varies with age. Respondents over 55 have considered the team synergy to be the most important factor in teamwork (as well as respondents under 35), while respondents are 35-55 years rated associate's skills with the highest score. Employees with the highest level of education have opted for quality, while among the respondents with the lowest level of education the synergy is the most important parameter of teamwork. Linking individual parameters of teamwork to number of years spent in organization shows that respondents with up to five years of seniority evaluate as the most important the innovation (6-15 years of synergy, 16-20 skills, and over 20 years of quality). All this confirms that socio-economic characteristics have a positive effect on synergy, skills, innovation and quality.

Based on the conducted analysis of job satisfaction, the authors Vapa-Tankosić and Lekić (2018) show that employees job content satisfaction contributes most to overall job satisfaction. The results indicate that the employees satisfaction with the incentive rewards policy and additional education opportunities is rated as the lowest in overall job satisfaction. The subject of the recent research (Lekić *et al.*, 2019) on job satisfaction in public sector in Belgrade region in two independent time periods (in 2017 and 2010) was to analyze whether the salary, cooperation with closest associates, and possibility of promotion, remuneration policy, cooperation and good relationships with superiors and nature of the job are directly and positively associated with total job satisfaction. In the last seven years, the increase in job satisfaction in regard to satisfaction with salaries, the promotion on a hierarchical scale, remuneration policy and the nature of the job,

has been observed. On the other hand, the results show that the employees' satisfaction with cooperation with their closest associates or cooperation and relations with superiors has not been improved.

The aim of this paper is to identify the motivational factors of employees in public companies and to determine whether they are related to socio-demographic factors such as gender, age, number of years spent in an organization and level of education. In the next section we discuss revealed relations between the motivational and socio-demographic factors in order to reach relevant conclusions.

2. METHODOLOGICAL FRAMEWORK

The survey has involved 508 respondents employed by public companies in Belgrade and was performed in the year 2017. Data collection was done by an anonymous survey. The first part of the survey includes the socio-demographic factors: gender, years of age, years of work experience and educational level. The motivation of the employees of the companies that were the subject of the research was tested using nine motivational factors: the amount of earnings (M1); good relations with the manager (M2); greater autonomy in work and decision making (M3); better awareness of future company business (M4); professional development opportunities (M5); additional education (M6); incentive reward system (M7); going on paid vacation (M8); the possibility of resolving the housing issue (M9).

Due to the specificity of the issue of motivation of employees in public companies, the first hypothesis from the research is to investigate whether there is a significant relationship between motivational attitudes (M1-M9) with gender, age, years of work experience and level of professional qualification of employees. The chi-squared test was used to test the interdependence of the variables. More specifically, with this test we wanted to answer the question of whether the characteristics are independent of each other. Depending on the number of characteristics, two factors exist $2x2$ or rxk, where $r > 2$, $k > 2$,and r represents the number of rows while representing the number of columns, contingency tables. According to the authors of Woolson and Clarke (2002), the null hypothesis of this test assumes that there is no dependence between the characteristics observed by two factors, whereas by working or alternative hypothesis it is assumed that there is dependence. The expected and obtained values determine the test statistic χ^2:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \qquad (1)$$

where O_i represents the obtained values, while E_i represents the expected values. This value is compared to the value $\chi^2_{\alpha(r-1)(k-1)}$ which is found in the tables χ^2

, α represents a significance threshold and a $(r-1)(k-1)$ number of degrees of freedom.

As stated by the authors Radović-Marković and Hanić (2018), Pearson's Contingency Coefficient, which is calculated based on the realized value of statistics χ^2-test

$$C = \sqrt{\frac{\chi^2}{n+\chi^2}} \qquad (2)$$

shows the strength of the relationship between the (categories) of the observed variables and takes values in the range from 0 to 1, with a larger number indicating a stronger dependence of the two variables. The Phi coefficient is most commonly used to measure the correlation for two-row and two-column contingency tables. Cramer's V effect size is calculated for tables larger than $2x2$. V coefficient is calculated for tables of format larger than $2x2$

$$V = \sqrt{\frac{\chi^2}{n(r-1)(k-1)}} \qquad (3)$$

where χ^2 test statistic is obtained by (1), n is the total number and $(r-1)(k-1)$ number of degrees of freedom. The interpretation of the values is presented in Table 1.

Table 1. *Interpretation of the value of the Kramer effect of interest*

$(r-1)(k-1)^*$	low significance	medium significance	high significance
1	0.10	0.30	0.50
2	0.07	0.21	0.35
3	0.06	0.17	0.29
4	0.05	0.15	0.25
5	0.04	0.13	0.22

*– number of degrees of freedom

Source: Hae-Young (2017)

The second hypothesis argues that sociodemographic factors have an influence on motivational attitudes regarding direct material incentives (M7–M9). This study will use regression analysis of the influence of two or more explanatory variables on the dependent variable. With this regression, we want to determine how many percentages of variability of the dependent variable are explained by a given set of independent variables, and the relative contribution of each independent variable included in the regression analysis. Multidimensional logistic regression is a statistical method that examines the influence of multiple independent factors on a single dependent factor (Rosner, 2011; Hanić *et al*., 2010). The equation of the multidimensional logistic regression model is defined by:

$$ln\left(\frac{p}{1-p}\right) = \beta_0+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n \qquad (4)$$

where the independent factors are X_i , the regression coefficients are β_i and p the probability that the event has occurred. In this case, the dependent factor is binary so we shall use binary logisitc regression. The statistical package SPSS (Statistical package for Social Sciences) was used to analyze the data of this study. In all statistical tests, the significance threshold (α) was set at 5%.

3. RESULTS AND DISCUSSION

The respondents' socio-demographic characteristics are presented in Table 2.

Table 2. *Structure of the sample according socio-demographic characteristics*

		2017.	
		Frequency	Percentage
Sex	Male	217	42.7
	Female	291	57.3
	Total	508	100.0
Age group	Up to 35	189	37.2
	35–55	258	50.8
	Over 55	61	12.0
	Total	508	100.0
		Average value: 40.70 Std. Dev = 6.08 Coeff. Var =14.95%	
Education*	D	182	35.8
	C	92	18.1
	B	195	38.4
	A	39	7.7
	Total	508	100.0
The number of years spent in the organization	Less than 5	117	23.0
	6–15	221	43.5
	16–20	63	12.4
	Over 20	107	21.1
	Total	508	100.0
		Average value: 12.6 Std. Dev = 5.49 Coeff. Var = 45.22%	

* A. post–graduate qualification, B. college diploma, C. higher educational diploma, D. high school diploma

Source: Authors own research

Descriptive statistics show that 57.3% of female and 42.7% of male respondents participated in the 2017 survey. The average age of the respondents is 40.70 years. The highest number of respondents (38.4%) has a university degree. Each respondent spent an average of 12.6 years in their organization. The results of descriptive statistics in relation to motivational factors are given in Table 3. Descriptive statistics of all motivational are presented by the percentage according to the total number of respondents who chose the appropriate answer to the motivational claim: (4) yes; (3) moderately; (2) slightly; (1) no.

Table 3. *Descriptive statistics of motivational attitudes*

		Frequency	Percentage
M1. Do your earnings influence your job performance?	Yes	123	24.2
	Moderately	225	44.3
	Slightly	84	16.5
	No	76	15
	Total	508	100
M2. Does a better relationship with your manager influence your job performance?	Yes	97	19.1
	Moderately	220	43.3
	Slightly	99	19.5
	No	92	18.1
	Total	508	100
M3. Does a greater autonomy in your work and decision making influence your job performance?	Yes	179	35.2
	Moderately	132	26
	Slightly	93	18.3
	No	104	20.5
	Total	508	100
M4. Does information on company's future business plans influence your job performance?	Yes	152	29.9
	Moderately	155	30.5
	Slightly	93	18.3
	No	108	21.3
	Total	508	100
M5. Do professional development opportunities influence your job performance?	Yes	143	28.1
	Moderately	165	32.5
	Slightly	92	18.1
	No	108	21.3
	Total	508	100
M6. Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance?	Yes	175	34.4
	Moderately	132	26
	Slightly	92	18.1
	No	109	21.5
	Total	508	100
M7. Do monetary incentives influence your job performance?	Yes	471	92.7
	No	37	7.3
	Total	508	100
M8. Does the possibility of going on a paid vacation influence your job performance?	Yes	301	59.3
	No	207	40.7
	Total	508	100
M9. Does the possibility of solving housing issues influence your job performance?	Yes	275	54.1
	No	233	45.9
	Total	508	100

Source: Authors own research

From the descriptive analysis of the motivation attitudes for the question M1. Do your earnings influence your job performance? the majority of respondents (68.5%) answered that it has a strong and moderate influence. When asked by M2. Does a better relationship with your manager influence your job performance? the majority of respondents (62.4%) answered that it has a strong and moderate influence. When asked by M3. Does a greater autonomy in your work and decision making influence

your job performance? the majority of respondents answered that it has a strong and moderate influence (61.2%). When asked M4. Does information on companies future business plans influence your job performance? the majority of the respondents answered that it is has a strong and moderate influence (60.4%). When asked M5. Do professional development opportunities influence your job performance? the majority of the respondents answered that it is has a strong and moderate influence (60.6%). When asked M6. Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance? the majority of the respondents answered that is has a strong and moderate influence (60.4%). When asked M7. Do monetary incentives influence your job performance? the majority of respondents answered yes (92.7%). When asked M8. Does the possibility of going on a paid vacation influence your job performance? the majority of respondents answered yes (59.3%). When asked M9. Does the possibility of solving housing issues influence your job performance? the majority respondents answered yes (54.1%).

3.1. Independence of socio-demographic characteristics and motivational attitudes

Below, we shall present the results obtained using the Chi square test to examine whether there is a statistically significant difference between sociodemographic characteristics and motivation. The starting hypothesis is that there is dependence of each socio-demographic factor (gender, age, education and number of years spent in the organization) with each motivational attitude. We analyze at the relationship of respondents' motivational attitudes to the gender (Table 4). The following motivational attitudes: Does a greater autonomy in your work and decision making influence your job performance? Does information on company's future business plans influence your job performance? Do monetary incentives influence your job performance? Does the possibility of solving housing issues influence your job performance? have a value of $p>0.05$, so it can be concluded that there is no statistically significant association. If we look at employee motivation with socio-demographic characteristics, we conclude that gender is statistically significant thus related to the following motivational factors: earnings, better relationship with your manager, professional development opportunities, possibility to acquire (improve) a foreign language, work on a computer, and possibility of going on a paid vacation and the hypothesis of the independence of the gender and the motivational attitudes has been partially confirmed.

Table 4. *CROSSTABS – Gender* motivation*

GENDER						
	YES	*MODERATELY*	*SLIGHTLY*	*NO*	**p**	**Cramer's V****
M1	Do your earnings influence your job performance?					
M	16.1%	47.5%	19.8%	16.6%	**0.003**	0.167
F	30.2%	41.9%	14.1%	13.7%		
M2	Does a better relationship with your manager influence your job performance?					
M	9.2%	48.4%	23.0%	19.4%	**0.000**	0.219
F	26.5%	39.5%	16.8%	17.2%		
M3	Does a greater autonomy in your work and decision making influence your job performance?					
M	31.3%	23.5%	20.7%	24.4%	0.084	0.114
F	38.1%	27.8%	16.5%	17.5%		
M4	Does information on companies future business plans influence your job performance?					
M	30.9%	24.9%	19.8%	24.4%	0.098	0.111
F	29.2%	34.7%	17.2%	18.9%		
M5	Do professional development opportunities influence your job performance?					
M	30.9%	23.5%	21.2%	24.4%	**0.003**	0.167
F	26.1%	39.2%	15.8%	18.9%		
M6	Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance?					
M	33.6%	19.4%	23.0%	24.0%	**0.005**	0.157
F	35.1%	30.9%	14.4%	19.6%		
	YES		*NO*		**p**	**Cramer's V****
M7	Do monetary incentives influence your job performance?					
M	92.2%		7.8%		0.731*	0.018
F	93.1%		6.9%			
M8	Does the possibility of going on a paid vacation influence your job performance?					
M	66.8%		33.2%		**0.003***	0.133
F	53.6%		46.4%			
M9	Does the possibility of solving housing issues influence your job performance?					
M	59.0%		41.0%		0.060*	0.084
F	50.5%		49.5%			

* Fisher's Exact Test

We analyze the relationship of respondents' motivational attitudes to the age (Table 5). The following motivational attitudes: Do your earnings influence your job performance? Does a better relationship with your manager influence your job performance? Do monetary incentives influence your job performance? have a value of $p>0.05$, so it can be concluded that there is no statistically significant association. If we look at employee motivation with socio-demographic characteristics, we conclude that age is related to the following motivational factors: greater autonomy in your work and decision making, information on companies future business plans, professional development opportunities, possibility to acquire (improve) a foreign language, work on a computer, and possibility of going on a paid vacation, solving housing issues and the

hypothesis of independence of the age and the motivational attitudes has been partially confirmed.

Table 5. *CROSSTABS – Age* motivation*

AGE						
	YES	*MODERATELY*	*SLIGHTLY*	*NO*	**p**	**Cramer's V****
M1	Do your earnings influence your job performance?					
<35	20.1%	47.1%	15.3%	17.5%	0.462	0.075
36-55	26.4%	43.0%	16.3%	14.3%		
>55	27.9%	41.0%	21.3%	9.8%		
M2	Does a better relationship with your manager influence your job performance?					
<35	19.6%	45.5%	16.4%	18.5%	0.139	0.098
36-55	17.4%	45.7%	19.8%	17.1%		
>55	24.6%	26.2%	27.9%	21.3%		
M3	Does a greater autonomy in your work and decision making influence your job performance?					
<35	29.6%	34.4%	14.3%	21.7%	**0.000**	0.157
36-55	42.2%	20.5%	17.8%	19.4%		
>55	23.0%	23.0%	32.8%	21.3%		
M4	Does information on companies future business plans influence your job performance?					
<35	21.2%	41.8%	15.3%	21.7%	**0.000**	0.164
36-55	38.0%	22.9%	19.0%	20.2%		
>55	23.0%	27.9%	24.6%	24.6%		
M5	Do professional development opportunities influence your job performance?					
<35	22.2%	39.2%	16.4%	22.2%	**0.016**	0.124
36-55	34.9%	26.7%	18.2%	20.2%		
>55	18.0%	36.1%	23.0%	23.0%		
M6	Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance?					
<35	30.2%	32.3%	15.3%	22.2%	**0.010**	0.128
36-55	40.7%	20.9%	17.8%	20.5%		
>55	21.3%	27.9%	27.9%	23.0%		
	YES		*NO*		**p**	**Cramer's V****
M7	Do monetary incentives influence your job performance?					
<35	91.0%		9.0%		0.470	0.055
36-55	93.4%		6.6%			
>55	95.1%		4.9%			
M8	Does the possibility of going on a paid vacation influence your job performance?					
<35	48.7%		51.3%		**0.000**	0.178
36-55	67.4%		32.6%			
>55	57.4%		42.6%			
M9	Does the possibility of solving housing issues influence your job performance?					
<35	47.1%		52.9%		**0.002**	0.154
36-55	61.6%		38.4%			
>55	44.3%		55.7%			

* Fisher's Exact Test

Table 6. *CROSSTABS – Educational level* motivation*

EDUCATIONAL LEVEL***						
	YES	*MODERATELY*	*SLIGHTLY*	*NO*	**p**	**Cramer's V****
M1	Do your earnings influence your job performance?					
A	15.4%	51.3%	17.9%	15.4%		
B	20.9%	52.7%	16.5%	9.9%	**0.001**	0.139
C	34.8%	26.1%	25.0%	14.1%		
D	24.1%	43.6%	12.3%	20.0%		
M2	Does a better relationship with your manager influence your job performance?					
A	7.7%	59.0%	12.8%	20.5%		
B	23.1%	44.0%	20.9%	12.1%	**0.038**	0.108
C	16.3%	39.1%	26.1%	18.5%		
D	19.0%	41.5%	16.4%	23.1%		
M3	Does a greater autonomy in your work and decision making influence your job performance?					
A	28.2%	43.6%	15.4%	12.8%		
B	29.7%	30.8%	20.9%	18.7%	**0.019**	0.114
C	33.7%	22.8%	21.7%	21.7%		
D	42.6%	19.5%	14.9%	23.1%		
M4	Does information on companies future business plans influence your job performance?					
A	23.1%	48.7%	12.8%	15.4%		
B	22.0%	36.8%	20.3%	20.9%	**0.002**	0.130
C	28.3%	31.5%	19.6%	20.7%		
D	39.5%	20.5%	16.9%	23.1%		
M5	Do professional development opportunities influence your job performance?					
A	35.9%	33.3%	12.8%	17.9%		
B	20.9%	38.5%	19.8%	20.9%	**0.000**	0.148
C	15.2%	42.4%	22.8%	19.6%		
D	39.5%	22.1%	15.4%	23.1%		
M6	Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance?					
A	38,5%	25,6%	17,9%	17,9%		
B	28,6%	29,7%	19,2%	22,5%	0.637	0.068
C	32,6%	28,3%	17,4%	21,7%		
D	40,0%	21,5%	17,4%	21,0%		
	YES		*NO*		**p**	**Cramer's V****
M7	Do monetary incentives influence your job performance?					
A	79,5%		20,5%			
B	95,6%		4,4%		**0.006**	0.156
C	92,4%		7,6%			
D	92,8%		7,2%			
M8	Does the possibility of going on a paid vacation influence your job performance?					
A	48.7%		51.3%			
B	49.5%		50.5%		**0.001**	0.182
C	63.0%		37.0%			
D	68.7%		31.3%			
M9	Does the possibility of solving housing issues influence your job performance?					
A	35.9%		64.1%			
B	46.7%		53.3%		**0.001**	0.180
C	56.5%		43.5%			
D	63.6%		36.4%			

*** A. post–graduate qualification, B. college diploma, C. higher educational diploma, D. high school diploma

* Fisher's Exact Test

Table 7. *CROSSTABS – The number of years spent in the organization* motivation*

THE NUMBER OF YEARS SPENT IN THE ORGANIZATION						
	YES	*MODERATELY*	*SLIGHTLY*	*NO*	**p**	**Cramer's V****
M1	Do your earnings influence your job performance?					
<5	21.4%	40.2%	20.5%	17.9%	**0.000**	0.164
6-15	16.7%	52.0%	14.5%	16.7%		
16-20	19.0%	47.6%	19.0%	14.3%		
>20	45.8%	30.8%	15.0%	8.4%		
M2	Does a better relationship with your manager influence your job performance?				**0.002**	0.131
<5	15.4%	42.7%	20.5%	21.4%		
6-15	15.4%	50.2%	16.7%	17.6%		
16-20	15.9%	33.3%	31.7%	19.0%		
>20	32.7%	35.5%	16.8%	15.0%		
M3	Does a greater autonomy in your work and decision making influence your job performance?				**0.016**	0.116
<5	34.2%	22.2%	17.1%	26.5%		
6-15	34.8%	31.7%	14.9%	18.6%		
16-20	23.8%	23.8%	31.7%	20.6%		
>20	43.9%	19.6%	18.7%	17.8%		
M4	Does information on company's future business plans influence your job performance?				**0.001**	0.133
<5	28.2%	25.6%	188%	27.4%		
6-15	28.5%	38.5%	14.0%	19.0%		
16-20	20.6%	25.4%	33.3%	20.6%		
>20	40.2%	22.4%	17.8%	19.6%		
M5	Do professional development opportunities influence your job performance?				0.087	0.100
<5	29.1%	23.9%	21.4%	25.6%		
6-15	29.9%	36.2%	13.6%	20.4%		
16-20	23.8%	28.6%	30.2%	17.5%		
>20	26.2%	36.4%	16.8%	20.6%		
M6	Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance?				0.104	0.098
<5	30.8%	23.1%	19.7%	26.5%		
6-15	36.7%	29.4%	14.5%	19.5%		
16-20	23.8%	25.4%	30.2%	20.6%		
>20	40.2%	22.4%	16.8%	20.6%		
	YES		*NO*		**p**	**Cramer's V****
M7	Do monetary incentives influence your job performance?				**0.026**	0.135
<5	92.3%		7,7%			
6-15	89.6%		10,4%			
16-20	100.0%		/			
>20	95.3%		4,7%			
M8	Does the possibility of going on a paid vacation influence your job performance?				**0.000**	0.203
<5	69.2%		30.8%			
6-15	48.9%		51.1%			
16-20	57.1%		42.9%			
>20	71.0%		29.0%			
M9	Does the possibility of solving housing issues influence your job performance?				**0.000**	0.192
<5	70.9%		29.1%			
6-15	46.6%		53.4%			
16-20	54.0%		46.0%			
>20	51.4%		48.6%			

* Fisher's Exact Test

We analyze the relationship of respondents' motivational attitudes to the educational level (Table 6). The following motivational attitude: Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance? has a value of $p>0.05$, so it can be concluded that there is no statistically significant association. If we look at employee motivation with socio-demographic characteristics, we conclude that educational level is related to the following motivational factors: earnings, better relationship with your manager, greater autonomy in your work and decision making, information on companies future business plans, professional development, monetary incentives, possibility of going on a paid vacation, solving housing issues and the hypothesis of the independence of the educational level and motivational attitudes has been partially confirmed.

We analyze the relationship of respondents' motivational attitudes to the number of years spent in the organization (Table 7). The following motivational attitudes: Do professional development opportunities influence your job performance? Does the possibility to acquire (improve) a foreign language, work on a computer, influence your job performance? have a value of $p>0.05$, so it can be concluded that there is no statistically significant association. If we look at employee motivation with socio-demographic characteristics, we conclude that number of years spent in the organization is related to the following motivational factors: earnings, better relationship with your manager, greater autonomy in your work and decision making, information on companies future business plans, monetary incentives, possibility of going on a paid vacation, solving housing issues and the hypothesis of the independence of the number of years spent in the organization and motivational attitudes has been partially confirmed.

3.2. Binary logistic regression

Binary logistic regression was conducted to test the impact of socio-demographic factors (gender, seniority, years, education) on each individual issue – motivational attitude (from M7-M9). Table 8. shows the estimated regression coefficients (B), standard error, p value, odds ratio (Exp (B)). Due to the large number of categories (by each socio-demographic variable), we only present those statistically significant predictors in the Table 8. We can conclude that only one of the independent variables made a unique statistically significant contribution to the motivational attitude M7 (Do monetary incentives influence your job performance?). The only significant predictor was the Educational level ($p=0.013$), recording an odds ratio of 0.639, indicating that for every additional higher education level respondents were 0.639 times less likely to be motivated to perform better by the monetary incentives, controlling for the other factors in the model.

Two independent variables, gender (p=0.015) and educational level (p=0.031), made a unique statistically significant contribution to the motivational attitude M8 (Does the possibility of going on a paid vacation influence your job performance?) As the predictor variable Gender recorded an odds ratio of 0.619, we can conclude that that the female respondents were 0.619 times less likely in regard to male respondents to be motivated to perform better by going on a paid vacation, controlling for other factors in the model. Other predictor variable the Educational level recorded an odds ratio of 1.225, we can conclude that for every higher education level respondents were 1.225, times more likely to be motivated to perform better by going on a paid vacation, controlling for the other factors in the model.

Table 8. *Binary logistic regression result with motivational attitudes from M7–M9 as dependent variables*

		B	S.E.	Wald	Sig.	Exp(B)
Do monetary incentives influence your job performance?	Educational level	-0.447	0.179	6.222	**0.013**	0.639
Does the possibility of going on a paid vacation influence your job performance?	Gender	-0.479	0.196	5.955	**0.015**	0,619
	Educational level	0.203	0.094	4.640	**0.031**	1.225
Does the possibility of solving housing issues influence your job performance?	Age	0.468	0.191	6.031	**0.014**	1.597
	Number of years spent in the organization	-0.361	0.119	9.240	**0.002**	0.697

The strongest predictor of M9 Does the possibility of solving housing issues influence your job performance? was the Age. This indicated that respondents with the age increase were over 1.597 times more likely to be motivated to perform better on their job by possibility of solving housing issues, controlling for all other factors in the model. The odds ratio of 0.697 for number of years spent in the organization was less than 1, indicating that for every additional number of years spent in the organization respondents were 0.697 times less likely to be motivated to perform better on their job by possibility of solving housing issues, controlling for the other factors in the model.

CONCLUSION

From the analysis performed we can conclude that all the motivation factors selected for the research influence the job performance with the majority of respondents have declared that the monetary incentives influences their motivation (92.7%). Earnings, better relationship with the manager, greater autonomy in the work and decision making, information on companies future business plans, possibility of professional development, possibility to acquire a

foreign language, work on a computer possibility of going on a paid vacation, solving housing issues do represent a significant m motivational factors that the human resources managers should take in consideration and concentrate their efforts to establish an adequate motivational program for the public employees. The higher educational level has been shown to be less motivated to perform better by monetary incentives, but higher education level respondents were more likely to be motivated to perform better by going on a paid vacation. Therefore we can conclude that non material motivational factors also represent a crucial motivational factor for highly educated employees. Respondents with the age increase were more likely to be motivated to perform better on their job by possibility of solving housing issues, but as the number of years spent in the organization increases they tend to be less motivated by this factor. Hence we can conclude that solving housing issues is very important as employees get older but only for employees that have not yet been spent many years in the organization. Given their age, number of years spent in the organization and the level of professional qualifications of their employees, managers need to find the right system of motivation and rewards in order to increase their motivation not only by financial incentives.

The following research can help public managers to establish a motivational program based on the investigated motivational factors which can influence the loyalty and the commitment to the organization of their employees. Managers should keep in mind that motivation directly influences organizational commitment. Employees need to be able to develop professionally by creating an environment that encourages their creativity, innovation, initiative to implement business change and processes and develops teamwork. Those companies that know how to motivate and value their employees can successfully compete in today's market.

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DOES HIGH INNOVATION INPUT ALWAYS LEAD TO HIGH INNOVATION OUTPUT?

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Abstract: In the era of intensive globalization, innovations become the crucial driving force of raising competitiveness in the global market. Therefore, effective management of the national innovation system (NIS) has become an essential factor in economic growth and development. To formulate an effective innovation development strategy, policymakers need to understand the mechanisms behind NISs. However, there is a limited number of papers dealing with factors of innovation development in different countries. This study is one of rare that attempts to identify how different countries use their innovative capacities. In that sense, this paper aims to classify European economies according to innovation capacities and results, using the K-mean clustering. The values of innovation inputs and outputs are extracted from the Global Innovation Index (GII) 2019 report, to identify the current state of the art in this area.

Keywords: national innovation systems (NIS), competitiveness, clustering, Global Innovation Index (GII)
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1. INTRODUCTION

Global economic growth is losing momentum compared to the previous year. Productivity growth is very low. The economic uncertainty is very high. There are trade battles. However, despite economic and geopolitical uncertainty, innovation around the world is flourishing because there is a global political determination to drive innovation. Both developed and developing economies promote innovation to achieve economic and social development. The way economies experience innovation has improved. Many emerging economies, including those with low incomes, are increasingly monitoring their innovation performance and working to improve them (Cornell University *et al.*, 2019).

The rapid changes that are happening in segment of society today are the result of developments in science, technology and innovative activities. Therefore, innovation is heavily influenced by technology development. Today's business is characterized by the beginning of the Industrial Revolution, called Industry 4.0.

The impact of ICTs and their effects on national economies in developed countries has increased. The globalization intensified competitive pressures in the market and enterprises are looking for ways to improve their competitive position. Most companies in the world, especially those operating in transition economies, focus mainly on technology, and less on human resources and organizational competencies (Djordjevic *et al.*, 2018; Sampaio *et al.*, 2014). The process of transition causes the population's concerns to arise from business uncertainty and unemployment (Panić & Voza, 2019). All this has contributed to the increasing importance of innovation and technological development, which are the driving forces in today's competitive environment. Also, innovation has a very positive impact on the competitiveness of any economy, economic development and productivity (Cantwell, 2005; Fagerberg & Srholec, 2008), and greatly contributes to reducing unemployment rate (Pianta, 2006).

Considering the numerous positive effects of innovation development for the economy and society in general, the policymakers should support the successful implementation of ideas (Dodgson *et al.*, 2013). Government and institutions play a key role in generating and disseminating innovation in the national economy (Watkins *et al.*, 2015), and their contribution to innovation processes to advance innovative outcomes is multiple (Gustafsson & Autio, 2011; Davidson & Potts, 2016). They should spread innovation more systematically to drive global technology growth, so innovation policies must support international cooperation and the global dissemination of knowledge (Pençe *et al.*, 2019).

However, in modern business conditions, this definition of innovation has been significantly expanded. Innovation is no longer limited to R&D and the publication of scientific papers. Nowdays, they include both social and business model innovations as well as technological innovations. Innovation is not only a driver of economic growth and competitiveness, but also a source of solutions to many social issues, in both developed and underdeveloped economies.

2. NATIONAL INNOVATION SYSTEM (NIS)

In the current business conditions, competitiveness of any economy depends heavily on the National Innovation System (NIS) and this is why understanding the mechanisms of NIS functioning is very important (Gogodze, 2016). NIS, as the conceptual framework, represents a specific network of linkages among the factors involved in innovation processes, whose interactions determine the innovation performance (Freeman, 1987; Nelson, 1993). It can be said that NIS provides a cumulative outcome that is a combination of the impact of institutions and organizations and their interactions, as well as intangible investments and public policy(Lundvall, 1992).

NIS determines the innovative capacity of a country which can be defined as its ability to manage the resources and skills through which existing knowledge translates into new knowledge, technology and creative output, all for the benefit of the firm, industry or the entire economy (Fagerberg & Srholec, 2008; Furman *et al.*, 2002; Lopez-Carlos & Mata, 2009). In this sense, it can also be considered as a socio-economic system in which a large number of formal and informal institutions cooperate. NIS uses all available resources of one country (human, financial, institutional and infrastructural) in order to achieve economic development, value creation and well-being. For these reasons, there must be an appropriate model for measuring the quality of NIS (Gogodze, 2016; Archibugi & Coco, 2004).

3. LITERATURE REVIEW

Most of the research conducted has examined the determinants of cross-national and regional differences in innovation rates and innovation activity. Very few researchers have addressed the determinants of innovation and how the innovation system works in different countries. Authors Suzuki and Demircioglu (2019) focuses on the specific characteristics of the administrative infrastructure: professional and impartial public administration conducting a cross-national study of 108 countries. Sohn *et al.* (2016) proposed a structural equation model (SEM) based on the national innovation structure among seven factors. Coccia (2007) developed a classification model of country performance and risk assessment which uses economic and technological indicators with principal component analysis.

Gogodze (2016) developed a conceptual model to examine the relationships between NIS components using the Structural Equation Modeling (SEM). Authors Crespo and Crespo (2016) test whether high innovative performance can be predicted using the NIS approach. According to them, achieving high innovation performance is possible if countries develop different parts of their innovation systems. Lately, there has been an increase in research addressing low-income countries (Alcorta & Peres, 1998; Metcalfe & Ramlogan, 2008). As it is expected the dimensions that support innovative performance in developed and underdeveloped economies are different (Watkins *et al.*, 2015).

Although the question of how to measure innovation capacityhas been addresed in numerous studies (Arundel & Huber, 2013; Bloch & Bugge, 2013; Demircioglu & Audretsch, 2017; Meissner, 2015; Meissner *et al.*, 2017), there is no agreement on measuring the level of innovative performance. Until now, innovation has been measured mainly by the number of patents or R&D costs, which has resulted in a focus only on inventions and business activities (Waarts & Van Everdingen, 2005).

Jankowska *et al.* (2017) tried to explain how national innovation systems may transform innovation input into innovation output in different counties using the Global Innovation Index (GII) and cluster analysis. Of course, there is a problem in selecting innovative inputs and outputs. Almost all measurements of innovative inputs involve increased R&D costs. Innovative inputs have been the subject of numerous researches (Köhler *et al.*, 2012; Cunningham & Gök, 2012; Rigby & Ramlogan, 2013; Mairesse & Mohnen, 2002).

Ersoz (2009) applied the Hierarchical Clustering Analysis to the innovation indicators for Turkey and a Multivariate Analysis of the innovation indicators for Europe in order to identify the cluster in which Turkey is classified. Tezcan (2015) compared the EU and Turkey in terms of innovation performance by using multidimensional scaling analysis and clustering analysis.

Considering the overview of the research done so far on this topic, it can be considered that the research carried out in this paper has a significant contribution. First of all, the analysis was done in European countries, unlike previous studies that have analyzed countries from all over the world. In addition, the survey is based on current data that is publicly available in the most recent GII report for 2019.

4. GLOBAL INNOVATION INDEX (GII)

The Global Innovation Index (GII) is a leading reference on innovation at the national level (Rinne *et al.*, 2012; Suzuki & Demircioglu, 2019). It ranks the innovation performance of countries and economies around the world. It has been published for the first time in 2007, by Cornell University, INSEAD (Institut European d'Administration des Affaires), a business school, and the WIPO (World Intellectual Property Organization), and is published annually.

Each year, GII ranks innovative performance from nearly 130 economies from around the world (Gogodze, 2016). For over a decade, GII has fueled national strategies and international debates on innovation in many ways. First of all, GII helps to rank low- and middle-income countries according to innovation capacities and performances. Also, GII enables countries to evaluate the performance of their national innovation system and analyze their innovation strengths and weaknesses. Based on these results, innovative policies and actions are changing. In that sense, it can be said that the GII report aims to promote global innovation as a win-win proposition and to facilitate improved policy-making (Dutta *et al.*, 2016).

GII aims to rank countries based on various innovation factors. It includes two sub-indices (innovation inputs and innovation outputs), which are composed of seven components, called pillars. Each pillar is divided into sub-pillars, and each sub-pillar is a product of individual indicators. GII reflects the extensive

experience of previous studies and the current understanding of NIS and the mechanisms by which it operates.

4.1. Innovative inputs

Innovative inputs consists of five pillars: Institutions, Human capital and research, Infrastructure, Market sophistication, and Business sophistication.

4.1.1. Institutions

The essential factor for innovation development is creating an institutional framework that drives growth by providing good governance and appropriate level of protection and incentives. Institutional environment include the political, legal and business environment. The political environment is characterized by the perception of the likelihood that the government can destabilize both the quality of public and state services, the formulation of policy and its implementation. The legal environment refers to the perception of the government's ability to formulate and implement cohesive policies that promote the development of the private sector, as well as the assessment of the rule of law (contract enforcement, property rights, police, courts). The business environment refers to aspects that directly affect private entrepreneurial endeavors using the World Bank index on ease of starting a business and dealing with illiquidity (Cornell University *et al.*, 2018).

4.1.2. Human capital and research

The level of education and research activities in the country are also imortant for innovative capacity. This pillar is measured by combination of different education indicators. It measures quality of education at all levels. Higher education is key to the advancement of value chain economies. Higher education targets sectors traditionally associated with innovation. The R&D field measures the level and quality of R&D, gross expenditures, R&D expenditures, as well as the quality of research institutions (Cornell University *et al.*, 2018).

4.1.3. Infrastructure

Infrastructure refers to ICTs, general infrastructure and environmental sustainability. Good and environmentally friendly communication, transport and energy infrastructures facilitate the production and exchange of ideas, services and goods, as well as their integration into the innovative system through increased productivity and efficiency, lower costs, better access to markets and sustainable growth. General infrastructure includes average electricity generation, logistic performance, gross investment, purchase of plant, machinery and equipment, construction of roads, railways, etc., including schools, hospitals, private residential buildings and commercial industrial buildings. Environmental sustainability refers to GDP per unit of energy consumption and environmental performance (Cornell University *et al.*, 2018).

4.1.4. Market sophistication

Credit availability and an investment supportive environment, access to the international market and competition are critical to business and innovation development. Market sophistication refers to policies and practices that affect the coverage and availability of credit information, as well as the degree of ease of getting credit. Also, it examines the ease of protection for minority investors, whether market size matches market dynamics, and provides information on venture capital transactions. Markets opened for foreign trade and investment expose domestic firms to best practices in the world, through the adoption and dissemination of knowledge, which is crucial for innovation (Cornell University *et al.*, 2018).

4.1.5. Business sophistication

This innovation input assesses the level of business sophistication to determine the performances of firms in any economy. The business success of a company is measured based on the results that the company achieves in the market (Savić *et al.*, 2014). Businesses leverage their productivity, competitiveness and innovative potential by hiring highly qualified experts and technicians. Besides, it assesses the extent to which women with a college degree are employed. Linking the qualitative and quantitative data related to business/university cooperation in terms of R&D is also very important, so GII evaluates various indicators for measuring innovative connectivity in the economy (Cornell University *et al.*, 2018).

4.2. Innovation outputs

Innovative outputs represent the results of innovative activities within the economy. They allow GII rankings to be calculated, just like inputs. This includes Knowledge and technology outputs and Creative outputs.

4.2.1. Knowledge and technology outputs

Knowledge and technology outputs refer to variables traditionally considered to be the fruits of the invention and / or innovation. Besides indicators of knowledge creation, it contains of specific indicators that measure result from inventive and innovative activities and knowledge impact refering to statistics that represent the impact of innovative activities at the micro and macroeconomic level (Cornell University *et al.*, 2018).

4.2.2. Creative outputs

GII emphasize the importance of measuring creativity for innovation. First of all, this refers to intangible assets (trademark filing by residents, industrial design, use of ICTs in business and organizational models), creative goods and services that enable creativity and creative results and creative goods export measured as its share in total trade (Cornell University *et al.*, 2018).

5. DATA AND METHODOLOGY

In order to perform the classification of European countries according to their innovation performances, data on innovation inputs and outputs are employed for clustering.

5.1. Data

The variables used in this research are indicators of the national level of innovation inputs and innovation outputs mentioned in the previous section, which are obtained from the GII report (Cornell University *et al*., 2019). A large number of authors used data from the GII report to research this area (Crespo & Crespo, 2016; Meissner, 2015; Rinne *et al*., 2012; Sohn *et al*., 2016; Zhan *et al*., 2015; Suzuki and Demircioglu, 2019). Published annually, the latest version (as of this writing) was released in 2019. The 2019 report covers 129 economies around the world. In order to investigate characteristics of national innovation systems in Europe the data for 42 countries are employed: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Greece, Montenegro, North Macedonia, Moldova, Romania, Russian Federation, Serbia, Turkey, Ukraine, Austria, Belgium, Cyprus, Czech Republic, Estonia, Hungary, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovakia, Slovenia, Spain, Denmark, Finland, France, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland, United Kingdom. As this research aims to determine if the perceived level of innovation input leads to the appropriate level of innovation output, the k-means clustering is applied.

5.2. Methodology

There are many different clustering procedures and they can be classified into two wide groups: hierarchical and non-hierarchical (partitioning) methods. K-means clustering belongs to the group of non-hierarchical methods. The k-means algorithm uses the within-cluster variation as a basis to form homogenous clusters. Namely, this type of clustering aims at segmenting the data in such a way that the within-cluster variation is minimized (Mooi and Sarstedt, 2011).

The advantages of k-means clustering are (Mooi and Sarstedt, 2011; Crowther and Lauesen, 2011; Charry *et al*. 2016):

1. it is less affected by outliers and the presence of irrelevant clustering variables,
2. it can be applied to very large datasets (as the procedure is less computationally demanding than in the case of hierarchical methods),

Disadvantages of k-means clustering are (Mooi and Sarstedt, 2011; Crowther and Lauesen, 2011; Charry *et al*. 2016; Norusis, 2008):

1. the researcher has to pre-specify the number of clusters to retain from the data (the researchers usually apply a hierarchical procedure to determine the number of clusters to avoid this problem),

2. the procedure is relatively sensitive to the initial classification,
3. the algorithm repeatedly reassigns cases to clusters, so the same case can move from cluster to cluster during the analysis, which is not true for hierarchical clustering, where cases are added only to existing clusters.

The steps in the k-means clustering procedure are as follows (Crowther and Lauesen, 2011):

1. Choosing the initial cluster centers (set of observations that are far apart - each subject forms a cluster of one and its center is the value of the variables for that subject);
2. Assigning each subject to its nearest cluster (in terms of the distance to the centroid);
3. Finding the centroids of the clusters that have been formed;
4. Re-calculating the distance from each subject to each centroid and move observations that are not in the cluster that they are closest to;
5. Following the same procedure until the centroids remain relatively stable.

The presented procedure is applied to GII data to answer group considered European countries.

6. RESULTS AND DISCUSSION

First of all, the descriptive statistics should be analyzed in order to take the first insight into the characteristics of the observed group of countries. The descriptive statistics are presented in Table 1.

Table1. *Descriptive Statistics*

	N	Minimum	Maximum	Mean	Std. Deviation
Institutions	42	53.9	93.9	75.333	10.9984
Human capital and research	42	16.9	63.4	42.717	12.6032
Infrastructure	42	35.3	69.9	54.495	8.7581
Market sophistication	42	39.6	76.0	53.212	7.4621
Business sophistication	42	24	69	42.36	12.628
Knowledge and technology outputs	42	12.2	70.3	35.517	13.5408
Creative outputs	42	10.8	56.6	37.838	10.4282
Valid N (listwise)	42				

From Table 1, it can be concluded that the highest differences among considered countries are recorded in Knowledge and technology outputs, where the highest standard deviation is calculated. The lowest level of this indicator is recorded in Albania, amounting to 12.2, while Switzerland has the highest value of this indicator (70.3). The observed countries are slightly less different according to

another indicator of innovation output – Creative outputs, having in mind that the lower standard deviation is obtained. The difference between the best and the worst performer in this area is also considerably lower. Switzerland is again the country with the best results, with an indicator amounting 56.6, while the most unfavorable indicator in this area is recorded in Belarus (10.8).

If innovation input is considered, it can be noticed that the standard deviation and, hence, the highest differences among analyzed countries are recorded in Business sophistication, where Sweden achieved the best results (69). On the other hand, Albania has the lowest level of this indicator, amounting to just 24. Slightly lower standard deviation is obtained in the area of Human capital and research, where the maximum value of the mentioned indicator has Finland (63.4) and the minimum is recorded in Armenia (16.9). On the other hand, the lowest value of standard deviation is recorded in the area of Market sophistication, where the highest value of representing indicator is 76 and it is recorded in the United Kingdom, while the lowest level of indicator amounting 39.6 has Serbia.

Considering these differences in the values of observed indicators, it can be concluded that this is a very heterogeneous group of countries. The differences in this area cause the differences in their economic development, which, in turn, predetermines the innovativeness of any economy. But, some very logical research questions arise here: Are there any similarities across analyzed economies? Can observed counties be classified in some groups according to these similarities? Are there some common patterns of innovation inputs and outputs within groups?

In order to address these questions, observed countries are classified by using the k-means clustering. Having in mind that performing k-means clustering requires the definition of clusters number, the hierarchical clustering is conducted, to identify the number of clusters from dendrogram The Euclidean distance and average distance between groups were used to perform hierarchical clustering. From the dendrogram, it can be concluded that the three clusters solution should be chosen. Since this prior analysis results from hierarchical clustering are used as an input for the k-means procedure, the problem of selecting the "correct" number of segments is solved (Mooi and Sarstedt, 2011).

Before using the k-means method, the segmentation variables are usually standardized, as was done in this case. The next step in k-means clustering is finding the k centers, which is done iteratively. It started with an initial set of centers and then they are modified until the change between two iterations is small enough. Each iteration aims at reducing the least squared Euclidean distance. This process is iterative until all cases are in the optimal cluster and no reassignment is necessary (Charry *et al*. 2016). In this case considering

economies are classified into three groups through 4 iterations, which can be seen from Table 2.

Table 2. *Iteration History*

Iteration	Change in Cluster Centers		
	1	2	3
1	1.801	1.177	1.616
2	.175	.136	.221
3	.088	.107	.000
4	.000	.000	.000

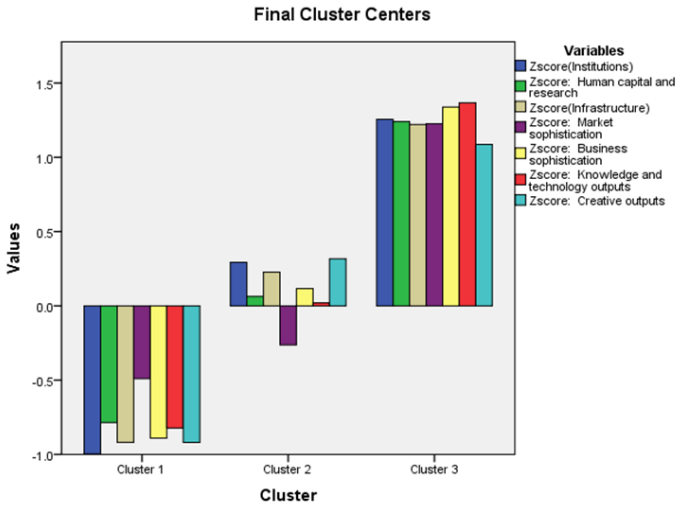
a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 4. The minimum distance between the initial centers is 4.038.

From Table 2, it can be concluded that after the fourth iteration, the convergence is achieved because further reallocation of cases from one cluster to another would not change or improve the obtained solution significantly. The relatively low number of iterations indicates that the obtained solution is considerably stable.

After all of the cases have been assigned to clusters, the cluster centers are recomputed, based on all of the cases in the cluster. K-means clustering was performed with three cluster solution and the final cluster centers are graphically presented in Figure 1, to gain deeper insight into characteristics of countries belonging to each of the formed clusters. They represent the mean for each variable among ventures in the cluster and are assumed to represent the characteristics of the typical cluster member.

It is obvious from Figure 2 that the first cluster is characterized by low inputs and low outputs, the third cluster has opposite characteristics - high inputs and high outputs, while the second cluster comprises the economies with lower inputs (especially Market sophistication) and relative lower outputs in comparison to the third cluster.

Figure 1. *Final cluster centers*



To validate obtained results, the ANOVA analysis is performed and results are presented in Table 3.

Table 3. *ANOVA results*

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Zscore(Institutions)	16.988	2	.180	39	94.308	.000
Zscore: Human capital and research	12.967	2	.386	39	33.566	.000
Zscore(Infrastructure)	15.008	2	.282	39	53.292	.000
Zscore: Market sophistication	10.068	2	.535	39	18.821	.000
Zscore: Business sophistication	15.805	2	.241	39	65.641	.000
Zscore: Knowledge and technology outputs	15.097	2	.277	39	54.483	.000
Zscore: Creative outputs	13.840	2	.342	39	40.525	.000

It can be concluded from Table 3 that the significance level for all variables is lower than 0.05, so all considered variables contribute to the formation of the clusters. According to ANOVA results presented in Table 3, it can be concluded that Market sophistication is the variable that contributes least to defining clusters (lowest F score). On the other hand, the most important factor influencing the creation of clusters is Institutions, with a high F score. It should

be noted that among innovation outputs the Knowledge and technology outputs has a relatively higher F score, which indicates that such kind of innovations is more important to the classification of observed countries in identified three clusters.

SPSS results indicated that the clusters contain a relatively uniform number of countries – in the first cluster there are 17 countries, the second contains 15 countries, while the third consists of 10 countries. Further analysis needs to indicate the classification of considered countries across the formed clusters using the k-means clustering (Table 4).

Table 4. *The classification of considered economies*

CLUSTER 1 **Low innovation cluster**	**CLUSTER 2** **Medium innovation cluster**	**CLUSTER 3** **High innovation cluster**
Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Greece, Montenegro, North Macedonia, Moldova, Romania, Russian Federation, Serbia, Turkey, Ukraine.	Austria, Belgium, Cyprus, Czech Republic, Estonia, Hungary, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovakia, Slovenia, Spain.	Denmark, Finland, France, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland, United Kingdom.

As it was expected, the developed old EU Member States are classified in the third cluster, like Finland, France, Germany, Ireland, Netherlands, Sweden and the United Kingdom, as well as, Norway and Switzerland, which are among the major competitors of EU in the global market and highly developed economies. Most of them are at the top of the GII rankings according to innovation input and/or output. It is interesting to emphasize that Switzerland is the world's leader in innovation for nine consecutive years. This economy is the best performer in the Innovation Output Sub-Index and Knowledge and technology output pillar since 2012 and it is ranked in 4th position worldwide according to quality of innovation, just after the US, Germany and Japan (Dutta *et al*. 2019). Sweden is ranked as the second most innovative economy worldwide in 2019, which is among the top ten economies in all considered pillars except Market sophistication (where it is ranked at 14th position). Among the world's top 10 innovators in GII 2019 are also the Netherlands (4th position), the United Kingdom (5th position), Finland (6th position), Denmark (7th position), Germany (9th position) and Ireland (10th position). France is also a member of the cluster, as it very well positioned in the GII 2019. This country is 11th country worldwide according to Human capital and research and Infrastructure, 12th

according to Market sophistication, while in the remaining areas it is ranked among the top twenty countries in the world. Due to good rankings in mentioned areas this country is the 16th most innovative economy worldwide.

In the second cluster, there are countries have joined the EU in 2004 - Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. These countries still have not reformed their institutional infrastructure in line with the market economy principles. They achieved some progress in achieving smart, sustainable and inclusive growth (Radulescu *et al*. 2018; Fedajev *et al*. 2019), but there is still room for progress. Italy, Portugal and Spain are also classified in this cluster. These countries have been facing numerous economic problems after the sovereign debt crisis emerged in 2010. One more economy is included in this cluster – Luxemburg. Luxembourg is a small open economy, characterized by limited geographical space and a lack of natural resources (Dutta *et al*. 2019). However, this country is a regional hub for trade and investments, with a strong service sector, especially financial services, which significantly contribute to the economic development of this country (Durkalic *et al*. 2019). Although old and developed EU Member States, Austria and Belgium still have not created a favorable environment for innovation similar to those existing in countries from high innovation clusters and this is why these two countries are lagging behind them in terms of innovation output.

The majority of countries classified in the third cluster are non-EU developing economies (Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Montenegro, North Macedonia, Moldova, Serbia, Turkey, Ukraine), where ongoing transition process limit innovation potential of their economies. This is particularly true for reforming the institutional framework, having in mind that these countries are still building their institutional infrastructure according to the principles of the market economy. This is also the reason why these countries are characterized by the low level of Market sophistication indicator, which can be seen from Figure 2. Besides them, three new EU Member States are classified in this cluster - Bulgaria, Romania and Croatia. Although these countries are EU members (Bulgaria and Romania from 2007 and Croatia from 2013), they still have not managed to reform their economies and NIS, which lead to their lagging behind the Member States from second and third clusters. The member of this cluster is also Greece, in which NIS was considerably affected by the global economic and sovereign debt crisis. The public and private expenditure on R&D is still very low, far below the OECD average. Furthermore, links between scientific institutions and the private sector are very weak reflecting the institutional weaknesses and cultural resistance to public-private collaboration (Sotiropoulos *et al*. 2018).

In the end, it is interesting to note that the Russian Federation is a member of this cluster. Although this country is one of the major players in the global

market, the innovation system management in this country is still not efficient enough (Vasin and Gamidullaeva, 2017). In addition, the global trend of accelerated ICT development and its comprehensive application in all segments of economy has promoted gradual emergence of new forms of innovation intermediaries (business incubators, technological parks, business accelerators, innovation centers, etc), which potentials have not yet been sufficiently utilized in Russian Federation. This country established a network of regional innovation intermediaries, but an unsystematic development of innovative infrastructure and its institutional weakness lead to limited interaction between science and industry and poor innovation performances during the last decade (Gamidullaeva, 2018). In the current geopolitical and economic conditions (which is primarily reflected by the limited access to financial and technological resources caused by the sanctions), this country needs to intensify innovative activities to ensure a transition to an innovative development path.

CONCLUSION

National innovation capabilities represent an important factor of economic growth and development of any country, so understanding how countries can enhance their capabilities may enable them to boost their economic performances and improve their competitive position in the global market. This research pointed out that high innovation outputs are the result of supportive institutional infrastructure development of human capital due to the existence of quality educational and research systems, advanced infrastructure that enables knowledge sourcing and transfer and enabling business and market environment.

The countries classified in high innovation output cluster (Denmark, Finland, France, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland, United Kingdom) manage to create such favorable conditions for innovation development, which resulted in high innovation outputs. NIS of Austria, Belgium, Cyprus, Czech Republic, Estonia, Hungary, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovakia, Slovenia and Spain, the economies belonging to medium innovation cluster, haven't developed all aspect of innovation climate (especially Market sophistication), which resulted in lower innovation outputs. Such characteristics of NIS particularly affected the level of Knowledge and technology outputs. Finally, low innovation level cluster consists of countries with low level of innovation inputs (Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Greece, Montenegro, North Macedonia, Moldova, Romania, Russian Federation, Serbia, Turkey and Ukraine), which resulted in considerably lower level of innovation outputs in comparison to countries belonging to before mentioned clusters.

Based on these results, it can be concluded that if one country strives to improve its innovative outputs, it should implement a comprehensive set of strategic measures aimed at the improvement of all aspects of NIS.

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THE INNOVATIVE PROPENSITY OF THE REPUBLIC OF SERBIA

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Abstract: The economies that are most developed in the modern world and which have the highest GDP per capita are said to be knowledge-based economies that base their development on innovation. The Republic of Serbia does not belong to that group of countries, so, naturally, it raises a number of questions related to this statement. Where is the Republic of Serbia placed among the most developed countries by order from the achieved GDP and by expressed innovation? Also, what is the situation in this sense in the region? What the Republic of Serbia should do to reduce the gap and get closer to the most developed countries? This paper addresses these questions and attempts to answer them by using, comparing and analyzing data on global innovation and competitiveness of the World Economic Forum (WEF), the European Union and INSEAD & WIPO.

Keywords: innovation, development, competitiveness, economy
JEL: O30, F02

1. INTRODUCTION

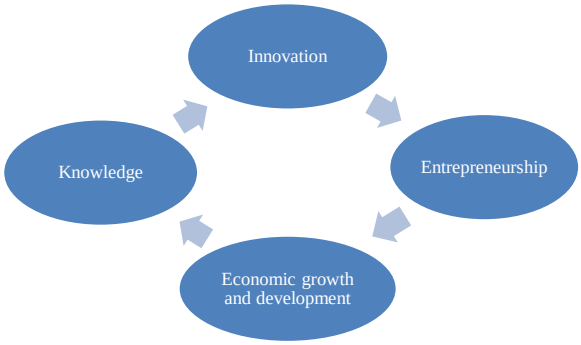
The period from the mid-twentieth century to the present day is characterized by intense scientific and technological progress that has brought about a series of changes in all spheres of human life. These changes have been particularly intensified since the last decade of the 20th century with the widespread use of computer and information technologies.

The paradigm of the most developed economies and the key to further success and development in the modern world is: knowledge → innovation → entrepreneurship → economic growth and development.

"Consumer becomes the focus of economic events, and the battle for his affection leads to a knowledge based economy, the economy in which knowledge becomes the key factor of production. Economies that base its growth and development on knowledge, are called entrepreneurial economies. Entrepreneurial economies are based on innovation - the practical application of

new information and knowledge, or the application of existing knowledge in a new, different way, thus creating competitive advantage. So innovations and innovativeness became a key factor for economic development." (Ivković & Knežević, 2014).

Figure 1. *Characteristics of Modern Economy*



Source: Ivković & Knežević, 2014, p. 64

The achieved level of development of economies is most often expressed by GDP per capita. According to the Global Competitiveness Report, all economies are divided into 3 core groups and 2 transit groups. The main groups include: factor-driven economies (<2000 USD per capita); efficiency-driven economies ($ 3000-8999 pc), and innovation -driven economies (> $ 17000 pc). The transition groups include: economies transiting from factor-driven economies to efficiency-driven economies (2000-2999 USD pc) and economies transiting from efficiency-driven economies to innovation-driven economies (9000-17000 USD pc).

Economies with the highest GDP per capita are innovation-driven economies, that is, economies that base their growth and development on innovation. This can be interpreted from another point of view: innovation has become a key factor of growth and development. This also means that the economy successfully overcame previous steps in its development and made efficient use of available resources, and that a satisfactory level of investments in resources and the results of these investments have been reached.

Of course, respecting the fact that value is created in enterprises, the assumption is that in the most developed economies there are also the best conditions for business operations within the economic system. Since each economic system is extremely complex, the quality of the environment in which the companies operate depends on many factors: development of institutions, macroeconomic environment, market development, financial environment, labor force characteristics, etc.

2. ELABORATION

2.1. Innovation indicators

Two methodologies have been developed to look at the level of innovative characteristics achieved in order to compare national economies. Innovation on a global scale will be INSEAD and WIPO.

For the needs of its members as well as candidates for accession to the European Union, the European Commission publishes an Innovation Scoreboard.

In addition to these two innovation-focused methodologies, Global Competitiveness Report, which is an important factor in innovation, can be used to look at innovation.

2.1.1. Global Innovation Index

The Global Innovation Index (hereinafter referred to as GII) was designed by the INSEAD Business School, and the first publication containing this index was published in 2007. INSEAD has been joined by WIPO, the World Intellectual Property Organization, in 2012, and since 2013, by Cornell University. To date, 12 publications have been published with data on the value of this index.

GII index is calculated as the average of two sub-indices: the input sub-index and sub-index of output. The input sub-index consists of 5 basic indicators: Institutions, Human capital and research, Infrastructure, Market sophistication, Business sophistication.

The output sub-index consists of two basic indicators: knowledge and technology outputs, and creative outputs. Each of the basic indicators consists of 3 other indicators. The total number of indicators used to derive the GII index is about 80. The number of countries covered by these surveys varies depending on the availability and reliability of the data used in the calculation of this index. For example, the 2007 GII Report covered 107 countries, in 2011 125 countries, in 2013 142 countries with 94.9% of the world population generating 98.7% of world GDP, and in 2019 129 countries or 91.8% of the world population, which creates 96.8% of world GDP.

Since 2011 until the last survey related to 2019 Switzerland is the undisputed leader and country with the most innovative features. According to the research carried out in the period of 2007-2010 the innovation leaders were USA in 2 surveys and Iceland in one survey. In 2019, and in earlier years, 6-7 European countries are consistently among the top 10 countries. It is also interesting that all the Nordic countries are highly ranked. According to a 2019 survey, Sweden, Finland and Denmark are among the top 10, with Norway and Iceland among the top 20 countries in the world.

Table 1. *Leading countries by innovation characteristics*

Year Rank	2019		2011	
	Country	GII	Country	GII
1	Switzerland	67,40	Switzerland	63,82
2	Sweden	63,65	Sweden	62,12
3	USA	61,73	Singapore	59,64
4	Netherlands	61,44	Hong Kong	58,80
5	United Kingdom	61,30	Finland	57,50
6	Finland	59,83	Denmark	56,96
7	Denmark	58,44	USA	56,57
8	Singapore	58,37	Canada	56,33
9	Germany	58,19	Netherlands	56,31
10	Israel	57,43	United Kingdom	55,96

Source: Authors, based on The Global Innovations Report 2011 and 2019

In 2019, and in earlier years, 6-7 European countries are consistently among the top 10 countries. It is also interesting that all the Nordic countries are highly ranked. According to a 2019 survey, Sweden, Finland and Denmark are among the top 10, with Norway and Iceland among the top 20 countries in the world.

Values of GII innovation input index and the index of output of innovation for Serbia compared to the world average and the average of European countries are shown in the table below.

Table 2. *GII and sub-index*

		Year								
		2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
World	**GII**	36,67	36,81	37,41	36,90	37,01	36,73	37,12	36,97	36,32
	II	43,07	42,27	42,15	42,82	43,55	43,86	45,10	45,20	45,34
	IO	30,30	31,35	32,67	30,99	30,67	29,60	29,15	28,73	27,28
	NC	125	141	142	143	141	128	127	126	129
Europe	**GII**	45,22	47,93	47,64	47,23	47,99	46,85	47,10	46,67	46,42
	II	52,00	52,95	52,83	52,30	53,48	53,11	54,54	53,98	54,77
	IO	38,51	42,91	42,45	42,17	42,50	40,59	39,65	39,40	38,08
	NC	36	39	39	39	39	39	39	39	39
Serbia	**GII**	36,31	40,00	37,87	35,89	36,47	33,75	35,34	35,46	35,71
	II	39,09	41,50	41,55	40,06	41,78	40,94	43,79	43,50	44,50
	IO	33,53	38,50	34,20	31,73	31,16	26,57	26,90	27,42	26,93
	WR	55	46	54	67	63	65	62	55	57
	ER	29	30	33	37	36	36	36	35	34
	POP	9,9	7,4	10,2	7,2	9,5	8,9	8,8	8,8	8,8

Source: Authors, based on The Global Innovations Report 2011-2019

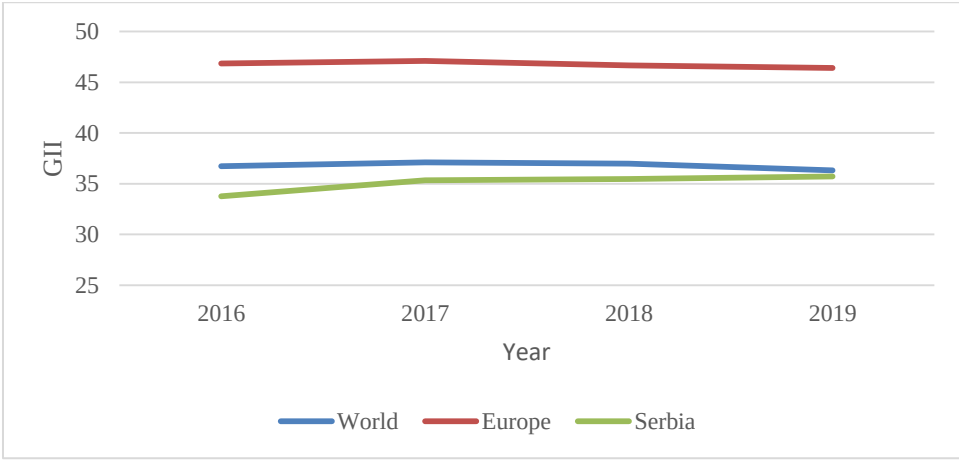
Legend: GII-Global Innovation Index; II-Innovation Input sub-index; IO-Innovation Output sub-index; NC- number of countries covered by the report; WR rank in the world; ER-rank in Europe; POP - population represented in the Report in millions.

According to the ranking on the world list, Serbia is in the first half of the observed countries, while at the European level it is at the end of the list.
Overall, it can be concluded that the innovative characteristics of Serbia are below the world average, and also below the European average, with the lag behind the EU average significantly higher than the world average.

The data presented in the table contains certain inconsistencies which call into question the data presented, at least when it comes to Serbia. In fact, from 2011 to 2015 the population in Serbia ranges from 7.2 million to 10.2 million, which brings into question the validity of the data presented, however it also makes it practically useless for serious analysis. Since 2016, the population of Serbia is "stabilized" at 8.9 or 8.8 million, and in that sense, data related to GII for Serbia, can be considered more or less relevant.

Thus, as far as the 2016 period is concerned, it is observed that there is a slight decline in GII at the world level. The same can be said for the European average. At both the global and European levels, a slight decrease in GII is a consequence of the fall in the value of the output sub-index, while the sub-index of inputs has a growing value at both the world and European level.

Figure 2. *Serbia and the World - GII 2016-2019*

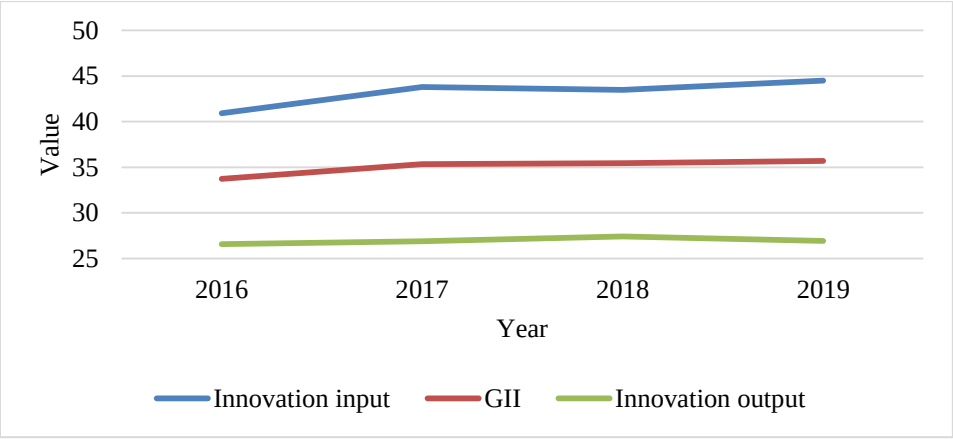


Sorce: Authors, based on The Global Innovations Report 2016-2019

During this period, the Republic of Serbia constantly, but very slightly, raised its innovative performance. The values of all three indicators are higher in 2019

than in 2016. The value of the innovation input sub-index increased more than the value of the innovation output sub-index.

Figure 3. *Serbia-GII and sub-indexes 2016-2019*



Source: Authors, based on The Global Innovations Report 2016-2019

Observed by main indicators within the sub-index of innovation input and innovation output, in the period 2016-2019 in comparison with the European average, Serbia has no value above the average, while compared to the world average, there are two indicators in the whole observed period which are above average, institutions and infrastructure. For 2019, Serbia has better indicators than the world average for Human capital & research and Knowledge & technology outputs. Serbia is far behind the European average in all indicators. Compared to the world average Serbia lags significantly behind in the indicator of Market sophistication, a backlog of records and for Business sophistication and Creative outputs indicators.

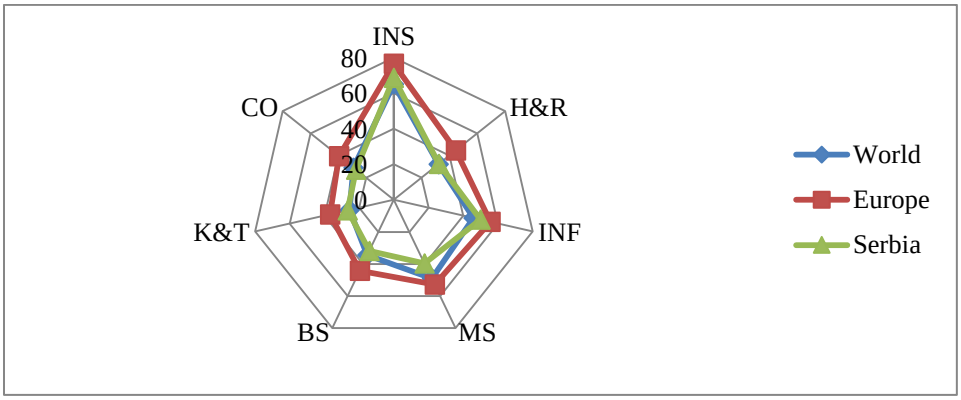
Table 3. *Serbia and the World-Basic Indicators GII 2016-2019*

	Year											
	2016			2017			2018			2019		
	W	E	S	W	E	S	W	E	S	W	E	S
INS	63,10	76,00	65,70	63,05	75,57	67,70	64,08	75,75	67,20	65,08	76,57	68,7
H&R	33,91	46,73	32,80	34,03	46,41	33,90	33,00	44,82	32,20	32,13	44,61	32,4
INF	43,36	53,61	43,70	46,19	56,10	49,70	45,19	54,76	49,60	45,98	55,66	49,9
MS	45,37	49,81	34,30	47,23	51,72	38,70	48,05	51,65	39,20	49,04	52,78	39,6
BS	33,58	40,39	28,10	34,97	42,93	28,90	33,89	42,94	29,20	34,56	44,22	31,9
K&T	27,58	37,57	27,70	25,77	35,24	24,70	26,59	31,20	26,70	25,55	36,86	26,7
CO	31,62	43,61	25,50	32,53	44,05	29,10	30,41	41,49	28,10	29,03	39,36	27,2

Source: Authors, based on The Global Innovations Report 2016-2019

Legend: INS-Institutions; H&R-Human capital & research; INF-Infrastructure; MS-market sophistication; BS-Business sophistication; K&T- Knowledge& technology outputs; CO-Creative outputs; W-World; E-Europe; S-Serbia

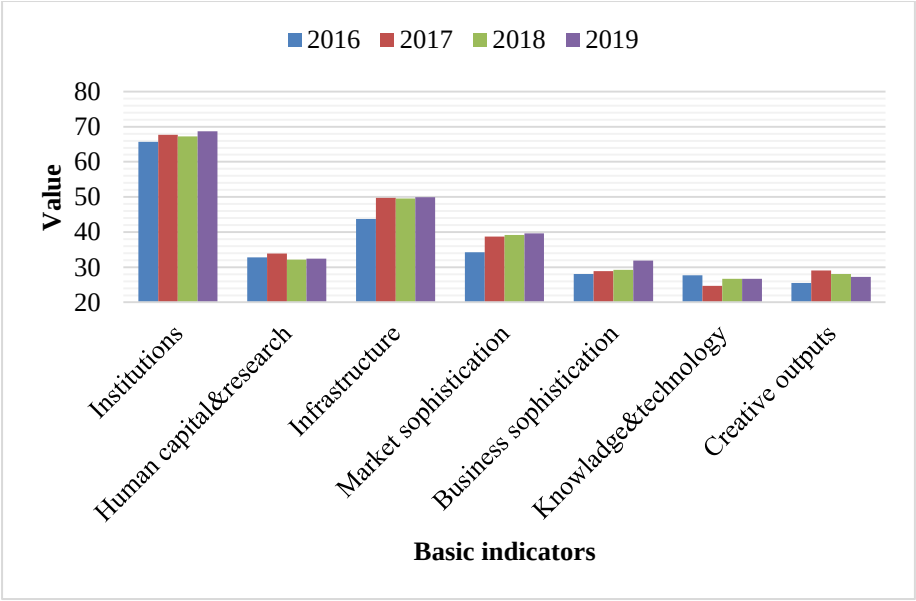
Figure 4. *Serbia and the World-Basic Indicators GII 2019*



Source: Authors, based on The Global Innovations Report 2019

In the observed period Serbia has significantly raised the performance related to the Institutions, Infrastructure, Market sophistication and business sophistication. Performance is also rising in Creative outputs, while two indicators are stagnant: Human capital & research and Knowledge & technology outputs

Figure 5. *Serbia-GII Core Indicators 2016-2019*



Source: Authors, based on The Global Innovations Report 2016-2019

2.1.2. Summary Innovation Index

In order to measure innovation at European Union level, the Summary Innovation Index (SII) was constructed. The values of this index for the Member States, as well as for a certain group of countries of interest for the European Union are published by the European Commission, annually in the publication European Innovation Scoreboard. In 2019 eighteenth publication was published.

Depending on the value of the SII, and relative to the European Union average, all countries surveyed are divided into 4 groups:

Innovation leaders - which include the countries with the value SII more than 20% above the average SII for the European Union;

Followers of innovators - which include the countries with SII value 90% - 120% of the average value of SII index for the European Union;

Moderate innovators - which include the countries with SII value 50% -90% of the average value of SII index for the European Union, and

- Modest innovators, until 2010, the countries in this group were called catching-up countries - countries with a SII value below 50% of the average SII index value for the European Union.

Four groups of indicators are used to calculate the value of the SII index.: Framework conditions, Investments, Innovation activities and Impacts.The methodology used for the calculation of the SII index varies from the methodology used for the calculation of the index GII. However, although the methodologies differ, the leader remains unchanged. The leader with the most innovative features in Europe, although not a member of the European Union, is Switzerland. Within the European Union, the leading countries in terms of innovative features are: Sweden, Denmark and Finland, respectively.

Serbia first appeared in this report in 2009, and was ranked among the poorest-catching-up countries. Since 2011, Serbia has been included in the Moderate innovators group, in which it is located to this day.

Serbia, as well as countries from the immediate environment, are significantly behind the most innovative country in Europe, Switzerland, and the most innovative country in the European Union, Sweden. The innovative performance of these countries is well above the European Union average (Table 4). In terms of its immediate environment, Serbia is ranked just behind Hungary, a member of the European Union, in terms of innovative performance. Behind Serbia are three EU member states: Bulgaria, Croatia and Romania, as well as Northern Macedonia. In the period from 2011 to 2018, in the group of observed countries, Serbia has had the highest increase in SII, 45.5%, and had the highest average annual growth rate of 5.5%.

Table 4. *SII 2011-2018*

Country		Year								R18	G%	AG%
		2011	2012	2013	2014	2015	2016	2017	2018			
EU28	SII	0,482	0,478	0,483	0,482	0,490	0,503	0,513	0,525	100,0	8,9	1,2
	R11	100,0	99,2	100,2	99,9	101,6	104,4	106,3	108,8			
SW	SII	0,779	0,760	0,765	0,775	0,785	0,802	0,812	0,823	156,7	5,6	0,8
	R11	161,4	157,6	158,7	160,7	162,8	166,2	168,4	170,6			
SE	SII	0,692	0,699	0,705	0,695	0,698	0,713	0,716	0,713	135,8	3,0	0,4
	R11	143,4	145,0	146,1	144,1	144,6	147,8	148,5	147,7			
BG	SII	0,223	0,194	0,206	0,219	0,220	0,227	0,231	0,235	44,8	3,5	0,8
	R11	46,3	40,2	42,7	45,5	45,7	47,0	47,9	48,7			
HU	SII	0,319	0,304	0,303	0,308	0,314	0,320	0,328	0,333	63,4	4,4	0,6
	R11	66,2	63,1	62,8	63,9	65,1	66,4	68,1	69,0			
RO	SII	0,216	0,193	0,189	0,151	0,144	0,150	0,155	0,165	31,4	-23,6	-3,8
	R11	44,8	40,0	39,1	31,3	29,8	31,1	32,2	34,1			
HR	SII	0,271	0,251	0,260	0,237	0,251	0,251	0,260	0,287	54,8	14,3	0,8
	R11	56,1	52,0	53,8	49,1	52,0	52,1	54,0	59,6			
NM	SII	0,183	0,178	0,187	0,196	0,209	0,212	0,223	0,209	39,9	14,2	1,9
	R11	37,9	36,9	38,8	40,7	43,4	43,9	46,3	43,4			
RS	SII	0,211	0,261	0,265	0,277	0,282	0,276	0,299	0,307	58,5	45,5	5,5
	R11	43,7	54,1	55,0	57,4	58,4	57,3	61,9	63,7			

Source: Authors, based on European Innovation Scoreboard 2019

Legend: EU28-European Union with 28 members; SW-Switzerland; SE-Sweden; BG-Bulgaria; HU-Hungary; RO-Romania; HR-Croatia; NM-North Macedonia; RS-Republic of Serbia; SII-SII value; R11-SII relative to EU28 in 2011; R18- SII relative to EU28 in 2011;G%-growth 2018:2011 in %; AG%-average growth in % in period 2011-2018.

Observed by individual indicators (Table 5) Serbia is below the EU28 average by all indicators. Serbia came closest to the EU28 average for Innovators and Firm Investments and Sales Impact indicators. The furthest from the European average are the Intellectual Assets indicator, and Research Systems and Finance and support indicators.

Compared to the immediate environment, Serbia has the best performance in Human Resources, Innovators and Linkages indicators. Indicators of Intellectual Assets and Innovation Friendly Environment can be considered bad, with only Northern Macedonia behind Serbia in both cases.

Table 5. *Basic indicators of SII in 2018, relative to EU28 = 100*

Country	HR	RS	IE	FS	FI	IN	LI	IA	EI	SI
SW	195,5	207,9	147,0	134,9	175,0	157,2	158,6	173,4	112,3	115,8
SE	174,9	166,2	172,3	109,3	124,3	115,4	147,3	156,2	134,5	88,0
BG	52,7	20,5	53,8	15,5	41,5	27,0	30,1	81,0	108,7	37,9
HU	43,9	49,7	91,5	42,2	82,2	34,0	54,9	41,2	118,9	81,6
RO	13,7	24,2	76,9	26,9	9,1	0,0	39,3	23,0	46,3	61,6
HR	49,9	33,7	41,3	30,3	93,6	95,4	62,9	30,0	64,6	35,3
NM	33,2	53,4	35,2	14,0	62,1	53,0	25,1	16,3	6,2	50,1
RS	54,7	31,3	39,9	36,7	79,7	96,3	63,2	24,5	38,1	67,3

Source: Authors, based on European Innovation Scoreboard 2019

Legend: EU28-European Union with 28 members; SW-Switzerland; SE-Sweden; BG-Bulgaria; HU-Hungary; RO-Romania; HR-Croatia; NM-North Macedonia; RS-Republic of Serbia; HR-Human resources; RS-Research system; IE-Innovation friendly environment; FS-Finance and support; FI-Firm investments; IN-Innovators; LI-Linkages; IA-Intellectual Assets; EI-Employment Impacts; SI-Sales impact.

2.1.3. Global Competitiveness Index

The World Economic Forum (WEF) deals with the competitiveness of national economies, and publishes annual reports on the value of the Global Competitiveness Index (GCI). Although this research does not directly address innovation, there is a strong link between innovation and competitiveness. It should be emphasized that this also applies to long-term competitiveness, understood as a concept that determines the development perspectives of individual economies in the future. (Knezević & Ivković, 2014)

In addition, two of the twelve pillars of competitiveness, used to derive GCI values, are related to innovation, namely: Business dynamism and Innovation capability. In addition to those mentioned, there are indicators that are important for innovation but are treated either as separate pillars or within other pillars.

According to the latest available report, for 2018, Serbia is ranked 65th out of 140 countries by GCI. Business Dynamism is ranked 59th and Innovation capability 56th. Compared to the previous year, the vast majority of indicators used in the calculation of the above two indexes show growth.

Of the eight indicators used to calculate the Business Dynamism Index, six indicators show an upward trend, one is declining, Insolvency recovery rate, and one is unchanged, Insolvency regulatory framework. Ten indicators are used to calculate the Innovation Capability Index, and all indicators show an upward trend compared to the previous year.

Within the Business Dynamism pillar, Serbia is ranked best in Insolvency regulatory framework, 14th place. The Time to start business indicator was ranked 25th. The worst ranked indicator under this pillar is Attitudes toward entrepreneurial risk, at 119th place. Within the Innovation capability pillar, International Co-Inventions ranked 41st and R&D expenditures% GDP 42nd and Buyer sophistication 127th.

2.2. Discussion and analysis

In order to understand the phenomenon of innovation in the Serbian economy, it is important to look at the trends and characteristics of its economic system. In that sense, the Serbian economy can be said to have gone through two phases and is currently in the third phase. These phases are:

- Devastation phase;
- Wandering phase;
- Consolidation phase.

The devastation phase covers the period from the early 1990s to the end of 2000. The characteristics of this period are: the dissolution of the SFRY; the war in the territory of the former Socialist Federal Republic of Yugoslavia (hereinafter: the SFRY); hyperinflation; economic sanctions from the international community; NATO aggression and bombing; two implementation of the privatization process.

The intensification of the globalization process and events such as the fall of the Berlin Wall in November 1989 launched a series of processes at the global level, that affected Yugoslavia, part of which was the Republic of Serbia. At the end of the 1980s, Serbia was in the group of Central and Eastern European countries that began the transition process, a process aimed at changing the social order, with ultimate goal of moving from a socialist to a capitalist society. The first step in the transition is to change the form of ownership, in which private ownership of the means of production should become the dominant form of ownership. To work toward this goal, the Law on Social Capital was adopted at the level of the SFRY in 1989, and at the level of the Republic of Serbia in 1991 the Law on the Procedure for Conversion of Social Property into Other Forms of Property. This initiated the transition process.

In the following period, the breakup of the SFRY and the beginning of armed conflicts in the territory of the former SFRY begin. So as to separate individual Republic from the SFRY, in April 1992 the Federal Republic of Yugoslavia (FRY) was formed, consisting of two former Yugoslav Republic, Republic of Serbia and Montenegro. The armed conflicts in the territory of the former SFRY lasted until the end of 1995.

Immediately after the proclamation of the FRY, in May 1992 the United Nations imposed economic sanctions on the FRY, and these sanctions lasted until October 1996. With the lifting of international community sanctions, the story of the FRY sanctions did not end. In 1998, the European Union and the USA reintroduced the FRY sanctions, which were soon abolished against Montenegro and applied only to Serbia. The sanctions remained in place until September 2001, when they were officially abolished.

Table 6. *Inflation rate in Serbia in period 1995-2018*

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
Rate%	82,7	95,6	23,3	30,2	42,4	71,1	95,0	19,5	9,9
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Rate%	11,0	16,1	11,7	6,4	12,4	8,1	6,1	11,1	7,3
Year	2013	2014	2015	2016	2017	2018			
Rate%	7,7	2,1	1,4	1,1	3,1	2,0			

Source: https://data.worldbank.org/indicators

The period from late 1992 to early 1994 will be mostly remembered for hyperinflation, which has become one of the largest hyperinflations in world history. The daily inflation was over 60% per day, or 2% per hour (it is today's annual inflation rate Serbia). Hyperinflation stopped in January of 1994, just before the denomination and stabilization of the dinar value, the monthly price growth rate was 313.563.558%. Due to hyperinflation, a revaluation was carried out in 1995 as part of the privatization process, virtually canceling and suspending privatization that began in 1989-1991 (Ivković *et al*., 2012). The next attempt at privatization begins with the adoption of the Law on the Basics of Changing the Ownership of Social Capital, at the level of FRY, in 1996, and the Law on Property Transformation in Serbia, 1997. Privatization in Serbia was carried out on the aforementioned regulation until 2001, when a set of new legal regulations related to privatization was adopted.

The end of the last decade of the twentieth century rounded off all the hardships Serbia went through in the twentieth century. On 03/24/1999 NATO launched a bombardment, i.e. aggression against Serbia and the FRY. After 78 days of bombing, with the signing of the military-technical agreement, on 06/10/1999, the NATO aggression ended.

These events left the economy of Serbia with devastating consequences, from which the Serbian economy has not recovered to this day. It is believed that the Serbian economy lost about three annual GDPs in that ten-year period. GDP in

Serbia in 2000 was over 50% lower than the GDP in 1989 (Arsić, 2016). There was a depletion of the population, falling per capita GDP, the blossoming shadow economy, euroization of the monetary system, the loss of confidence in our own institutions, the destruction of economic facilities and infrastructure by the NATO Pact. Estimates of destroyed structures during the bombing range from $ 5 billion to over $ 100 billion USD.

The sanctions that were applied to Serbia left immeasurable consequences on the economy and lives of its people. The last decade of the twentieth century is marked by the widespread use of ICT technologies and computers in the world. There was new knowledge, many new inventions and innovations, which resulted in the creation and application of new technologies and led to the obsolescence of many assets. Serbia remained deprived of this new knowledge and cognition so at the end of this period, it came out with a completely devastated economy and physically or morally depreciated fixed assets. The consequences of the sanctions, which have spread throughout the last decade of the 20th century, represent a kind of technological genocide over the economy of a nation.

It is clear that in this period, period of devastation, we cannot talk about the normal economic situation, so innovation cannot be treated as it would be in normal circumstances. If every person is a potential innovator, then in Serbia, in the mentioned period, these potentials were directed at other things, not towards economic prosperity.

The great English writer George Bernard Shaw, in the drama "Major Barbara" in 1907, wrote: "...Food, clothing, dismissal, rent, taxes, reputation and children. And nothing but money can remove that burden from a man's hump. And his spirit cannot be lifted until that burden is removed."

The wandering phase begins after the democratic changes in 2000, and lasts until 2015. Characteristics of this period are: implementation of the process of privatization of public property, the disappearance of Yugoslavia and the emergence of the State Union of Serbia and Montenegro (hereinafter: SUSM) termination of SUSM and the formation of the Republic of Serbia as an independent state, the resumption of political pressures and tensions, the emergence of the global economic crisis.

In 2001, a new Privatization Law was adopted whose main goals was to change ownership structure and create an open and efficient economy. It was expected that privatization would be completed in a few years and that future owners would buy socially owned enterprises to make them strong and modern businesses, not for the sake of acquiring their fixed assets. Everything that happened later was very much out of the box. The privatization process turned

into a process that took too long and was implemented throughout the wandering phase. In addition, the results achieved were below expectations, the process was followed by many scams, often businesses were bought for the sake of property and soon after the purchased company was closed, etc. In short, the privatization process conducted in this way cannot be considered successfully implemented.

Economic policy makers believed that the Serbian economy should be developed in a neoliberal fashion, despite numerous warnings by analysts that a devastated and rotten economy was uncompetitive on the world stage, that such an open economy could do no good, and that blind application of the Washington Consensus principles, which in addition to privatization implies liberalization and deregulation, cannot significantly improve the Serbian economy, but only create an additional problem and slow down Serbia's transition path.

All that was happening in the Serbian economy during this period was significantly influenced by political circumstances. In February 2003, the FRY ceased to exist and the SUSM was formed. The new state lasted until June 2006, when Montenegro declared independence and practically created the Republic of Serbia, as an independent state.

The political issue is not over. In fact, in February 2008, Kosovo and Metohija, the autonomous province within Serbia unilaterally, in spite of the Constitution of the Republic of Serbia declared independence. This created constant political pressure on Serbia, that continues to this day and has a significant impact on Serbia's economy. In late 2008 and early 2009 world economy went into recession, outbreak of the global economic crisis did not bypass Serbia.

Table 7. *Serbia-GDP growth rate*

Year	2005	2006	2007	2008	2009	2010	2011
Rate%	5,5	4,9	6,4	5,7	-2,7	0,7	2,0
Year	2012	2013	2014	2015	2016	2017	2018
Rate%	-0,7	2,9	-1,6	1,8	3,3	2,0	4,3

Source: Ministry of Finance RS, Public Finance Bulletin 1/2019

Growth rates at the beginning of the phase are the result of the low intensity of economic activity in the preceding period, and generated revenue from the privatization process. With the advent of the global crisis, Serbian economy entered a recession that lasted from 2009 to 2015. During three years the negative growth rate was recorded, 2009, 2012 and 2014, so it can be said that in the observed period, 2009-2014, there was no economic growth. Not only did the Serbian economy perform poorly in quantitative terms due to the effects of the global economic crisis, its qualitative performance was also poor. This is best reflected in its competitiveness during this period. (Knezević & Ivković, 2015).

Table 8. *Serbia-Employment and unemployment in period 2005-2018*

Year	2005	2006	2007	2008	2009	2010	2011
Employment (in 000)	2.171	2.115	2.085	2.082	1.985	1.901	1.866
Unemployment (in 000)	888	913	850	756	747	744	753
Unemployment.rate %	20,8	20,9	18,1	13,6	16,1	19,2	23,0
Year	2012	2013	2014	2015	2016	2017	2018
Employment (in 000)	1.866	1.865	1.845	1.896	1.921	1.977	2.053
Unemployment (in 000)	762	775	741	743	713	651	583
Unemployment.rate %	23,9	22,1	19,2	17,7	15,3	13,5	12,7

Source: Ministry of Finance RS, Public Finance Bulletin 1/2019

The trend of employment and unemployment since the beginning of the observed period is accompanied by developments in the privatization process. 2005 and 2006 saw a decrease in employment and an increase in unemployment. Deteriorating indicators came at a time of recession, with the fall of the number of employees, and growing rate of unemployment grains.

During this period, Serbia is starting to appear in innovation reports, and in the European Commission's report it is improving its position from modest innovator to moderate innovator.

Phase of the consolidation is the phase in which Serbia is today, and it begins with 2015. Since 2015, Serbia is intensively implementing reforms, implementing fiscal consolidation, there is a more intensive attraction of foreign investments that are necessary for further development, as domestic savings in the entire period are insufficient for the level of investment that is required for more intensive economic growth. Investment in road and rail infrastructure has also been intensified. During this period, macroeconomic indicators from the Serbian economy improved. The rate of economic growth was increased, employment was increased, unemployment was decreased, public debt has been reduced, inflation is low. All this is still happening in the context of unresolved political issues, above all the issue of Kosovo and Metohija.

Table 9. *Serbia-External debt in period 2005-2018*

Year	2005	2006	2007	2008	2009	2010	2011
External debt	12.520	14.291	17.382	20.982	22.272	23.509	24.123
in % GDP	56,3	55,1	55,1	58,8	68,6	74,5	68,1
Year	2012	2013	2014	2015	2016	2017	2018
External debt	25.645	25.644	25.679	26.234	26.494	25.578	26.901
in % GDP	76,1	70,4	72,4	73,5	72,1	65,3	62,9

Source: Ministry of Finance RS, Public Finance Bulletin 1/2019

Table 10. *Serbia-Public debt in period 2005-2018*

Year	2005	2006	2007	2008	2009	2010	2011
Public debt	10.283	9.352	8.875	8.781	9.849	12.157	14.789
in % GDP	47,6	33,9	27,9	26,8	30,9	39,5	42,8
Year	2012	2013	2014	2015	2016	2017	2018
Public debt	17.717	20.141	22.762	24.819	24.820	23.222	23.015
in % GDP	52,9	56,0	66,2	70,0	67,8	57,9	53,8

Source: http://www.javnidug.gov.rs/upload/

Table 11. *Serbia-Forign direct investments in period 2005-2018*

Year	2005	2006	2007	2008	2009	2010	2011
FDI net	1,25	3,3	2,5	2,5	2,1	1,1	3,3
in % GDP	5,6	12,8	8,0	7,0	6,4	3,6	9,4
Year	2012	2013	2014	2015	2016	2017	2018
FDI net	0,7	1,3	1,2	1,8	1,9	2,4	3,2
in % GDP	2,2	3,6	3,5	5,1	5,2	6,2	7,5

Source: Ministry of Finance RS, Public Finance Bulletin 1/2019

However, although favorable tendencies and positive trends are present, it will take at least another seven years with an average growth rate of 4% to reach the GDP level of the 1990s, that is, before the transition period (Jakopin, 2018). In order to achieve such growth, it is necessary for investments to be close to 25 % of GDP, or 5-6% more than now. (Petrović *et al*.,2019) consider that Serbia will come out from the consolidation phase and move to the next phase when, finally, reaches a GDP from the 90's.

In terms of innovation, Serbia has slightly increased its innovative performance in this period.

CONCLUSION

Innovation is an important determinant of every economy, and as the economy becomes more developed, that innovation has a significant role in its growth and development. This further shows the relationship between the material bases, as measured by GDP per capita, and innovation.

The countries with the highest GDP per capita are the most innovative.

As far as Serbia and its economy are concerned, it is obvious that it takes a lot of time to reduce the gap between Serbia and developed countries. In the future, it is necessary to achieve higher rates of economic growth and increase GDP per capita. Also, it is necessary to continuously build and improve the environment (institutions, infrastructure, markets, human capital), etc., which will favor the development of entrepreneurship and, of course, expressing innovation.

Particular attention and special place in this belongs to the education system, which should educate personnel with pronounced entrepreneurial characteristics. In the future, Serbia will need to take a serious commitment to addressing brain drain. This problem has always existed in Serbia, but there has never been a right way to keep this negative phenomenon under any kind of control (Ivković *et al*., 2012). If the most educated and innovative people leave, if 10% of the population declines in 10-15 years, and if the mortality rate is higher than the birth rate, then the prospects of such an economy, as well as of the people, cannot be great. Serbia is not strong enough or economically powerful to solve the future problem of labor shortages necessary for economic development right now, in the way developed countries, such as Germany did, by importing labor and accepting migrants.

How and in which way Serbia will deal with these issues depends largely on the political system and economic policy makers, that are most responsible for creating an economic environment conducive to the development of entrepreneurship and innovation.

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IMPORTANCE OF THE EU INTEGRATION FOR ENHANCING SERBIA'S INNOVATION POTENTIAL

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Abstract: The paper discusses the consequences of cooperation between Serbia and the EU in the context of innovation development prospects of the former. The main hope for Serbia was that she would be able to increase its innovation potential, especially the one applicable in its manufacturing sector. To detect a possible increased innovative content of the Serbian export sector, we analyze qualitative changes of domestic exports through tendencies of goods at higher levels of processing, of which the eventual increase would create important conditions for sustainable and stronger export growth. Additionally, the indices of intra-industry trade were calculated, as well as the changes in export specialization. Then, the obtained results are compared with those achieved by Central and Eastern Europe economies. Despite the strong growth of Serbian exports in 2000-2018 and moderate structural advancement, there are no conclusive signs of sufficient improvements of calculated indicators to imply significant innovation development.

Keywords: Serbian exports, innovation content, high-tech products.
JEL: F14, F15, B41

1. INTRODUCTION

On January 2014, the first Intergovernmental Conference took place, signalling the formal start of Serbia's EU accession negotiations. When it comes to the Chapter referring to innovation policy (Chapter 25-Science and Research), the screening process had started in October and was completed in December 2014 being the first Chapter to be (provisionally) closed (December 13, 2016).

Judging by EU's Serbia 2019 Report (EC, 2019, pp. 81-83), namely part referring to Chapter 25 Serbia is at a good level of preparation in the area of science and research. European Commission (EC) claims that regarding research and innovation policy the main priorities of the European Research Area are incorporated in Serbia's strategy on scientific and technological development. Some progress in implementing the strategy was made with the adoption of the

action plan in July 2018. Serbia continues to be active and successful in Horizon 2020 as well as in EUREKA and COST. However, the national level of investment in research remains low at 0.93% of GDP with only one-third of this amount coming from the private sector. On measures for the Innovation Union, the Serbian Innovation Fund continues to be active with increased budget contributions from the Ministry of Education, Science and Technological Development. According to the EC, Serbia should in particular increase the national funding for research and stimulate more intense cooperation between increasing activity of private industry and academia.

It is important to note that the EU set the ability to compete within the single market as the main economic criterion for EU accession. Serbia ranks well among candidate countries but has not made significant progress in its innovation potential and policy with respect to the EU. It is clear that greater efforts had to be taken in the field of innovation policy to make the country competitive and efficient at the European level. Firstly, as an overall measure, government expenditure on research and development (R&D) in Serbia is only half of the EU28 average (1.97%). Secondly, changes are needed in scientific and higher education policies in order to fully integrate them into the European Research Area.

Importantly, factors that most determine the competitiveness of any country, as well as Serbia, are: GDP per capita (pc), FDI inflows into the economy, foreign trade balance, exports. Additionally, potentially one of crucial competitive advantage is innovation capacity of the country. All these factors supposed to be improved after the integration of Serbia to the EU. Until now, all those indicators are well improved, but from a very low base, taking as the initial year 2000, or some other year in the early 2000s linked with the beginning of Serbia's EU integration process. Yet, the question is whether the inherent dynamics of the EU have a convergence phenomenon itself and how it could be positively used by Serbia.

According to Erste Report (2013), the EU integration is "a factor of paramount importance" in shaping the economic catch-up of the region. The key to further catching up will be to replace the knowledge import with innovative products generated in CEE countries – very hard objective. It is expected that in medium- to long term CEE countries – among them Serbia – will continue their path of catching up with the technological frontier. Of course, the question is how realistic it is for these countries – especially EU candidate countries, including Serbia – to make substantial progress in this field.

2. RELATED LITERATURE – INSIGHTS INTO CEE EXPERIENCE USEFUL FOR SERBIA

CEE economies participate as full members of EU framework programs for funding research and innovation, including the current Horizon 2020 (2014-2020). Although their participation in the EU programs for research and innovation is considered not different from the "old" EU 15 member states, there are however differences in terms of a number of successful projects winning European competitions and of EU funding attracted for R&D activities. Borota *et al*. (2019) have documented large heterogeneity in innovation policy and performance between old and new EU member states, and presented firm-level evidence on the close link between FDI spillovers and eastern European firms' innovation. They built a two-region endogenous growth model to analyze the gains from innovation policy cooperation in an economic union. The two regions, the West and the East (the new post-2004 members) – feature firms competing in innovation for market leadership – are integrated via free trade and costly technology transfer via FDI and have different innovation performance and policy. Calibrating the model to reproduce key features of the EU economy, they compared the outcomes of an East-West R&D subsidy war with a cooperation scenario with unified subsidy across regions. They found that the dynamic gains spurring from the impact of cooperation on the economy's growth rate are sizable and substantially larger than the static gains obtained internalizing the strategic motive for subsidies. Additionally, the model suggests that the presence of FDIs (along with the knowledge spillovers carried by them) and multinational production facilitates the strategic motive and increases the gains from cooperation.

Chistruga and Crudu (2016) have evaluated the influence of European integration through the EU financing dimension upon the evolution of external competitiveness of new members of the EU since 2004 and 2007 (excluding Malta and Cyprus). The findings contribute to confirm the assumptions that the European integration and the EU financing instruments had important effects in improving the industrial performance and international competitiveness of those countries. The paper by Antimiani and Costantini (2013) analyses the role of the enlargement process of the EU as a factor fostering international competitiveness of EU member states. The study argues that the economic integration process has reduced the technological gap between old and new EU members, and this pattern of technological innovation can partially explain the strong impulse on the export dynamics of European countries. By using a dynamic panel data estimator the authors find that the enlargement process has produced an overall larger positive impact on export flows for new members than for old ones – and more importantly that sectors with the higher technological content have received the strongest impulse. Additionally, the augmented gravity model allows shaping the crucial role of technological

innovation in fostering export competitiveness. The policy implication is that the more the new EU members catch up technologically as a result of the integration process, the more they will benefit in terms of economic development.

Petrariu *et al*. (2013) in a comprehensive study aimed to show the empirical evidence on the link between innovation and economic growth in the CEE countries. Their paper encompasses a number of different proxies to measure innovation. In the study conducted in 15 states, including Serbia, with data for each country covering the period 1996-2010, the findings are consistent with the existing literature that innovation makes a significant contribution to national competitiveness and economic growth and that the gap between the Western and Eastern economies can be reduced by investing in innovation. Final conclusion is that the development level of a country is the engine of innovation - allocating funds to research and development is the main source of support offered in this respect. However, regarding innovation factors that influence growth, they fail to make a significant contribution in the case of the CEE states. Namely, these countries had rapid economic growth, but a growth not based on the innovation process, as innovation is in a catch-up process, related to the growth rate.

To add, for each economy, ranking according to the Global Innovation Index is important. This Index covers more areas, among others number of patents by origin, score in scientific and technical articles, citable documents (H-index), creative goods exports, trademarks by origin, high-tech imports, knowledge-intensive employment, females employed with advanced degrees, FDI net inflows, expenditure on education, gross capital formation (investments). According to the Global Innovation Index (2019), among 129 countries, Serbia ranks only at 57th place with index 35.71, lagging behind Slovenia (31th), Bulgaria (40th), Montenegro (45th), Croatia (44th), and Romania (50th). In sub-group innovation input Serbia is 62nd place, while in sub-group innovation output it is 57th. Regarding the first year when Serbia appeared in this ranking (2008-09), its place was 92nd among 130 ranked countries, with a similar position in two sub-ranking (Innovation Input Sub-Index at 91th, and Innovation Output Sub-Index at 89th), implying solid progress obtained since 2009.

3. COMPARATIVE ANALYSIS OF THE TECHNOLOGICAL STRUCTURE AND FACTOR INTENSITY OF SERBIAN EXPORTS

As mentioned, according to the EC Report (2019), Serbia should increase the national funding for research (and innovation) – as the EU sets the ability to compete within the single market as the main economic criterion for EU accession. With the share of government spending on R&D slightly below half the EU average, it is clear that Serbia faces a difficult task. In this part of the

paper, we will analyze what is done until now and what we can expect in the close future.

The best way to determine whether Serbian products are becoming more competitive in last two decades of the EU integration is to analyze the tendency and trend of Serbian exporting products by proposed classification according to applied technology and factor intensity, that is, by segregating (medium and) high tech or high skill intensive part of domestic exports. Before that, to provide comparative insight into dynamics of merchandise exports of Serbia and selected CEE countries we calculated average annual growth rate for international trade expressed in EUR, but also in volume (WTO, 2019). What is especially important is that detected the average export growth of Serbia (8.1%) was higher than the average growth rate of international trade in 2007-2018, which increased by rate of 4.4% expressed in EUR (and 2.3% expressed in volume). Also, the Serbian average export growth rate was higher than the one of EU28 (4.3%), as well as the ones of Bulgaria (7.1%), Croatia (4.5%), Hungary (4%), and Turkey (5.6%), again implying above-average trade growth of the country, yet from a very low base. To have additional comparative insight we obtained data on export per capita for Serbia as well as for several other CEE economies. As expected, these data are disappointing, as Serbian exports pc in 2018 (2234 EUR) is almost five times smaller than the one of Hungary, and near twice smaller than Bulgarian (4248 EUR).

In the whole study, the period from 2007 to 2018 was analyzed, excluding Serbia where were additionally covered 2000 and 2004 (from national sources). We have used the structure of exports (and imports) by SITC (Standard International Trade Classification), Revision 4. When it comes to data referring to absolute values of trade we generally used EUROSTAT online database (2019), as well as national statistic sources. As an initial year, which served for all comparison, we took 2007, when Serbia was practically in an early phase of the EU integration process and, most importantly, the last year before the Great Recession. The last available year is 2018. The data on countries' export structures are drawn from the UN COMTRADE database (2019) covering 261 merchandise groups at the SITC 3-digit.

By analyzing the tendency of shares of high-skill manufactures and high tech products in total export we are finally coming to product innovation, a vital task for the modern corporation. Namely, the product innovation has to be viewed from a marketing perspective, but also with consideration of the R&D function and the difficulties of managing science and technology.

Given the key role of changing the nature of the skill and technological composition of products to boost economic performance, the purpose of this part of the paper is to investigate the quality of domestic exports by classifying the

exported products in accordance to the applied level of skill and technology. We will use different classifications, those which were applied by referent international organization (like UNCTAD), or referent economists. Generally, export databases are decomposed into different categories by their level of skill and technology composition. The export merchandise groups (261 of them) are used to compute different indicators – including those consisting of products with large investment in R&D or with high-technology intensity – to indicate how countries are moving out from primary commodities to manufactures-skill and technology content sectors, including high-tech products.

Among others, we have used shares of high-skill and technology-intensive manufactures, defined by UNCTAD. Additionally, qualitative changes in Serbian export are measured through tendencies in High-Tech products, combined medium- and high-tech products (both given by Muncacsi 2009), and through shares of skill-intensive manufactures (methodology developed by Mayer and Wood, 2001), where higher-level indicates its better quality. It should be noted that the basic condition for accelerating export growth – which consequently leads to GDP growth – is its structural improvement. Closely connected with this, Nikolić (2005, p. 158) pointed out that numerous studies and empirical evidence confirm that the ratio of exports of capital-intensive products (which we will calculate in this research) and exports of labor-intensive products (Capital-Labor Ratio) is significantly positively correlated to economic growth – basic goal of any economic policy.

We first used UNCTAD (2018) methodology where all products are classified into five categories (Primary commodities: Agriculture and food: Minerals: Manufactures: Labour-intensive and resource-intensive manufactures: Low-skill and technology-intensive manufactures: Medium-skill and technology-intensive manufactures, and High-skill and technology-intensive manufactures). High-skill and technology-intensive manufactures covers section 5 of Standard International Trade Classification (SITC), SITC divisions 75, 76, 87, 88 and SITC groups 776, 792, 891, 892, 896, 897. However, marginally more inclusive classification with the same title (high-skill and technology-intensive manufactures) was given in UNCTAD (2019) adding merchandise group 898 (Musical instruments, parts; records, tapes & similar).

Munkacsi (2009) had classified the exports, according to technology structure, into four categories relating to the technology level of the products. We first used two categories combined (medium- and high-tech). Products sorted as medium - and high tech are: merchandise groups 266- Synthetic fibres suitable for spinning and 267- Other man-made fibres suitable for spinning; section 5 - Chemicals and related products (without 52 - Inorganic chemicals; 551- Essential oils, perfumes; 592- Starches, inulin, wheat gluten); 653 - Fabrics, woven, of man-made textile materials; merchandise groups 671- Pig-iron; 672-

Ignots and other primary forms; 678- Wire of iron and steel; sector 7 (Machinery and transport equipment); divisions 81 (Prefabricated buildings; sanitary plumbing, heating and lighting fixtures and fittings); divisions 87 (Professional, Scientific, Controlling Material); divisions 88 (Photographic Apparatus, Optical Goods, Clocks). Then we separated only High-Tech products covering next merchandise divisions and groups: 54 - Chemicals and related products, 712, 716, 718, 75 (Machinery and transport equipment); 761, 764, 77 (without 772, 773, and 775), 792, 871, 874, and 881 (Photographic Apparatus).

Analysis of share of skill-intensive manufactures in total exports is given in the study by Mayer and Wood (2001, pp. 9-10), and in accordance with its methodology, we have extracted the shares of skill-intensive manufacture products in Serbian exports. Manufactured exports - categories 5±8 less 68 (non-ferrous metals) of the SITC - is divided between skill-intensive items and labor-intensive items, using the classification in Mayer and Wood (1998), which was based on a review of earlier studies that ranked individual manufacturing industries by their skilled/unskilled labor ratios or other measures of skill intensity. This classification covers: Chemicals 5 (without: phosphorus pentoxide and phosphoric acids 522.24, aluminum hydroxide 522.56, and radioactive material 525), Cut diamonds 667.29, Non-electrical machinery 71-74, Computers and office equipment 75, Communication equipment 76, Electrical machinery 77, Motor vehicles (parts thereof) and aircraft 781-784, 792, Scientific instruments, watches and cameras 87- 88.

The mentioned classifications were used in numerous studies. According to Fabrizio *et al*. (2006) increasing high-tech export share causes higher unit value compared with other countries. In parallel with deeper integration, the export structure also changed markedly in CEE states. Crespo & Fontoura (2007) examined the new member states' exports of goods going to the EU15 in time and by cross-section. The export structure of CEE countries changed significantly - mainly in Slovakia and Hungary - but the change was even greater in the Baltic economies. The Czech and Hungarian export structure was the most similar to that of old EU member states, with the Hungarian export structure resembling mainly the Austrian and German examples. Landesmann & Worz (2006) analyzed the export specialization of new CEE member states. Regarding medium and high-tech products, specialization increased, which the authors explained by unit labor costs.

Table 1. *Shares of (Medium- and) High-Tech products, High-skill and technology-intensive manufacture products, and Skill-intensive manufactures in Serbian exports 2000-2018*

	2018	2017	2016	2015	2011	2008	2007	2004	2000
High-Tech	7.5	8.2	8.7	7.2	6.6	8.3	6.4	5.0	6.0
High Skill Tech-Int.	12.8	12.5	12.3	12.1	12.2	14.2	13.5	14.4	11.0
Skill-Intensive	36.7	36.6	37.7	36.9	24.2	25.1	23.4	21.7	21.5
Medium + High	38.4	38.4	39.4	39.0	26.5	28.3	25.4	23.7	23.6

Notes: High Skill = high-skill and technology-intensive manufactures; Skill-Intensive = Skill-intensive manufactures; Medium + High = (Combined) Medium- and high-tech products; High Skill Tech-Int. = high-skill and technology-intensive manufactures.
Source: Author's own calculation based on the UN COMTRADE database and Serbia's Customs Administration (2000 and 2004).

Regarding the Serbian export structures, products classified in all four different categories have shown rather similar tendencies in the period under review. Namely, Table 1 is showing that the shares of High- Tech, high-skill and technology-intensive manufactures, (combined) medium- and high-tech products, and skill-intensive manufactures in Serbian exports have moderately increased since 2000. However, there are significantly different trends regarding the first two narrower categories covering more technology and skill intensive products and remaining two, which are more inclusive encompassing practically all merchandise groups from SITC sector 5 (Chemicals and related products) and sector 7 (Machinery and transport equipment). Namely, High-Tech and High-skill and technology-intensive manufactures achieved a modest increase in their shares and regarding after 2004 tendency of those products is stagnant in at the best case. Given their strong importance, concerning technological and skill intensity of Serbian exports, it is not encouraging tendency. Even worse, looking at their trends since 2008, the proportions of these types of products have been even moderately decreasing. True, they generally retained roughly the same portion in domestic exports during all observed period. It suggests a relatively low value of products with the largest possibility to be placed in sophisticated markets, as is the one of the EU. Given that these groups of products are mainly those that have the largest innovation content and potential, it implies the weak performance of the Serbian export sector in this important domain. Namely, only two merchandise groups: 542-Medicaments (1.4%) and 716-Rotating electric plant and parts thereof (3%) have a significant share in Serbian export (2018) when High-Tech products are concerned.

When it comes to the second most important classification – high skill and technology-intensive manufactures – the situation is something better because slightly wider coverage. Namely, to the two mentioned merchandise groups we can add an additional two with a share of minimal 1%: 554-Soap, cleansing and polishing preparations with 1% and 581-Tubes, pipes and hoses, and fittings for

them (of plastics) with 1.3%. Yet, both of them certainly don't cover products with strong innovation content.

Additionally, the trend of the growth of all four analyzed indicators is a worldwide phenomenon, but it seems that Serbia detected solid growth of two more covering indices (medium- and high-tech products and skill-intensive manufactures) in a relatively short period, especially after 2012. Of course, obtained structure improvements in 2018 compared to the one in 2000, even moderate is still far from the level achieved by most CEE economies (Table 2) and especially developed countries. It implies improving but weak domestic export quality in the European context.

Table 2. *Shares of (Medium- and) High-Tech products, High-skill and technology-intensive manufacture products, and Skill-intensive manufactures in total exports of selected CEE countries 2007-2018*

	2007	2018	2007	2018	2007	2018	2007	2018	2007	2018	2007	2018
	Bulgaria		Hungary		Romania		Czechia		Turkey		Croatia	
High-Tech	7.3	10.4	29.3	24.4	6.4	9.1	20.5	22.4	4.5	3.9	10.5	13.3
High Skill Tech-Int.	10.8	13.8	31.6	27.2	8.7	10.9	22.6	24.9	9.2	8.1	14.6	18.2
Skill-Intensive	22.5	30.6	66.8	68.8	35.8	53.2	60.0	65.1	34.0	46.5	29.5	35.1
Medium + High	24.2	33.0	68.3	70.5	40.6	56.0	63.5	67.6	39.6	49.4	42.0	39.4

Notes: See Table 1

Source: Author's own calculation based on the UN COMTRADE database.

According to Table 2, it can be seen that from 2007 to 2018 the majority of observed CEE countries detected a moderate share increase in all four categories of products. Hungary has the best results, as expected, with medium- and high-tech products accounting for 70.5% of exports in 2018 and with High-Tech products achieving even one-fifth of country exports. Czechia has similar results, with medium- and high-tech products amounting to 67.6% of its exports in 2018, while high-skill and technology-intensive manufactures were almost 25%. The findings for those two countries, in particular, imply their higher innovation capacity, which was translated into five or seven times higher per capita exports than Serbian one. True, the problem with Hungary is virtually stagnating structure at a high achieved level, while all other observed economies detected solid improvements.

As is expected, those countries have a higher share of high processing export products than Serbia, excluding Bulgaria which has something worse structure but a 90% higher absolute level of exports, while Croatian export per capita is higher for 53%, but with modestly better quality (structure). The Romanian text-book example of success was very indicative. She strongly improved export quality in the period under review, at the same time achieving its strong absolute growth. The structure is improved also in Turkey, but the average growth rate is significantly slower (5.6%) than Serbian one, while per capita export is by a one fifth lower. Generally, Central European countries (like Czechia,) have a

significantly higher share of high processing export products than Balkan states. This is in spite of the fact that already since 2000 majority of those economies saw an increase in medium- and high-tech products share in their total exports, but from a low base (Nikolić, 2013, pp. 128-130).

In summary, Tables 1 and 2 showed that the share of products at higher levels of processing in almost all observed economies virtually always increased in the observed period. Generally, these are good signs, but it is a small consolation for Serbia given the worldwide growing trend of this kind of products in world trade, and regarding the higher achieved level of other CEE states.

4. INTRA-INDUSTRY TRADE AS INDIRECT INDICATORS OF PRODUCTS INNOVATION

Integration, openness and intra-industry trade are very important regarding the correspondence of business cycles, and as Munkacsi (2009) pointed out Hungary is already very open and integrated, with a share of intra-industry trade similar to that of the euro area. Although the euro area is still the most important export partner, the role of foreign trade between EU new member states was increased significantly. The share of high-level products in exports and value-added was significant, which helped avoid negative cost competitiveness shocks at the same time increasing the level of intra-industry trade.

Intra-industry trade represents international trade within industries rather than between industries. Such trade is more beneficial than inter-industry trade because it stimulates innovation and exploits economies of scale. The most common, standard, indicator of measuring the share of intra-industry trade from a data set composed of both homogeneous and differentiated goods is Grubel-Lloyd index. It measures the degree of intra-industry trade due to product differentiation with scale economies, which indicates how a country imports and export simultaneously varieties of a particular product. The index is expressed as the ratio of intra-industry trade (two-way trade within industries) to total trade. The index will be equal to zero in the absence of intra-industry trade, but to one in the absence of inter-industry trade. In the aggregate intra-industry trade index higher ratios suggest that the economies of scale and various sources of gains are being exploited. Thus, if the bilateral Grubel-Lloyd index is relatively large for a set of trade flow data, it can be inferred that a relatively large proportion of bilateral trade in this data set is associated with two-way trade in differentiated products (Grubel & Lloyd, 1975, pp. 21-23).

$$GL = \sum_{i=1}^{n} w_i GL_i = \sum_{i=1}^{n} \frac{X_i + M_i}{\sum_{i=1}^{n} (X_i + M_i)} GL_i = \frac{\sum_{i=1}^{n} (X_i + M_i) - \sum_{i=1}^{n} |X_i - M_i|}{\sum_{i=1}^{n} (X_i + M_i)} \quad (1)$$

GL – intra-industry trade index for total trade between the two countries;
GLi – intra-industry trade index for commodity class *i* (here: goods at 3-digit SITC level);
wi – share of trade in product *i* in the total trade;
Xi (*Mi*) – exports (imports) of product *i* from (to) given country to (from) a given country;
n – number of commodity classes (industries).
The low index value indicates the possibility of significant structural adjustment costs due to increased competition from other countries, indicating that the country is not making significant incomes from horizontal and vertical integration into the world economy and is not taking advantage of selling products in large markets and from specialization in certain areas. It has been empirically proven that a possible increase in intra-industry share in total trade is an indicator of economic development (and indicator of eventually decreased the gap in technology relative to more developed countries).

Recently, Grubel-Lloyd index is used in the study by Hayakawa *et al*. (2017). Authors, in order to measure the stability of two-way trade, proposed a measure that they refer to as the 'Intra-Industry Trade stability index". Their estimation results using the proposed measure show that two-way trade involving markets of different sizes and long distances are likely to be unstable and primary products are more unstable than manufactured products.

On the basis of our calculation, Serbia's intra-industry trade in 2000-2018 was obtained results presented in Table 3. Also, we calculated the same index for the CEE economies given in Table 4 to have better comparative insight. Looking at Serbia intra-industry indices there is moderate growth, certainly with some years oscillating around trend (e.g. 2012-2014 and 2015-2017). Yet, a growing tendency is not questionably, which is a good sign.

Table 3. *Grubel-Lloyd index of intra-industry trade, Serbian exports 2000-2018*

	2018	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**
standard G-L	0.540	0.516	0.502	0.521	0.498	0.507	0.504
weighted G-L	0.543	0.519	0.504	0.526	0.505	0.506	0.541
	2011	**2010**	**2009**	**2008**	**2007**	**2004**	**2000**
standard G-L	0.486	0.454	0.437	0.437	0.420	0.380	0.346
weighted G-L	0.510	0.467	0.461	0.481	0.462	0.453	0.361

Notes: Standard G-L is Standard Grubel-Lloyd index of intra-industry trade. Weighted G-L is Grubel-Lloyd index weighted with merchandise groups' trade shares.
Sources: Source: Author's own calculation based on the UN COMTRADE database and Serbia's Customs Administration (2000 and 2004)

Table 4. *Grubel-Lloyd index of intra-industry trade of selected CEE countries in 2007 and 2018*

	2007	**2018**	**2007**	**2018**
	Standard G-L		Weighted G-L	
Bulgaria	0.440	0.592	0.469	0.597
Hungary	0.725	0.735	0.725	0.742
Romania	0.427	0.614	0.470	0.601
Czechia	0.692	0.732	0.693	0.740
Turkey	0.404	0.442	0.430	0.445
Croatia	0.429	0.611	0.545	0.653

Notes: Weighted G-L is Grubel-Lloyd index weighted with merchandise groups' trade shares. In 2011 Czechia: 0.708, and in 2018 B&H: 0.430 (Weighted G-L: 0.402) and N. Macedonia: 0.365 (Weighted G-L: 0.306).

Source: Author's own calculation based on the United Nations COMTRADE database

When CEE states are concerned there is obvious moderate growth in all selected economies. The obtained level of intra-industry trade for Serbia, even almost constantly rising in the period under review, was the lowest among observed economies, apart from Turkey. Additionally, empirically is detected the trend of the growth of these coefficients generally. Also, since the 1990s in European countries in transition these indicators were also growing indicating to the positive change of their foreign trade both total and with the EU. For example, Kawecka-Wyrzykowska (2008; p. 15) showed that combined intra-industry trade index for (advanced) CEE 10 countries (which entered the EU in 2004) increased from 0.419 in 2000 to 0.508 in 2007 (calculated at the five-digit SITC level). The evolution of trade specialization in these economies has been clearly in one direction, consisting of the increasing role of intra-industry trade. It means that these countries have made great shift in changing their production structures and making their economies more similar to the EU economies (so-called catching-up process).

So, it is clear that the intra-industry trade index for Serbia is still relatively low indicating their unfavorable trade structure. Despite this, overall insight gives support to some positive expectations. Namely, the traditionally complementary nature of trade has become increasingly competitive. Additionally, volume and structural changes of the Serbian trade relations have been leading to more interdependence, deepening cooperation and developing or joining existing international production chains. As decades-long experience with the rapid growth of intra-industry trade among the developed countries shows, intra-industry trade does not only create more competition but also opens up new areas of cooperation and generates structural transformation.

The process of transformation of the Serbian trade pattern - from inter-industry to intra-industry one - can be seen, which is certainly a positive development

leading to more interdependence. Of course, this process is not comparable with the one seen in CEE 10, especially in the Visegrad Group, but any signs of such development are welcome.

Certainly, intra-industry trade has in some way driven Serbian trade developments in the observed period, which is above all consequence of strong inflow of FDI (largely from EU), allowing value chains to be formed. Related to this is modest growth innovative content of Serbian exports. Namely, as Serbia imports a very high level of sophisticated products mostly belonging to sector 7, especially from advanced EU markets, every rise of exports of the same products automatically means an increase of intra-industry trade almost by definition (of course, ceteris paribus).

5. EXPORTS SPECIALIZATION

In this part of paper we focus on the following research objectives: to assess the patterns and dynamics and degree of Serbia's export specialization and to derive policy implications based on the empirical findings. The Export Concentration Ratio (Cxj), also known as the Herfindahl-Hirschmann (H-H) index, is the most commonly used ways of measuring export concentration. The H-H coefficient is the numerical expression of concentration; the higher the coefficient is, the lower the level of diversification it represents. Export concentration reflects the degree to which a country's exports are concentrated on a small number of products (or countries). The index is the simplest and most affordable indices due to their ease of comprehension and availability of data. It ranges from 0 to 1, with 0 reflecting the least concentrated export portfolio and 1 the most concentrated (UNDP, 2011, p. 44). The index is normalized because of the number of merchandise product groups is different between countries. To be added, the decline in export concentration ratios was a tendency in almost all countries in the period after World War II, especially in the last two decades of the 20th century. Otherwise, it is natural that smaller (as well as less developed) countries have higher ratios of exports because they can't sufficiently diversify their export offer.

$$C_{xj} = \frac{\sqrt{\sum_{i=1} \left(\frac{X_{ij}}{X_j}\right)^2} - \sqrt{\frac{1}{n}}}{1 - \sqrt{\frac{1}{n}}} \qquad (2)$$

i = 1…n
n = number of SITC 3-digit export categories (about 260)
Xij = value of export of sector "i" from the country "j" in a given year
Xj= total export volume of the relevant country in the same year

In Table 5 it is obvious that H-H index practically stagnated for Serbia, excluding incidental growth of fall in some years.

Table 5. *Export concentration, total Serbian exports 2004-2018*

2018	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**
0.080	0.081	0.086	0.091	0.106	0.114	0.068
2011	**2010**	**2009**	**2008**	**2007**	**2004**	**2000**
0.075	0.077	0.065	0.088	0.088	0.077	0.088

Note: Serbia import concentration 2000=0.128

Sources: Source: Author's own calculation based on the UN COMTRADE database and Serbia's Customs Administration (2000 and 2004).

Looking at Table 6 this index is higher for Czechia, Romania, and Hungary in 2018 representing relatively new kind of high technology export concentration in these economies. For example, in Romania it was caused by the fact that only four technologically sophisticated merchandise groups accounted for about 27% of total exports: 772-Electrical apparatus for switching or protecting electrical circuits (5%), 773-Equipment for distributing electricity (5.9%), 781-Motor cars (6.9%), and 784-Parts and accessories of the motor vehicles (9.6%). In Hungary higher level of this index in 2018 was caused by a large portion of next six merchandise groups associated with high quality of exports: 542-Medicaments (3%), 713-Internal combustion piston engines and parts thereof (6%), 764-Telecommunications equipment (4.6%), 772- Electrical apparatus for switching or protecting electrical circuits (4.4%), 778-Electrical machinery and apparatus (3%), 781-Motor cars (9.2%), and 784-Parts and accessories of the motor vehicles (6.0%), with roughly 36% of total exports. On the other hand, merchandise groups with higher shares in Serbian export belong to less qualitative sort of export products, partly excluding 773 and 716. They are: 625-Rubber tyres (3.9%), 673-Flat-rolled products of iron or non-alloy steel (3.9%), 682-Copper (3.2%), 716-Rotating electric plant and parts thereof (3%), 773-Equipment for distributing electricity (6.8%), 821-Furniture and parts thereof (2.9%), which combined consisted nearly 24% of total exports.

Table 6. *Export concentration ratio (Herfindahl-Hirschmann index) for selected CEE countries 2007 and 2018*

	2007	**2018**
Bulgaria	0.131	0.093
Hungary	0.141	0.110
Romania	0.101	0.115
Czechia	0.096	0.129
Turkey	0.089	0.076
Croatia	0.116	0.071

Source: Author's own calculation based on the United Nations COMTRADE database.

Yet, one can say that H-H level generally represents a poor diversification of Serbia (legacy of the period before the 1990s) and that the overall development suggests that the level of export diversification, lead by technology improvement, has not come to significant improvements. But, looking at data the same can be said for Turkey and Croatia. Both countries had generally low H-H index in 2018 which is also characteristic for almost all advanced countries because of wide export supply (as these economies virtually cannot concentrate their exports). Certainly, the relatively low value of the coefficients, similar to those of the developed countries, is not a consequence of the broad supply of Serbia' export sector and its favorable structure, but above all, it was caused by the lack of certain competing products. Practically, there are only a few merchandise groups in our export going to the world or the EU market that have a significant share, and these are, as a rule, primary, resource, or labor-intensive products. The same is also case concerning all Balkans economies, as was shown in study by Nikolić (2013, p. 17) covering period 2001-2011. Findings from this paper showed relatively poor diversification of Balkan's economies as well as a lack of significant improvements.

It is not real, nor would it be good, to see a significant increase in the specialization of the Serbian economy because, given the domestic factor availability, or production potential, it would practically say that country is strongly increasing the share of certain products in the lower processing stage, which generally have a low unit value. In the long run, the preferred route is export diversification, basing exports on a large number of products of the multiple phases of finalization, and most preferably export based on new products with high innovative content.

Here used methodology is applied in many recent studies, among other by Márquez (2016) performs an analysis of the concentration or diversification of the export structure of the Andean Community member countries, and Kim (2019) traced the relationship between aid for trade and 133 aid recipients' export structure between 1996 and 2013, where he used the H-H Index to measure the degree of export concentration.

CONCLUDING REMARKS

The main objective of this study was to investigate the consequences of cooperation between Serbia and the EU in the context of innovation development prospects for the former. The question is whether the EU integration process has significantly increased Serbian innovation potential, especially the one directly or indirectly applicable in its manufacturing sector, which should be the main driver of merchandise exports of the country.

To address this issue and to better understand whether the nature of mutual economic relations between Serbia and the EU has changed allowing for

innovation potential of the Serbian manufacturing sector to grow strongly, we have calculated more indicators of the Serbian merchandise export in 2000-2018, beginning with its absolute growth. To detect eventually increased content of innovation potential of the Serbian exports sector we have analyzed qualitative changes of domestic exports, through tendencies of goods at higher levels of processing. Then, the indices of intra-industry trade were calculated and finally Serbia's export specialization. Obtained results are compared with those achieved by CEE economies.

So, is there sufficient improvement in the innovative capacity of the Serbian economy? At first glance, the answer is a positive one. Serbia detected very strong export growth since 2000, true from a very low base. In 2000-2018, solid structural advancement was achieved, measured through a share of goods at higher processing, and then looking at the rise of intra-industry trade (true, with stagnant export specialization coefficients). However, the same results are far better when other CEE states are concerned, almost in every of the mentioned measurements. It means that Serbia is lagging behind all the economies we are trying to compare with. Certainly, one of the reasons for such a situation is a low level of the innovation capacity of the domestic economy seen through the modest ability for export penetration, which is a consequence of weak manufacturing base from which such an undertaking could be derived. So, there are no conclusive signs of sufficient improvements in calculated indicators to imply significant innovation development, especially compared with the achievements of CEE countries.

The question arises what to do to significantly improve the situation, given the long prospect for EU membership that is expected to be a strong factor for technological accelerations. While the country's science and technology system has taken steps forward, there is a tremendous gap between Serbia and those countries identified as knowledge-driven economies. To close this gap, we have to become more focused on long-range objectives, including confronting Serbia's failure to commercialize the results of scientific research, and our inadequate production of knowledge workers capable of building a globally competitive economy. Transformation to a knowledge-based economy would necessarily imply higher investments in research activities and all areas connected with them. It is expected that in medium to long term, such action would increase the proportion of national income derived from knowledge-based industries, workers employed in knowledge-based jobs, and value of high tech products made by innovative technologies.

The previous conclusion referring to the importance of innovation is in line with a growing number of studies that look at the relationship between innovation and exports, that is with findings that more innovation tends to allow firms to export more. Blyde *et al*. (2018) used data from Chile and combine information on

innovation activities at the firm level with a rich dataset on exports at the transaction level. It was found that the firms that engage in innovation tend to export more than other firms because they are able to sell goods and target markets that reward innovation. Boddin (2018) created a new long-term patenting panel dataset for Germany to identify the causal effect of trade integration with Eastern Europe and China on patenting in the period 1993-2012. He exploited the cross-regional variation in the German industry structure and used trade flows to other advanced economies as instruments for regional import and export exposure. He found that an increase in net trade exposure causes an increase in regional patenting. This effect is purely driven by a positive link between import exposure and innovation, which is fully explained by trade integration with Eastern Europe. Chih-Hai (2018) has examined whether and how heterogeneity in exports affects firms' innovations in China, showing that exports have a positive impact on promoting innovations in terms of R&D and new product sales.

All said experiences imply that Serbia only with increased R&D investment, both by the private and public sectors has an opportunity to secure a greater share in European markets. By committing to growing the base of scientists, technology professionals, and engineers - both in general and in areas offering the most economic potential over the long term - Serbia is investing in human capital that will serve its needs well into the future.

For now, Serbia is failing to convert ideas into economic growth. While the government must invest throughout the entire innovation chain, strategic choices must be made. When it comes to competitive advantage, the government should invest in areas of the highest socio-economic return.

It is clear that countries like Serbia will have to move from a classical catching up by imitation, to a knowledge-based system with more value-added and more diversified exports, but the right question whether it is realistic to make competitive products today - in many cases virtually from the scratch. Of course, pure cost competitiveness will not be sufficient when Serbia approaches the technological frontier, but it seems that this moment is far away. Like other CEE countries in our phase of economic development, we practically must continue to use our relative cost advantage to modernize our industries with foreign technologies - high stocks of FDI along with a high share of exports and imports (largely consisted of foreign imported technologies) to GDP are a testimony to this. Yet, it is no recipe for the future, and it is certainly that this easier approach regarding innovation has to be gradually abandoned.

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SUSTAINABILITY OF THE MANAGED FLOATING EXCHANGE RATE REGIME IN SERBIA

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Abstract: The sustainability of the adopted exchange rate regime depends to a large extent on how the foreign trade balance, inflation and foreign exchange reserves will fluctuate over the medium term. Based on the applied correlation analysis, the relation between the nominal exchange rate of the Serbian dinar against the euro, exports and imports was determined, based on the monthly data of these variables for the period from 2007 to 2018. The paper shows that the increase in the nominal exchange rate in the Republic of Serbia is associated with a slight decrease in imports, and does not induce higher inflation on a monthly basis, while foreign exchange reserves are moving at optimal limits according to the applied indicators (ratio of foreign exchange reserves to short-term external debt and average monthly imports). Therefore, the managed floating exchange rate regime is sustainable and provides support for ensuring Serbia's macroeconomic stability.

Keywords: sustainability, exchange rate regime, managed floating exchange rate, inflation, foreign trade balance.
JEL: E52, E58, F32.

1. INTRODUCTION

The exchange rate is one of the important determinants of all economies. It is often said to be the most important price in an economy that also affects the formation of a general price level. In addition, the exchange rate also shapes international economic relations, since the level of the exchange rate is associated with a higher (lower) degree of competitiveness in the international market. In this way, it redirects demand from foreign to domestic products and vice versa. Recognizing the importance of prices as information and functional instruments in directing resources directly leads to the acceptance of the exchange rate as a key lever in regulating foreign trade flows and corresponding imbalances (Madžar, 2006, p. 113).

Each country chooses the exchange rate regime depending on the particular circumstances and development of its economy. Considering the structural characteristics of the economy and the achieved macroeconomic results in the

previous medium-term period, the best solution is made. Bearing in mind the situation from the beginning of the 21st century in the Republic of Serbia, when both inflation and nominal exchange rates rose rapidly, monetary and macroeconomic policy makers faced the problem of assessing which criteria have a higher specific gravity (impact) in the medium term. The exchange rate regime should certainly not be an acceptable and optimal solution once and for all. That is why many countries decide to change the applicable exchange rate regime after a certain period.

The basic division of exchange rates involves a fixed and floating exchange rate. However, there are a number of regimes between these extremes where there is greater or lesser influence of monetary authorities on its formation. Exchange rate regimes closer to the fixed exchange rate are the currency union, the currency board and the pegged currency, while the regimes that gravitate to floating exchange rates (there is greater possibility of oscillations and less central bank influence) are the creeping exchange rate, the moving corridor, the monitoring corridor and the managed floating exchange rate (Miljković, 2007).

It is often reported in the literature that small open economies threatened by high inflation rates due to excess money supply should apply a fixed exchange rate. However, the main drawback of the fixed exchange rate is the fact that it can cause a discrepancy between a stable nominal exchange rate and differences between inflation in the country and the country of the reference currency, which in the case of speculative shock, ultimately leads to regime collapse and the emergence of a currency crisis (Marinković, 2006, p. 75). In addition, monetary policy is not conducted freely because the monetary authorities in this case give up some monetary policy instruments in advance (Hausmann *et al*., 1999). This makes it impossible to balance the balance of payments with the depreciation of the national currency. A floating exchange rate allows greater flexibility for monetary policy at times of exchange rate pressures and economic difficulty (Mussa *et al*., 2000, p. 22).

The Republic of Serbia has chosen such a regime that falls within the fluctuating exchange rates, but with a smaller degree of intervention by the monetary authorities (the National Bank of Serbia) in order to stabilize it. It is a managed floating exchange rate regime. In fact, the exchange rate is formed in accordance with market principles and laws, but the central bank intervenes to prevent excessive daily fluctuations and speculative attacks on the foreign exchange market.

The exchange rate is a macroeconomic indicator that essentially determines the macroeconomic balance of the economy. It is an indicator that has a direct impact on the balance of payments and also on inflation. The high level of transmission to the general price level threatens price stability leading to the re-

depreciation of the Serbian dinar. Exactly this relation exchange rate - inflation - exchange rate is the relationship that is unbreakable in the Republic of Serbia. This influence is further corrected by upward (i.e., strengthening the exchange rate channel) psychological factors from the not-so-recent hyperinflationary past. The aim of this paper is to show whether the managed floating exchange rate regime is sustainable, taking into account the trends of exports, imports and inflation rate, depending on the monthly changes in the nominal exchange rate of the dinar against the euro in the Republic of Serbia from 2007 to 2018. as well as the movement of foreign exchange reserves of the National Bank of Serbia.

The central part of the research is structured as follows. First, the influence of the exchange rate on imports and exports and foreign trade balance and the Marshall-Lerner theorem was first defined theoretically, and then a correlation analysis was conducted. In order to determine whether inflation cancels the positive effects of the nominal exchange rate on the export and import of the Republic of Serbia, it has been examined: the inflation rate for the analysed period, the relationship between the exchange rate and the general price level (both on an annual and monthly level), as well as the underlying factors that strengthen this relationship. In the third part, a review and analysis of the optimality of the level of foreign exchange reserves of the National Bank of Serbia is given, based on the two most significant indicators, as another factor of sustainability of the applied exchange rate regime.

2. ELABORATION

2.1. Relationship between the exchange rate, exports and imports of the Republic of Serbia

Depreciation of the national currency (an increase in the exchange rate given that the Republic of Serbia has accepted the so-called European Convention, i.e. direct notation), by definition, has the effect of increasing the price competitiveness of exports and reducing the profitability of imports. Exports are then more attractive to domestic producers than directing products to the domestic market because domestic goods destined for foreign markets are cheaper. The opposite is the case in the event of a fall in the exchange rate. However, whether the quantities will respond in the desired direction and whether the balance of payments will balance depends on many adjustment factors. In the Republic of Serbia, high import dependency of the most important export-oriented sectors is one of the crucial problems. Import dependency raises costs in domestic production and exports, especially as a result of higher prices of imported raw materials and energy, due to the lack of domestic substitutes. Non-competitive export supply also does not contribute to the increase in export value despite the achieved depreciation of the currency, as well as the lack of production capacities and commodity stocks.

According to the Marshall-Lerner theorem, depreciation will improve the balance of trade if the sum of export elasticities (foreign demand for domestic exports) and import elasticities (domestic demand for imports) is greater than one (Todorović & Marković, 2016, p. 142). These are the following coefficients of elasticity:

$$\varepsilon x = \frac{\frac{\Delta Q_x}{Q_x}}{\frac{\Delta E}{E}} \qquad (1)$$

wherein:

εx - elasticity of foreign demand for domestic exports,

$\frac{\Delta Q_x}{Q_x}$ - relative change in the value of exports,

$\frac{\Delta E}{E}$ - relative change in the level of the exchange rate, and

$$\varepsilon m = -\frac{\frac{\Delta Qm}{Qm}}{\frac{\Delta E}{E}} \qquad (2)$$

wherein:

εm - the elasticity of domestic demand for imports and

$\frac{\Delta Qm}{Qm}$ - relative change in imports.

At the beginning of the analysis, Table 1 is provided, which tracks movements in the values of exports, imports and trade deficits, as well as the level of the nominal exchange rate. This gives a general picture of the movement of these variables for the analysed period.

Table 1. *Values of exports, imports, commodity balance of the balance of payments and nominal exchange rate in the Republic of Serbia (2007-2018)*

Year	Exports (in EUR million)	Imports (in EUR million)	Commodity balance (in EUR million)	Nominal euro exchange rate in dinars, end of year
2007	6382	13451	-7069	79,24
2008	7416	15917	-8501	88,60
2009	5978	10924	-4946	95,89
2010	7402	11983	-4581	105,50
2011	8440	13758	-5318	104,64
2012	8394	14028	-5634	113,72
2013	10515	14674	-4159	114,64
2014	10641	14752	-4111	120,96
2015	11454	15099	-3645	121,63
2016	12814	15933	-3119	123,47
2017	14066	18064	-3997	118,47
2018	15238	20483	-5245	118,19

Source: Author's presentation based on data of the National Bank of Serbia, 2019.

Based on Pearson's correlation coefficient, the coefficients are determined given in Table 2 between the chain indices of the following quantities for the period 2007-2018 on a monthly basis: nominal exchange rate (ER), export (EXP) and import (IMP). The correlation coefficients between the exchange rate and imports, as well as exports and imports, are statistically significant (at the significance level of 5% and 1%, respectively). There is no statistically significant correlation between the exchange rate and the export, while there is a very low level of correlation between the exchange rate and the import, with this connection being negative, i.e. an increase in the exchange rate reduces imports. A high degree of statistically significant correlation is present between exports and imports of goods and services. Based on the coefficient of correlation between exports and imports of 0.862, it can be concluded that there is a high import dependence on exports (export-oriented sectors) of the Republic of Serbia. More specifically, increasing exports requires higher imports due to a lack of domestic substitutes (e.g. energy, parts in the automotive and mechanical industries). However, as a result, depreciation will improve the balance of trade due to a higher decrease in imports relative to exports.

Table 2. *Correlation coefficients: nominal exchange rate, exports and imports in the Republic of Serbia (2007-2018)*

Correlations				
		ER	**EXP**	**IMP**
ER	Pearson Correlation	1	-,131	-,173*
	Sig. (2-tailed)		,120	,039
	N	143	143	143
EXP	Pearson Correlation	-,131	1	,862**
	Sig. (2-tailed)	,120		,000
	N	143	143	143
IMP	Pearson Correlation	-,173*	,862**	1
	Sig. (2-tailed)	,039	,000	
	N	143	143	143

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Author's calculation (IBM SPSS 22) based on data of the National Bank of Serbia, 2019.

Finally, one limitation in the research is highlighted. It refers to the mechanism of action of the rise in the exchange rate on exports and imports. Even if there are conditions that allow for the positive effects of depreciation on the commodity balance, the effects may not be immediately felt. This is because price adjustments are instantaneous, while it will take some time (usually a few weeks) to adjust the quantities and improve the balance of goods situation through an increase in exports and a decrease in the value of imports. For example, it takes time to recognize the change in relative prices, make a decision, activate production capacity, supply contracts and make payments. Also important are the expectations of business entities about the exchange rate movements in the future.

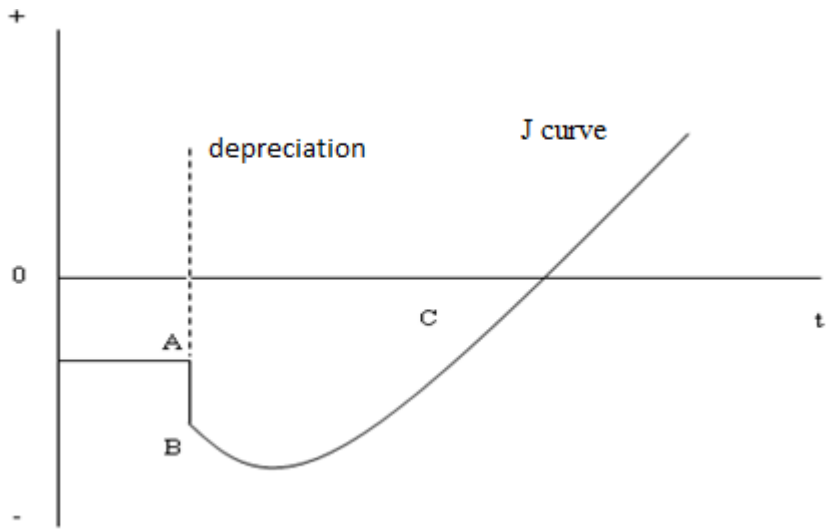
Figure 1 shows the J curve, which testifies to the above constraint. Commodity balance is in deficit (below the equilibrium line) before depreciation. At point A, the national currency depreciates. The deficit is exacerbated (point B), which is a consequence of faster price changes than changes in quantities. The value of imports (Qm * Pm * E) increases due to the increase in the exchange rate, while the value of exports (Qx * Px / E) also decreases due to the same factor, whereby:

Q_m - quantity of imports,
P_m * E - import price in domestic currency,

E - nominal exchange rate,
Q_x - amount of exports,
P_x/E - export price in foreign currency.

In point C, the effects of the depreciation of the national currency are only reflected, assuming the Marshall-Lerner theorem.

Figure 1. *J curve*



Source: Miljković (2007)

2.2. Impact of the nominal exchange rate on inflation in the Republic of Serbia

As the negative relationship between the nominal exchange rate and imports has been determined, it is necessary to investigate whether the depreciation of the Serbian dinar is linked to higher inflation rates and to what extent. First, the theoretical framework of the exchange rate-inflation correlation will be determined, and then based on empirical data, this relationship will be checked.

Monetary stability is an important factor in economic stability. It implies both the stability of the general price level and the exchange rate in the national economy. It should be noted here that stability does not mean the absolute invariability of these macroeconomic variables (zero inflation and exchange rate fixation). Price stability is ensured by achieving a low, predictable and stable inflation rate, while exchange rate stability is monitored and evaluated on the basis of the number, direction and strength of central monetary institution interventions in the foreign exchange market.

In floating exchange rate regimes, the main objective of monetary policies is to maintain price stability. In small, open economies, the exchange rate is the main nominal anchor in the formation of inflationary expectations. Due to the negative experiences from the previous inflationary period, as well as the high correlation between the exchange rate and prices, the National Bank of Serbia after 2000 has adopted the concept of a "controlled - floating" exchange rate (Slović *et al*., 2011, p. 125). Exchange rate stability is basically based on maintaining price level stability, which is ensured through a non-inflationary macroeconomic policy (Ćirović, 2000, p. 49). On the other hand, a stable exchange rate keeps national inflation rate in check. In addition to maintaining price stability, a stable exchange rate ensures predictability of operations, reduced panic of market entities, as well as stability of real wages.

The high pass-through of the exchange rate to prices, as a result of psychological factors, but also a high import dependence of the domestic economy and a high degree of unofficial euroization, made it impossible for the exchange rate to change significantly in order to balance the current balance without jeopardizing macroeconomic stability, thus creating a conflict between the achievement of these two goals (Janković & Stanišić, 2012, p. 398). This significantly reduces the efficiency and complicates the conduct of the monetary policy of the National Bank of Serbia, and also strengthens the transmission rate of the exchange rate increase to the general price level, which in Serbia is the strongest channel of transmission to inflation.

The present currency substitution in the Republic of Serbia increases the volatility of the exchange rate and makes it an important factor on the basis of which price changes are made. This greatly diminishes the interest rate channel, while enhancing the exchange rate channel. A huge part of savings in Serbia is in foreign currency, while debt is also in foreign currency, i.e. indexed in foreign currency. This means that the inflationary past still has its consequences. According to data from the National Bank of Serbia from May 2019, dinar and dinar indexed household savings amounted to only 5.40% of total household savings, despite its faster growth than foreign currency savings in the last few years.

Considering the inflation rate in the Republic of Serbia from 2013 to 2018, the Serbian economy is well on the way to securing the required medium-term stability of the general price level (Table 3), since it has absolutely come close to the average rate in developed countries. Until then, inflation rates in Serbia, calculated on the basis of the consumer price index, even exceeded the single-digit level in some years (2007, 2010, 2012).

Table 3. *Inflation rates in the Republic of Serbia from 2007 to 2018*

Year	Inflation rate
2007	11,0
2008	8,6
2009	6,6
2010	10,3
2011	7,0
2012	12,2
2013	2,2
2014	1,7
2015	1,5
2016	1,6
2017	3,0
2018	2,0

Source: National Bank of Serbia, 2019.

It should also be noted that any sudden increase in the exchange rate leads to panic reactions and consequently a rise in prices, thus increasing the role and importance of the central monetary institution in the Republic of Serbia from the aspect of monetary policy implementation. It is essential to stop these excessive oscillations. The rise in the inflation rate is reflected in the re-depreciation of the national currency, which can significantly increase the already high level of euroization of the economy. Therefore, it is unjustified that the National Bank of Serbia at this moment should increase the level of flexibility in conducting foreign exchange policy, in the sense of less intervention in the foreign exchange market.

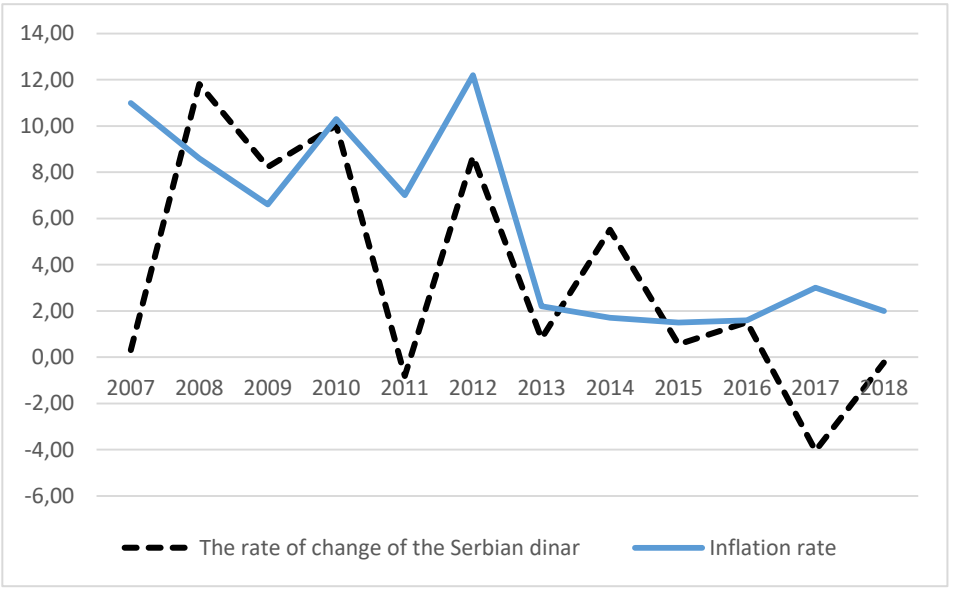
Due to the constant effect of inflation, domestic exporters cannot be price competitive in the foreign market without investing in the possibility of non-price competitive factors (Marković & Marković, 2014, p. 210). That is why it is important that inflation is kept under control and a low rate is achieved in the Republic of Serbia. This restores confidence in the domestic currency, which could cause the dinar savings to be more profitable than the foreign currency ones, thus creating conditions for reducing unofficial euroization (Janković & Stanisić, 2012, p. 399).

Another problem for monetary policy makers is inflationary inertia due to the hyperinflationary past. Inflationary expectations significantly limit the effectiveness of monetary policy measures. It is therefore of the utmost importance that inflation expectations move in line with inflation targets. Pursuant to the Memorandum of the National Bank of Serbia on Targeted Inflation Rates by 2021 (National Bank of Serbia, 2019a), a target rate of 3% has been set, which can fluctuate by 1.5 percentage points. This actually means that

the targeted inflation rate is 1.5% to 4.5%. High confidence level and low inflation rates in the medium term are the best means of reducing the present euroization in Serbia.

Over the last few years, exchange rate stability has been noticeable, largely thanks to the positive results of macroeconomic policy. This has, among other things, caused the inflation rate to stabilize at around 2%, which is the target level of the European Central Bank. A high correlation between exchange rate growth and inflation was present between 2008 and 2013 (Chart 1). Since 2013, the dinar has depreciated against the euro by only 4.10% (cumulatively).

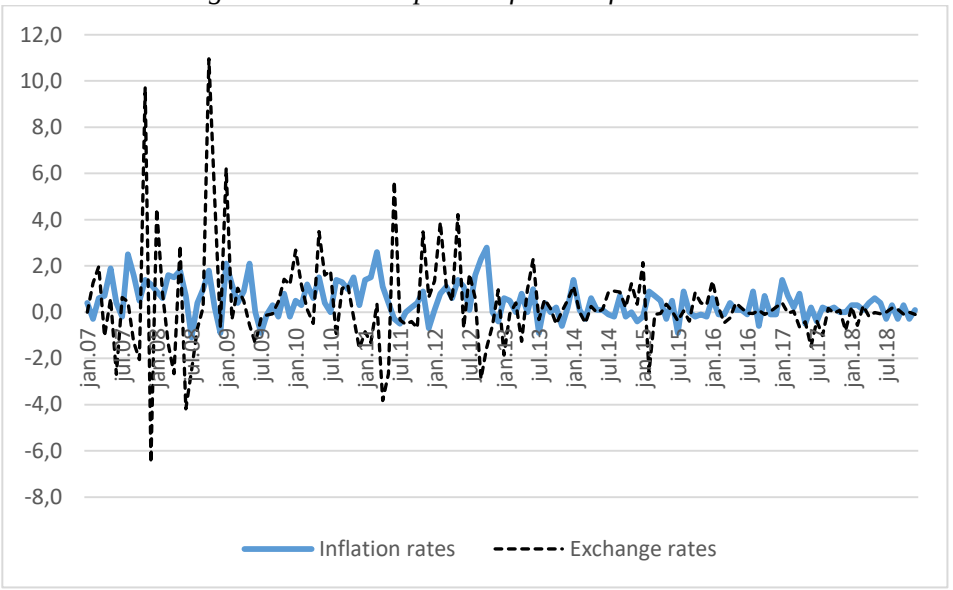
Chart 1. *Comparison of the rates of change in the nominal exchange rate and the rate of annual inflation in the Republic of Serbia in the period from 2007 to 2018*



Source: Author's calculation and presentation based on data from the National Bank of Serbia, 2019.

The following Chart 2 shows a monthly comparison of inflation rates and the nominal exchange rate of the Serbian dinar against the euro.

Chart 2. *Comparison of monthly inflation rates (chain indices) and nominal exchange rates in the Republic of Serbia from 2007 to 2018*



Source: Author's presentation based on data from the National Bank of Serbia, 2019.

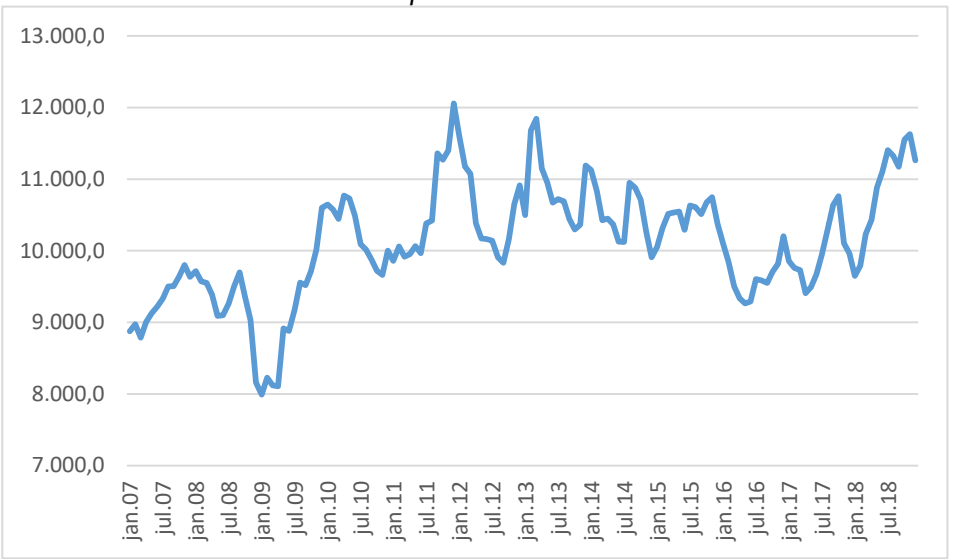
According to the authors' calculations, the correlation between the monthly growth rates of the nominal exchange rate and inflation for the analysed period is only 0.10, which tells us that there is almost no correlation between these 2 variables. This ultimately means that the rise in the exchange rate in the Republic of Serbia reduces the trade deficit due to a slight decrease in imports, without jeopardizing the goal of price stability.

2.3. Foreign exchange reserves as an indicator of the sustainability of the exchange rate

In the literature, several indicators have been used to evaluate whether reserve holdings are sufficient, with the most commonly used ratio being foreign exchange reserves and short-term external debt and the ratio of foreign exchange reserves to the value of average monthly imports. The ratio of reserves to short-term external debt measures the capacity of a country to service its external liabilities in the forthcoming year, should external financing conditions deteriorate sharply. According to the Greenspan-Guidotti rule, a ratio above one signals that a country holds an adequate level of reserves to face the risk of a financial crisis, while a ratio below one may suggest a vulnerable capital account (Green & Torgeson, 2007). The rationale is that, if reserves exceed short-term debt, then a country can be expected to meet its obligations in the coming year and thus avoid rollover problems stemming from liquidity concerns. First, the movements of the foreign exchange reserves of the National Bank of Serbia are

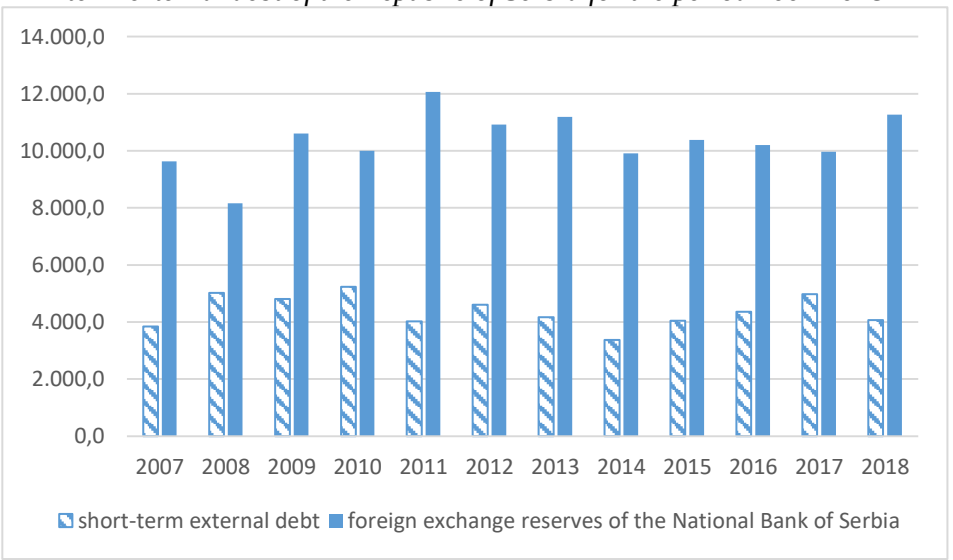
shown (Chart 3), and then the level of foreign reserves in relation to short-term external debt is shown (Chart 4).

Chart 3. *Changes in the foreign exchange reserves of the National Bank of Serbia from 2007 to 2018*



Source: Author's presentation based on data from the National Bank of Serbia, 2019.

Chart 4. *The National Bank of Serbia's foreign exchange reserves to the short-term external debt of the Republic of Serbia for the period 2007-2018*



Source: Author's calculation based on data from the National Bank of Serbia, 2019.

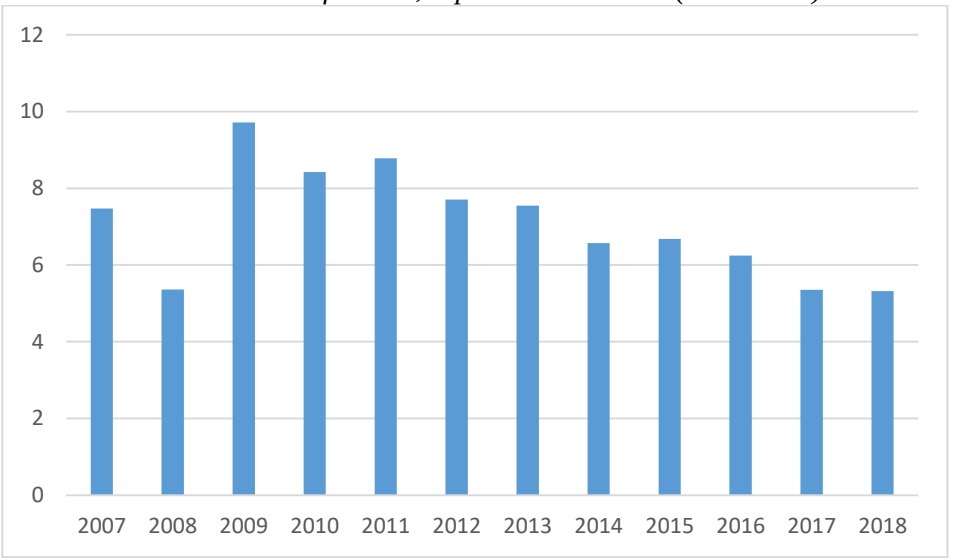
The results of the research show that over the whole period the considered racio is higher than the unit. The highest coverage of short-term external debt in 2011 was as high as 3, while it was the lowest at the beginning of the global economic crisis in 2008, at 1.63. Since 2011, this ratio has not fallen below 2, which means that the foreign exchange reserves of the National Bank of Serbia double the value of short-term external debt.

The ratio of foreign exchange reserves to imports is considered as a proxy for a country's current account vulnerability. This ratio measures the number of months a country is able to finance its current level of imports. Normally, a ratio of 3 and 4 would be considered adequate (Fisher, 2001). Although this ratio is considered the minimum acceptable, some authors in the case of coping with external shocks suggest keeping the higher level of foreign exchange reserves. This may also apply to Serbia, given that the dominant factors of currency crises are those from the external environment (Marjanović & Marković, 2019). The recommendation of traditional approach for macro-economically volatile countries is stabilization based on the exchange rate in order to cope with the external balance of payment shocks once the macroeconomic stability is accomplished. In the long run, it is commonly proposed that foreign exchange reserves ought to be sufficient to cope with shocks, with the amount which is not less than six months' value of imports, and must not be exploited to manipulate exchange rates by underestimation through outsized accumulations of foreign exchange reserves (Popov, 2019).

When examining similar ratios, Mendoza (2004) concludes that reserve management in many countries in emerging Asia is motivated by a desire to self-insure against a financial crisis. Although these ratios provide a good measure of reserve adequacy in terms of a country's resiliency when facing a potential financial crisis, they do not provide an upper bound for reserve holdings. However, a high level of foreign exchange reserves can cause inflation problems, especially in countries with inflation sensitivity.

According to the author's calculations, the foreign exchange reserves of the National Bank of Serbia at the end of 2018 amounted to EUR 11,261.8 million, and the average import of goods and services for the period January-December 2018 amounted to EUR 2,116 million, which means that the foreign exchange reserves of the National Bank of Serbia at the optimum level, given that they cover just over 5.3 months of the value of average imports of goods and services. The same principle has been applied to calculate this ration in all years since 2007 (Chart 5).

Chart 5. *Coverage of imports of goods and services of foreign reserves of the National Bank of Serbia, expressed in months (2007-2018)*



Source: Author's calculation based on data from the National Bank of Serbia, 2019.

In the period of the global crisis and the spillover of effects on Serbia, in 2008, it was the lowest value of this indicator. However, it has never, even then, been lower than 3, which means that the foreign exchange reserves of the National Bank of Serbia have always been at a higher level than the minimum. Imports were above 6 months until 2016, and this ratio has been steadily declining due to increased imports and reduced macroeconomic and external risks.

CONCLUSION

Adequate choice of the exchange rate regime applied should solve the problems of price volatility and trade deficit in the long run. However, there is a need for constant review as once defined exchange rate regime is not always acceptable once and for all. It is changed by international circumstances, but also by structural characteristics and economic opportunities in the internal environment (degree of euroization, exchange rate pass-through to inflation, inflation expectations). As a rule, countries with domestic problems, embodied in high inflation rates, choose a fixed exchange rate, while those facing balance of payments and environmental shocks apply a floating exchange rate regime to amortize those fluctuations. That is why exchange rate policy is a very important part of macroeconomic policy.

The research first considered the impact of the change in the nominal exchange rate on exports and imports, and then practically established the correlation. The

second part details the relationship between the exchange rate and inflation, with particular reference to 2 apparently different periods - the period up to 2012 and beyond. Since 2013, the Republic of Serbia has significantly improved its macroeconomic and fiscal position. Inflation stabilized and moved closer to the European average. Therefore, there is less and less advocacy on the part of economists to move to some modalities that would be closer to a fixed exchange rate. Also, the applied exchange rate regime will allow for the amortization of negative effects from abroad, as well as the adjustment of the balance of payments due to the still high trade deficit. Due to the shallow foreign exchange market, the position of the National Bank of Serbia in the context of conducting a policy of managed floating exchange rate is quite justified. In a world with high capital mobility, even small adjustments in international portfolio allocations to the emerging economies result in very large swings in capital flows (Edwards *et al*., 2003, p. 32). his policy implies the free exchange rate formation with occasional interventions in the foreign exchange market to prevent speculative attacks. These interventions are on a daily basis and are made through the sale of foreign currency on the foreign exchange market.

Since it has been established that the depreciation of the Serbian dinar is associated with a slight decrease in imports, and is not associated with higher inflation rates, while foreign exchange reserves relative to imports are slightly lower, the recommendation to monetary policy makers is to pursue a policy that will allow a slight depreciation, ie. lower level of foreign exchange market interventions when mild depreciation pressures occur. This increased flexibility will reduce the use of foreign exchange reserves, which will increase security and provide prevention through the transmission of the negative effects of future global crises. Also, flexibility should not be significantly increased due to the still considerable euroization.

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INNOVATIVE SYNERGISM AS A RESULT OF TRIZ AND LT - SYSTEM SYNTHESIS

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Abstract: Theory of Inventive Problem Solving (TIPS/TRIZ, rus.) is based on studying the characteristics of the technical systems in order to discover technical and physical contradictions which exist in the root of every problem. The solution to these contradictions, and consequently the whole problem, can be reached through the application of appropriate TRIZ tools. Considering that innovators, in the process of logical decision making about the ideal final solution to a problem, are naturally very biased, there is high chance that the chosen solution will be optimal, but not ideal. However, if the innovative problem is approached by a simultaneous application of TRIZ and Bartini-Kuznetsov-Maxwell dimensional LT-system, then the innovator moves from a biased verbally-logical solution to an objective mathematical-physical solution, which is closer to the ideal solution. On the example of the filtrating protective suit development the innovative synegry as a result of TRIZ and LT- systems has been confirmed.

Keywords: TRIZ, LT-system, innovative synergy
JEL: O1

1. INTRODUCTION

The development of all systems is moving towards increasing ideality (Rajić, 2017). There are many problems along the way that need to be addressed. The ideal final solution (IFS) of any problem is always associated with the maximum utilization of the material and energy resources that reside within the system, in its sub-systems or in the super-system (Rajić, 2019). At the heart of every problem are contradictions. They occur when the level of demand is increased compared to the existing system. In doing so, the requirements may be different, hence the diversity of contradictions. There are basically two types of contradictions: technical contradiction (TC) and physical contradiction (PC) (Rajić *et al*., 2016). TC occurs between system parameters. When one parameter improves, then the other one inevitably deteriorates. Since the "or-or" principle is represented in this case, the adopted TC solution is based on the optimization of the state of two different parameters (Rajić *et al.*, 2019). PC occurs only within one element of the system, when it is physically contradictory, i.e. simultaneously warm and cold, or heavy and light, etc. That is why the principle

of "and-and" is represented in PC, and the obtained solution is based on the idealization of the system, which is closer to the concept of IFS (Rajić *et al*., 2018). Since each TC contains one or more PCs, the PCs solution simultaneously leads to the solution of the TC and thus the problem as a whole. So, in the search for a solution, one has to go from defining and calculating IFSs, and then through detecting TCs, to solving PCs that are at the core of the problem.

Studying millions of patents, Altschuler discovered the basic laws of the development of technical systems (TS) and based on them he developed a set of tools within his theory of inventive problem solving (TIPS / TRIZ, rus.). The most famous TRIZ tool is a contradiction matrix that includes 39 parameters that describe any TS and 40 principles that are recommended to eliminate TCs. However, the principles proposed by Altshuller for dealing with TCs were powerful decades ago, while they may prove weak today. To overcome this weakness, the application of Functionally Oriented Search (FOS) as an additional tool of TRIZ should be combined with the matrix (Rajić, 2019). For example, for contradictions of the type "mass - duration of action", "mass - speed", "mass - strength", "mass - reliability", etc., the best available information is contained in the inventions of the aerospace and aerospace industries. Contradictions regarding the increase in accuracy are most effectively eliminated in the way present in the fields of experimental physics, etc. An innovative contradiction matrix, made using procedures taken from the leading fields of technology, will help to find powerful solutions to the 21st century innovative problems. Therefore, it must be considered only as a basis to be supplemented independently in accordance with new solutions contained in scientific, technical and patent publications.

One possible move in this direction is to rely on the work of Bartini (1965), who, in addition to design work in the field of aviation, has dealt with the theoretical innovation logic that is essentially the forerunner of TRIZ. He developed a method called "and-and" because of the principle of the physical connection of mutually exclusive properties, and implied "both this and that." This is exactly what Altschuller calls PC. Bartini analyzed the dimensions in an inventive problem using the mathematical apparatus of disaster theory. Bartini informed the Soviet military administration of his mathematical and physical study of the innovation process in 1935, 20 years before the first publication on TRIZ was published (Бушуев and Петров, 2017; Бушуев, 2015). For a long time, his work was not known to the general public because of the secrecy of the work he did. Therefore, it can be argued that Altschuler and Bartini discovered their dialectical systems in technics independently of one another. It was not until the late 20th century that Bartini's ideas emerged in the works on TRIZ (Бушуев and Петров, 2017; Бушуев, 2015; Бушуев, 2017). The authors propose to use Bartini's unit system together with TRIZ on a new mathematical basis. However,

there are certain weaknesses and inconsistencies in these works, which is why both TRIZ and LT systems can be used individually and only to a limited extent.

The aim of this paper is to explain the possible innovational synergism that occurs when logical-verbal TRIZ is upgraded with a mathematical-physical LT - system so that the two systems complement each other and are simultaneously used to solve TCs and PCs in the path of seeking the IFS. This creates an opportunity for more effective and much wider application of such an integrated dialectical system based on the compatible basic principle "and-and" that exists in both systems.

2. LT – PHYSICAL UNITS SYSTEM

Maxwell wrote about the possibility of creating systems of units of measure based only on length (L) and time (T) as far back as 1873, relying on Kepler's 3rd law and Newton's 2nd law (Чуев, 2007). If the rotation of the Earth and its inhomogeneity, as well as the deviation from the regular spherical shape, is neglected, the weight F of an object of mass m on or near the Earth's surface is equal to the gravitational force:

$$F=G\ (m_1m_2/r^2). \quad (1)$$

where F is force (body weight), G-gravity constant (dimensionless) which equals 1, m_1-mass of body 1, m_2--mass of body 2 on the Earth's surface, r^2-distance between the center of the bodies.

$$F= m_1a=m_1m_2/r^2. \quad (2)$$

where m is the mass of the body on the Earth's surface, and the acceleration a = G (m_2/r^2), where a is the acceleration of the Earth's gravity on its surface, which decreases with increasing body distance from the Earth. The force of the Earth's gravity (gravitational pull by the Earth) acts on the body, and the weight of the body acts on the substrate (or other body). Therefore, the mass dimension (m_2) is defined as the product of the acceleration dimension (LT^{-2}) and the dimension of the spatial expansion square (L^2). As a result, the dimension of mass in the LT dimension table looks like this:

$$[M]=L^3T^{-2}. \quad (3)$$

This value uniquely determines the mass of the Sun, or it can be otherwise said that it is determined by it.

For the mathematical representation of operations with the combination of different physical properties, a comparative system of kinematic quantities according to Bartini (1965) and an SI system of physical quantities (Table 1) can be compared. It turns out that the interconnectedness of physical quantities does

not depend on the system in which they were given (Коган, 2004a-d, Коган, 2007, Чуев, 1999; Чуев, 2003; Чуев, 2004; Чуев, 2007). This mindset is not loaded with psychological inertia. In studying the system of physical quantities, he illustrates the principles of the holistic structure of nature, according to which all individual parts belong to one whole, as each whole contains within itself all the characteristics of its constituent parts. A vision of the whole system and an understanding of the formal patterns in the relationships that exist between physical quantities make it easier to discover new laws of nature.

Table 1. *Important physical units and their characteristics in SI system and LT physical units system*

No.	PHYSICAL UNIT NAME	SYMBOL OR FORMULA	MEASURE UNIT	DIMENSIONS	
				SI	LT
1	Length	l	m	L	L
2	Time	t	s	T	T
3	Speed	v	m/s	LT^{-1}	LT^{-1}
4	Acceleration	a	m/s^2	LT^{-2}	LT^{-2}
5	Frequency	f	Hertz (Hz)	T^{-1}	T^{-1}
6	Mass	m	kg	M	L^3T^{-2}
7	Force	F=ma	Newton (N)	MLT^{-2}	L^4T^{-4}
8	Pressure, strain	P=F/s=W/V	Pascal (Pa)	$ML^{-1}T^{-2}$	L^2T^{-4}
9	Energy, work, heat quantity	W=FI	Joule (J)	ML^2T^{-2}	L^5T^{-4}
10	Force, radiation flux	N=W/t	Watt (W)	ML^2T^{-3}	L^5T^{-5}
11	Surface	S	m^2	L^2	L^2
12	Volume	V	m^3	L^3	L^3
14	Density	ρ_m	kg/m^3	ML^{-3}	T^{-2}
15	Impulse (amount of movement)	P=mv	kgm/s	MLT^{-1}	L^4T^{-3}
16	Surface voltage	F=F/I=W/S	H/m	MT^{-2}	L^3T^{-4}

Bartini (1965) observed the regular relationships between physical constants and presented them in the form of a kinematic system of physical quantities, and together with Kuznetsov developed a geometric direction in the study of physical dimensions (Bartini and Kuznetsov, 1978). Their LT table expresses the physical laws of conservation (Table 2). It is intuitively clear that an LT physical size chart could have significant practical value for innovators. However, they did not leave information on its possible practical application, nor did they in any way associate it with TRIZ.

If you look at Table 2, it is observed that the vertical columns of the kinematic system contain a series of whole degrees of length (from L -2 to L 5) and the horizontal rows contain a series of integers of degrees of time (from T -6 to T 3)

(Bushuev, 2008). The intersection of each column and each row gives a dimension of a certain physical size. The dimensions of all physical quantities are represented as a product of the whole degree, $L^n T^m$, where $|n+m| \leq 3$ for three-dimensional space.

Table 2. *LT Table - Kinematic System of Physical Units (length [L] and time [T])*

Values	L^{-2}	L^{-1}	L^0	L^1	L^2	L^3	L^4	L^5
T^{-6}					L^2T^{-6}	L^3T^{-6}	L^4T^{-6}	L^5T^{-6}
T^{-5}				L^1T^{-5}	L^2T^{-5}	• Surface power	L^4T^{-5}	Power
T^{-4}			L^0T^{-4}	• Specific gravity • Gradient of pressure	• Pressure • Tension	• Surface tension •Rigidity	Force	• Force momentum •Energy •Statistical temperature
T^{-3}			L^0T^{-3}	Current density	•Electromagnetic field strength • Ductility	Current • Loss mass	• Motion quantity •Impulse	• Angular momentum • Action
T^{-2}	nbsp;		• Mass density •Angular acceleration	• Magnetic displacement •Acceleration	Potential difference	• Mass •Quantity of magnetism or electricity	Magnetic momentum	Moment of inertia
T^{-1}		Volume charge density	Frequency	Velocity	• Two-dimensional abundance • Velocity of change of the area	Loss volume	L^4T^{-1}	L^5T^{-1}
T^0	$L^{-2}T^0$	• Crookedness •Change of conductivity	Dimensionless constants (for example, a radian)	• Length • Capacity •Selfinduction	Surface	Volume of space	Distribution of volume along length	
T^1	Changing of magnetic permeability	Conductivity	Period, Duration	Time necessary for change of length on unit	L^2T^1	L^3T^1		
T^2	Magnetic permeability	$L^{-1}T^2$	Surface of time	L^1T^2	L^2T^2			
T^3	$L^{-2}T^3$	$L^{-1}T^3$	Volume of time	L^1T^3				

Source: Bushuev (2008)

The importance of the LT table is reflected in the fact that it expresses the physical laws of conservation. For example, by equating the dimension of a cell L^1T^0 to a constant, one obtains the law of conservation of the length of a solid: L = const. Equation $L^{+5}T^{-4}$ = const. gives the energy conservation law. Equation $L^{+2}T^{-4}$ = const. reflects Hooke's law (Robert Hooke; 1635-1703). Equation $L^{+3}T^{-2}$ = const. is Kepler's (Johannes Kepler; 1571-1630) law (the ratio of planetary cubic radius and square of rotation is constant). A very important and useful

feature of Bartini's table is that each cell, or a corresponding law it contains, has a certain volume of object grouped into classes. Indeed, many cells contain not just one physical size, but several. For example, there are two physical quantities in cell $L^{+3}T^{-2}$: mass and amount of charge, in cell $L^{+1}T^{0}$ there are three quantities: length, capacitance, self-induction, etc. Moreover, many cells can be added even though they are not listed in Bartini's physical size chart. For example, in the SI system, thermal conductivity is measured in [WT/m·K]. If the power dimension $L^{+5}T^{-5}$ is put in place of Watt and instead of Kelvin the temperature dimension $L^{+5}T^{-4}$, then thermal conductivity must be added to the cell with dimension $L^{-1}T^{-1}$. According to the SI system, the mass flow rate is measured in [kg/s]. If the dimension kilogram is replaced by the force $L^{+4}T^{-4}$, then the value $L^{+4}T^{-5}$ is obtained. As you can see, in the original table, this size is not so specified. Since there is no kilogram - force in the dimension [kg/s], but there is a kilogram - mass, then $L^{+3}T^{-3}$ is obtained. The strength of classification is that each class contains an "invariant" property, i.e., a property that is represented in all elements of this class. Kuznetsov calls this object an entity, essence, or essence. What is the invariance or essence of length, capacity, self-induction for an innovator in his inventive tasks? The fact is that they all have the same physical dimension $L^{+1}T^{0}$. Therefore, when there are length, capacity, or self-induction properties in an inventive problem, these properties can be operationally utilized by the same methods. The same is true of something similar to what is called the "similarity criterion", when conservation laws are different in different fields of physics and have the same mathematical structure. For example, if in mechanics there is (in any formula) length expressed by square meter, then in a similar formula for electricity, capacity will also be expressed by squared symbol.

Bartini's table can be used to solve inventive problems at the physical level, i.e., in the case of PC formulation and solution, because it contains physical units, which characterize the spatial-temporal and sub-field (substance + field) resources in the problem.

2.1. Dimension analysis in a conflicting model of an inventive problem

Dimension theory in ARIZ has been used in the statics of the model of technical contradiction (Бушуев, and Литвинов, 2017; Бушуев and Петров, 2017; Бушуев, 2015). This model uses an elemental mathematical spike-type catastrophe with the potential function E (x) which has the following form:

$$E(x) = 0{,}25\,x4 + 0{,}5\,a\,x2 + bx. \qquad (4)$$

where x is the coordinate of the disaster state and a and b are the coefficients.
Elemental catastrophe (4) models the conflict pair - TC1 and TC2, i.e., tool + object as well as an X-element that resolves the conflict between them.

The potential function E (x) is characterized by an undesirable effect, while the remaining three coefficients, x, a, b - specify the product, tool, and X-element respectively.

Let x be the property of a product, which can be measured by some physical size, y = a / d - the property of a tool, which can also be measured by any suitable physical size, z = c / e - the property of an X-element, which can also be measured by some appropriate physical size, die coefficients that equal the dimensions of the physical quantities x, a, b. Then formula (4) can be written in the following way:

$$E(x) = (0.25x4 + 0.5dyx2 + ezx)f. \quad (5)$$

where f is the coefficient that equals the dimension of the physical magnitude E (x). Translating the formula from form (4) into form (5) is called disaster scaling.

The transition from the TC state to the PCs state and vice versa, can be efficiently represented by butterfly diagrams (Hyun and Park, 2016).
The TC removal method is proposed in the contradiction matrix in general form. The die is similar to a finished suit that needs to be adjusted according to the user i.e., individual characteristics of the task. If e.g. recommends principle 1 ("segmentation"), it just indicates that the solution is related to some sort of object division. The Matrix does not release a thinking innovator. It merely directs his thinking in the most promising way to finding an IFS. The use of typed methods is associated with the creative character of the inventive process. All modern inventors use typed methods, although they are not aware of it (Rajić, 2016).

If the solution to the problem is beyond the primary cause or PC, it will be more difficult to reach the IFS. TC can be reduced through technical advancement by complicating the entire system, but as a rule the PC will reappear elsewhere in the TS. In order to prevent the mass unwanted occurrence of the consequences of unresolved TCs, the place and time of occurrence of the primary cause should be determined as accurately as possible and PCs detected therein. Also, a cause-and-effect analysis should be performed; the primary cause of the occurrence, the undesirable occurrences and the necessary micro tasks to be solved at the subsystem level should be detected. PC is the cause of all TS problems. It can occur if IFS is defined when troubleshooting. The tactic is based on the application of the general principles of PC resolution. The system properties of the objects and the phase transitions of matter from one aggregate state to another are used. When the physics of the phenomena taking place in the operating area is not yet clear, and when the element in which the PC is manifested is not clearly identified, complexities arise in the application of the

principles. It is observed that the resolution of each PC in one way or another is related to the application of only two principles: the extension of contradictory properties in space and time. Other known principles, which raise the possibilities of systemic, phase, and physicochemical modifications, only help to realize the first two, i.e., represent some sort of functional mechanisms.

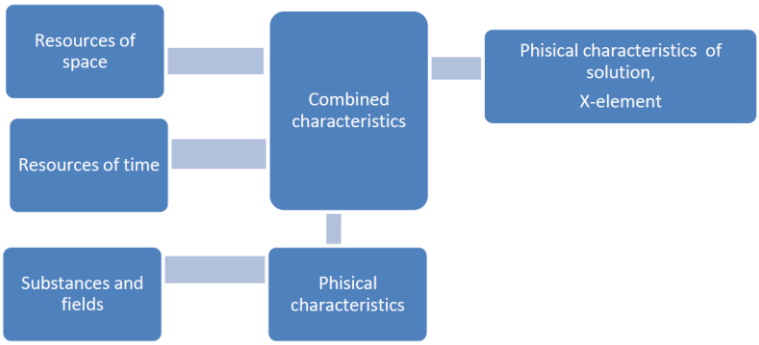
If the problem is free from redundant elements and if the contradiction is sufficiently clearly expressed, then the IFS can be formulated immediately, in direct relation to the element that is to be changed. If the problem is not clear, then one should first find and point out the contradiction it carries, then define the cause of the problem and formulate an IFS for it. To remove the TC and PCs using the appropriate resources. Available resources can be divided into six groups: substance resources (material), field resources (energy), space resources, time resources, information resources and functional resources (Rajić, 2019). It is necessary to compile a list of resources that are already in the system or easily accessible from the system. When generating a solution to a technical problem (the last step of each iteration), the search for resources from that list begins.

The Inventory Task Algorithm (ITA/ARIZ, rus.) as TRIZ's most powerful tool serves for comprehensive innovative problem solving and includes a series of steps that direct innovators toward IFS. The use of ARIZ is recommended for a thorough TS analysis through its components, functions of resources and TCs, that is, in the problem analysis phase, then for solving complex problems with 40 inventive and separation principles in the search for solutions and finally, in the comprehensive search for solutions in order to overcome competition through a system of patent protection. Once the problem is resolved, the result obtained must be standardized to prevent it from reoccurring. In the field of TRIZ, 76 TRIZ innovation standards are used as a tool in this regard.

As a result of solving the inventive problem in the first part of ARIZ, a TS model is formed in the form of TCs with two conflicting features TC1 and TC2 and an unknown X - element to be found in order to solve the contradiction. The second part analyzes spatio-temporal and also substance-field resources, from which the X-element in the future should be selected through analysis. This analysis is similar to the search for a criminal. First, one needs to determine what is different about a criminal as opposed to other people. This is determined by the actions he committed (or offenses) or did not commit. Similarly, a conflicting pair is required to determine good or bad results of product functioning, i.e., the characteristic that requires thinking, action, movement is determined. Then the appropriate mathematical model of search, which can be determined by a system of differential equations, describing the dynamics, movement and development of thought, should be thrown into the scene. Once the perpetrator is found to be the person who committed the unlawful acts, the search for evidence begins. In the case of ARIZ, this means looking for the

physical property that the X-element must possess in a given space and time. This problem was solved in the third part of ARIZ by the PC formulation. The features of this concept in human consciousness are discrete. Of course, the X-element can be more or less heated, but the physical property of heat or cold is distinguished by temperature and not mass, length, pressure, etc. The transition from ARIZ's space-time analysis and the collateral analysis of the resources of their physical properties is shown in Figure 1.

Figure 1. *Structural diagram of changing physical properties of resources*



Source: Бушуев & Литвинов (2017)

The resource model for transformation of physical properties shows the mechanism of transmission of inherited information in physical form. It is available in the domain of the physical resources of space and time, as well as the physical properties of the substance-field as a result of their combination. These physical properties are converted to X-element.

2.2. Analysis of LT table and TRIZ contradiction matrix over resource trends

If you compare Bartini's LT table with TRIZ tools, it is immediately apparent that the contradiction matrix is the most similar tool. It contains 39 TS parameters (length, volume, time, speed, pressure, force, temperature…) that describe TCs and 40 TRIZ principles (segmentation, isolation, grandmother…) that help overcome TCs. In nature, as in life, there is not one phenomenon that cannot be subsumed under the Law of Units. If these 39 TRIZ parameters are analyzed individually by nature, then they can be divided into 3 groups: basic physical quantities derived physical quantities, and state expressions (Table 3).

Physical size is a property of occurrence, body or substance that can be qualitatively differentiated and quantified or measured. The basic size has been agreed to be independent of any other size. It has a unit of measure adopted and defined by agreement. The derived size is a function of the basic sizes of that system. According to the SI system the basic units are length (m), mass (kg), time (s), electric current (A), thermodynamic temperature (K), amount of

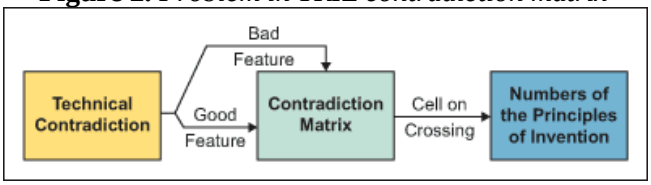
substance (mol), light intensity (Cd). Derived units are frequency (Hz or s^{-1}), force (N or $mkgs^{-2}$), pressure (Pa or $m^{-1}kgs^{-2}$), energy or operation (J or m^2kgs^{-2}) and voltage (V or $m^2kgs^{-3}A^{-1}$). The additional units are radian (rad) and steradian (sr). Condition expressions represent complex parameters of TS, which only cause-effect analysis can lead to the level of basic or derived physical quantities.

Table 3. *Classification of 39 parameters according to TRIZ*

Parameter type	**Number of TRIZ parameter (1-39)**
Basic parameter	1-11; 15-23
Derived parameter	26
Condition expression	12-14; 24; 25; 27-39

TRIZ's 39 TS parameters are shown as columns and rows in the contradiction matrix. When a TC is formulated, the innovator looks for a cell that arises by a crossover between a parameter that needs to be repaired and the parameter that will automatically deteriorate. This cell contains numbers of inventive principles that suggest a solution to the contradiction (Fig. 2). All 40 TRIZ principles represent condition expressions.

Figure 2. *Problem in TRIZ contradiction matrix*

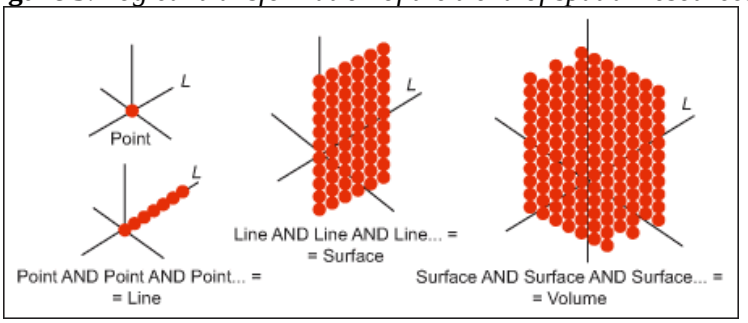


Source: Bushuev (2008)

In Table 4. the horizontal line T^0 should be noted. The fragment L^0T^0, L^1T^0, L^2T^0, L^3T^0 is known as the TRIZ sequence "point - line - surface - volume" (Figure 3). Let us consider the mechanism of transfer of inherited physical properties when going along the spatial trend T^0. The trend may be considered at the level of infinitesimal magnitudes. Indeed, the integral of the differential dl (point) is l (length), and the integral of ldl is l2 = S (surface), etc., up to the dimensionless coefficients. Therefore, as we move from T^0 trend from cell to cell, from left to right, the geometric dimension of space is increased by one by multiplying the previous dimension by L^{+1}: $L^{n+1}T^0 = L^nT^0 \cdot L^{+1}$. The trait dimensions of all the elements of a trend have in their composition the multiplier L^{+1}, which is inherited from the "parent", which can be called the gene of length. Length genes are transmitted to all elements (generation) of the physical property of a trend, whereby a set of lines is formed. Indeed, a line is a set of

lines (of one line), a surface is a set of lines, volume is also a set of lines, etc. But the T^0 trend in the table is unlimited, on the left and right, and can start with any cell. If it starts without dimension L^0T^0, then all subsequent generations will have the property of a set of points. It is necessary to find out how the inherited trait is physically transmitted.

Figure 3. *Logical transformation of the trend of spatial resources*



Source: Bushuev (2008)

Now the logical formula of the line can be written: line = "and" point "and" point "and" point .... "and" point ... This formula expresses the mathematical operation of logical multiplication "and" - "and" or a connection adding elements to an aggregate. In these logical formulas, "and" - "and" forms the Bartini method and the corresponding geometry (Bartini and Kuznetsov, 1978). That's the logic that connects thinking about moving geometry (mathematics) in physics properties. It is important to note that the property of the height line is expressed per unit length, and it already appears at two points where any places of this line are located. Then the minimum logical formula for the line to be: line = "I" point "and" point. Spatial analysis problems using Bartini table at terms similar to ARIZ step 2.1. There are defined resource area in which there is a contradiction, and where the X-element. What is the difference? In ARIZ, the X-element must be placed in the operating zone position. Valuable information that can be reached using the LT-table as location X-element in problem's geometry.

Now we need to think about how TC can be incorporated in Bartini's table. TC includes an object (product), the tool and the two alternative features that depend on the opposite state of the tool. The TC model with the solution is defined by the line "product (L1) → tool (L2) → X - element (L3) → solution (L4). This line is similar to the point-to-line-surface-volume trend (creating contact forms between tools and products). Dimensions in the LT table can be found for this trend. It is obvious that in the line T^0, where the geometric dimension of the point is the dimensionless size L^0, the dimension of the line - length L^1, etc. Multiplying the order of the point line by T^0- volume gives a fragment of L^0T^0, L^1T^0, L^2T^0, L^3T^0. A positive effect can be identified as an undesirable effect of E (X).

The other horizontal rows of the LT table allow for the development of trends in spatial development of resources. Each cell of a time trend is different from the next cell of the same trend by the multiplier of T. The diagonal lines of the LT table represent the slopes of the trend of resources. Each cell of the sub trend is different from the next cell of the same trend by the multiplier L^1 T^{-1}, i.e., velocity $V = L^1T^{-1}$.

For example, a spatial trend in pressure development: cell L^1T^{-4} determines the pressure gradient, cell L^2T^{-4} specifies pressure at a point, cell L^3T^{-4} determines the distribution of force along the line or surface tension, cell L^4T^{-4} represents force. Of course, this trend can also be seen as a development of strength in space. Similarly, LT table columns represent temporal trends of development through physical properties. The dimension in each cell of the time trend is different from the neighboring one by the factor T.

2.3. Integration of the Altschuller matrix with Bartini's LT system

Bartini's LT-Table can easily find TRIZ parameters classified as basic physical units (1-11 and 15-23) as well as derived parameter (26). However, other TRIZ parameters, which are classified as condition expressions (12-14; 24; 25; 27-39), cannot be found in the LT table. They can be reached through mathematical and physical unless you know the value of TRIZ parameters displayed as LT - size, then multiplication or division two known values identify an unknown parameter or TRIZ parameter or TRIZ principle as condition expression.

When combining the use of TRIZ's contradiction matrix and LT table, the basic and derived physical units have a convincingly high frequency of occurrence, i.e., extremely large number of repetitions of one LT - unit, while in the expression of state there are more LT - units that have the same frequency of occurrence. That's logical. For example, the TRIZ parameter "shape" is a condition expression. In aerodynamics, it could be reduced to basic physical unit (resistance to airflow), but in the case of the shape of the chair made for sitting, ergonomics and comfort are important, i.e., width and height or something similar, and not resistance. By searching for a reason for this, a cause and effect analysis might lead to a completely different basic parameter from resistance. So, in the case of shape, there are multiple LT-units of equal importance i.e., frequency, because it is a complex expression of a condition. Likewise, each of the 40 TRIZ principles has multiple LT – units of equal frequency of occurrence, which only confirms the fact that the principles are also expressions of condition.

3. A CASE STUDY

PFS is a filtrating suit which protects a user's body from high toxic materials (HTM) (Rajić, 2018). This paper deals with experiments that were conducted to test the basic physical and mechanical characteristics of PFS. FPS model reached ideality of 75.4% (Rajić, 2018). Increasing ideality of FPS models can be achieved by increasing their individual parameters. In the case of FPS the work is needed on constructional changes which would contribute to the lower value of heart frequency (R=67.1%) and the work should be done on fixing the parameter of surface mass i.e. total mass (R=56%) (Rajić, 2018). It is called technical improvement or innovation of a lower inventiveness level. Parameters that go the maximum ponder value were taken for the calculation of ideality.

If the FPS mass is low (desirable characteristic), then the heart rate is lower, but the protection against HTM is weaker (undesirable characteristic). If the protection against HTM by FPS is good (desirable characteristic), then its mass is too large (undesirable characteristic), causing physiological problems such as heat stress. There is a need to find for a solution that is a FPS with both, good protection (TC1) and low mass (TC2).

The Butterly algorithm can systematically find the solution strategy for the problem, and thus it helps to solve contradictions efficiently (Hyun and Park, 2016). The Butterfly diagram performs a visual role in analyzing phyisical contradictions and technical contradictions easily. By applying the propositional logic, the Butterfly easily. By applying the propositional logic, the Butterfly algorithm derives the right direction efficiently and logically.

In search of IFS we can use TRIZ matrix of contradiction. This means that the key parameter to be corrected is no. 2A (mass of the stationary object). In this case, more promising solution is to eliminate the inner protective layer from the existing FPS system which is impregnated with spherical particles of activated carbon, and instead introduce a new TiO_2 compound. This substance is able to decontaminate HTM in the presence of sunlight (Bauk *et al.*, 2012). The choice of self-contamination material of the external layer impregnated with nanoparticles of TiO_2 (Senic *et al.*, 2013; Senic *et al.*, 2013a), or some other nanomaterial, presents a completely different conceptual approach to the development of FPS.

If LT - physical units system is used in the FPS construction in case of searching for IFS, then it is evident that the mass of the stationary object should be reduced. This parameter is indicated by no. 2A in the Contradiction Matrix, and in the LT table, this is the size of L^3T^{-2}. Another parameter that needs to be fixed is protection time. This parameter is indicated by parameter no. 16 F, G in the Contradiction Matrix, and in the LT table this is the size L^0T^1. Multiplying these two parameters in the Contradiction Matrix gives the principle no. 2 as

recommended in order to obtain the highest likelihood of IFS. In practical terms, this means that one of the interfering components or features should be extracted from the FPS. As the mass needs to be reduced, this means that one layer of FPS, internal or external, should be discarded. If the outer layer of FPS is retained, then the desired goal can be achieved if it is e.g. impregnated with TiO_2 layer. If these quantities are translated into the LT system and multiplied, then L^3T^{-2}x L^0T^1=L^3T^{-1} is obtained. What in practical terms does the size of the L^3T^{-1} mean? The answer can be obtained by studying the proposed TRIZ principles and the contradiction matrix: 2x16 = 2; 27; 19; 6. Principle no. 2 suggests some isolation of the interfering component or characteristic. It could be e.g. FPS inner layer. Principle no. 27 suggests using cheap short-lived material instead of expensive long-lasting one. In this regard, the Sun can be used as a free source of energy for the decontamination of HTM. Principle no. 19 suggests periodic action. This means that with FPS, a chemical decontamination reaction occurs only when it is needed, i.e., in case of contamination. Principle no. 6 implies universality. This means that the FPS can be constructed as a work uniform that is used on a daily basis, and in the case of HTM protection, it will effectively protect the user.

Given this, the choice of a single layer FPS impregnated with TiO_2 could solve the mass problem and improve the protection system against HTM. This yields a principled design solution for FPS that is well above 75% of ideality, which is closer to the notion pf IFS.

CONCLUSION

TRIZ is based on the study of patents and disclosure laws of development of TS. LT system is based on the study of the law on the maintenance of physical units. The thread that connects both systems is the PC ("and-and" principle), which is at the root of every problem and presents its essence. Synthesis of the Altshuller contradiction matrix and Bartini's LT physical size table provides the synergy necessary to more effectively find the IFS in innovation problems.

The TS parameters according to TRIZ (1-39) are classified into 3 groups: basic, derived and condition expressions. Basic and derived have their place in LT - Table of physical units. Their mathematical operations of multiplication or division (the intersection of TRIZ parameters that are repaired and broken) yield LT-units whose verbal-logical description is derived from the TRIZ principles (1-40). This way it is possible to extend Bartini's existing physical units table to new sizes. In addition, by complementary integration of these two dialectical systems based on the “and-and” principle, abstract meanings of hitherto unknown or not-well-known LT-units can be logically explained.

Certain TRIZ parameters, as well as all 40 TRIZ principles, represent condition expressions. When translated into an LT system, there is no pronounced

separation of a single LT unit, as in the case of basic parameters. Therefore, a cause-and-effect analysis must be conducted to determine which LT expression is dominant in the particular case.

By integrating the Altschuler and Bartini systems, TCs and PCs are more efficiently solved than when they are tackled individually. This is illustrated by the example of the construction of FPS.

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THE DEVELOPMENT OF THE INNOVATION SECTOR IN SERBIA

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Abstract: Time is changing very fast. How quickly Serbia succeeds in following new developments will depend on how political institutions and policymakers of future innovative policies adapt to the rapid progress in this field and the increasing challenge of migratory movements of the most skilled workforce. The leading resources of the global economy are technology and innovation. They are also indicators of the state's competitiveness. The State of Serbia must have an effective innovation policy that will not only improve its competitiveness but also preserve and enhance its innovative capacity, which will be exposed in the coming years to the relentless race for human resources conservation highlighted by the Europe 2020 Strategy of its objectives - Improving the conditions for research, development and innovation through the Innovation Union. By analysing indicators of innovation activity in the period from 1990 to 2018, the authors will give an overview of the trends of the most important indicators in this sector and try to suggest good directions for further improvement of the state policy in the innovation sector.

Keywords: Global Competitiveness Index (GCI), Innovation, Competitiveness, Global Innovation Index (GII), Innovation Performance
JEL: O3, O31

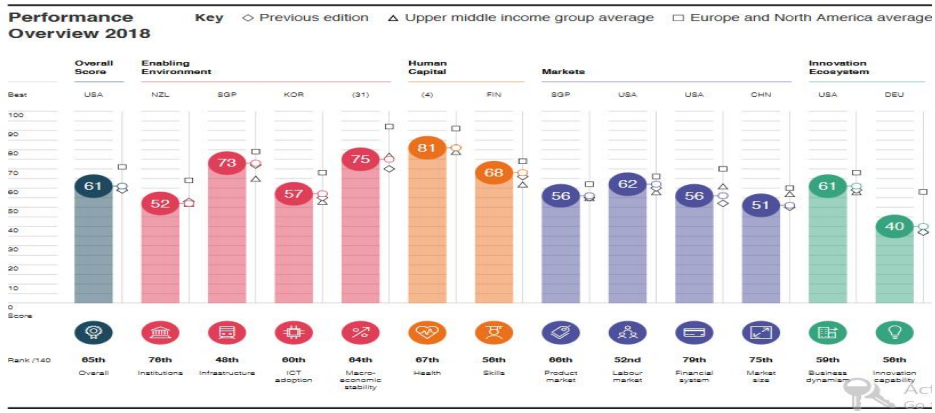
1. THE ROLE OF THE DEVELOPMENT OF THE INNOVATIVE SECTOR ON SERBIA'S GLOBAL COMPETITIVENESS

Global competitiveness is fostered by the country's long-term measures to achieve better results in the world market, through legislative, incentive and institutional action. National prosperity is not inherited. It is the result of constant encouragement of innovation.

Intensive globalization, increasing openness of Serbia, and in this context the very process of European integration, greater social and political stability, relative availability of knowledge, partial adaptation of educational institutions to the tendencies in the labor market and European regulatory framework, primarily in the field of technical and natural sciences, have made a significant contribution to Serbia's better ranking in the field of innovation.

According to The Global Competitiveness Report 2018, the World Economy Forum (WEF) Serbia has advanced to the list of the Global Competitiveness Index for 2018 published by the World Economic Forum, ranking 65th among 140 countries (Figure 1).

Figure 1. *Global Competitiveness Index (GCI 4.0)*

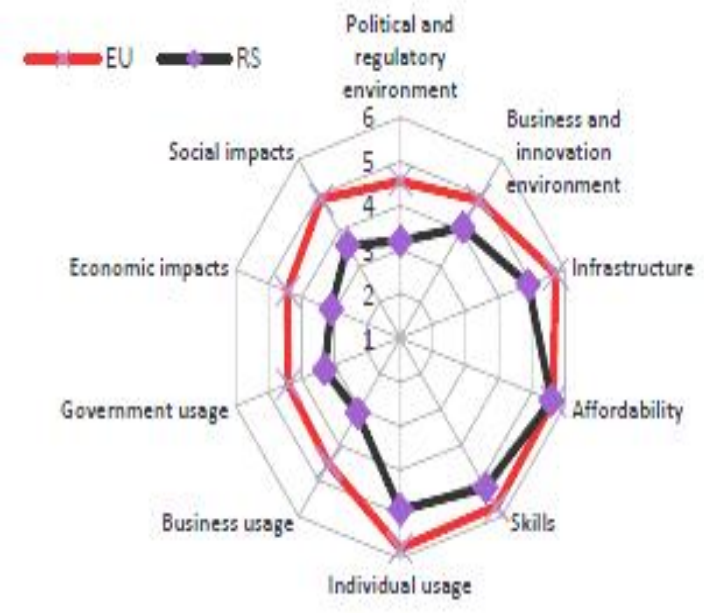


Source: The Global Competitiveness Report 2018, World Economic Forum (WEF)

Figure 2 gives the pillars of the NRI in Serbia and a comparison with the EU average and in the part of the innovation environment on which conditions in Serbia need serious improvement in the future.

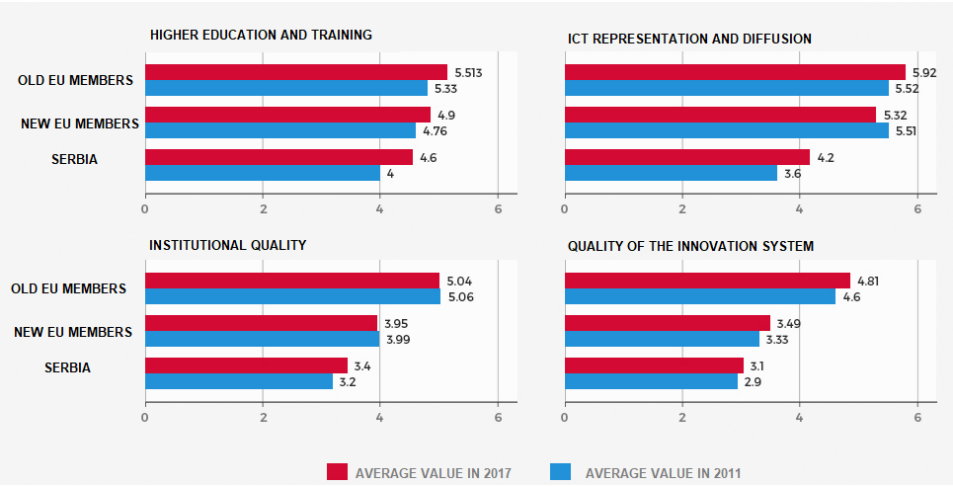
In the quality of the innovation system, Serbia recorded an increase in 2017 compared to 2011, but the gap with the same quality of the new and old EU members is evident. Serbia has made progress in the Third Pillar, which focuses on the innovation system, which is also the most subtle segment (Figure 3.) This is a segment where progress in Serbia (0.2 index points) has been almost identical to progress over the past seven years in the old EU member states. New member states have progressed more slowly and the gap between them and Serbia has narrowed. Thus, in 2011, Serbia was worse than all the new EU member states, and in 2017 it was better than Croatia, on par with Romania and slightly worse than Lithuania, Bulgaria, Slovakia and Greece. By this parameter, all countries are farthest from the ideal result, indicating the challenges they face in building a system that enables a dynamic innovation creation process.

Figure 2. *NRI pillars in Serbia: comparison with the EU average*



Source: The Global Competitiveness Report, World Economic Forum (WEF)

Figure 3. *Knowledge economy in Serbia and new and old EU member states*



Source: Monitoring the Social Situation in Serbia-MONS 2017

On the other hand, the participation of researchers in Serbia in the total number of employees is about 0.5%, while in the EU it is 1.5%, in some member states it is approximately much higher: Iceland (3.58%), Finland (3.22%), Sweden (2.71%). Financing for research, development and innovation in Serbia is carried

out within the government budget and amounts to about 0.38% of GDP, which is a very low percentage compared to the EU. And compared to smaller EU member states, these investments in Serbia are noticeably smaller: Bulgaria - 0.53%; Greece - 0.58%; Croatia - 0.84%; Hungary - 1.15%; Portugal - 1.66%; Slovenia - 1.86%; Austria - 2.75%; Denmark - 3.02%; Finland - 3.96%. For these reasons, it is necessary to increase both the number of researchers and the budget investment in science as soon as possible.

2. ANALYSIS OF THE INNOVATION ACTIVITY INDICATORS IN THE REPUBLIC OF SERBIA IN THE PERIOD FROM 1990 TO 2018

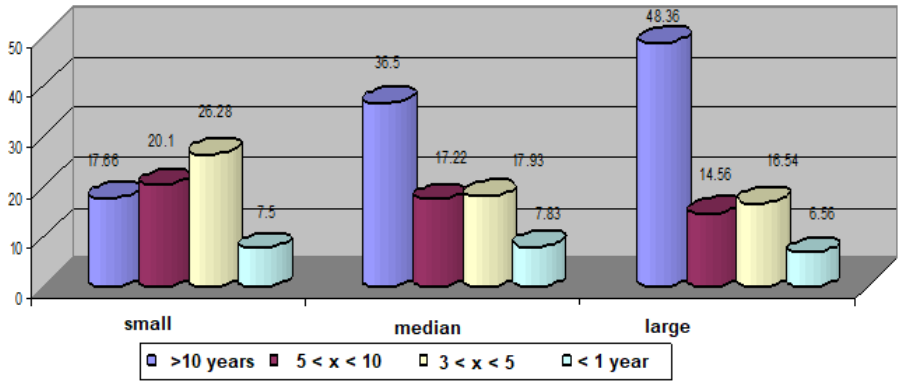
2.1. Analysis of Indicators of Innovation Activities in the Republic of Serbia from 1990 to 2000

According to Djurovic-Petrovic (2011) after escaping the difficult period of 1990s, the budgetary allocations for science in Serbia increased significantly in gross amount, from a modest € 27 million in 2001 to € 100 million in 2008.According to Djurovic-Petrovic (2012) until 2000, little had been done in this area in terms of legislation and in any other related activities as well, it was an uneasy task to make up more than a decade of what was missed. Along with initiating the procedures for creating a legal framework, the significant actions have been started to promote and emphasize the importance of this activity for the growth and development of the economy and thus the general society of Serbia. After 2000 and until the Law on Innovation Projects was passed, efforts related to the development of innovation have mostly been focused on the improvement of the legal framework that would regulate this matter in accordance with international standards and practices.

2.2. Analysis of Indicators of Innovation Activities in the Republic of Serbia from 2000 to 2004

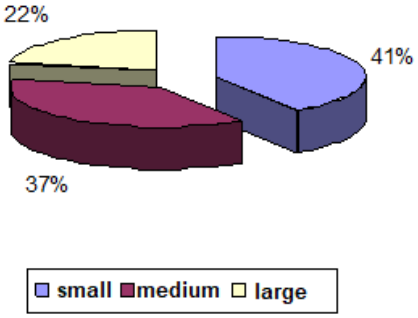
According to the Statistical Office of the Republic of Serbia (2002 - 2004), the highest intensity of innovation was achieved in the organization of the enterprise itself (in 57.34% of enterprises) and the lowest in marketing (in 28.81% of enterprises), Ministry of Science and Technology Development- "Law on Innovation Projects". Innovations in products / services (47.09%) and processes (46.81%) are almost the same, with the largest number of enterprises having innovative activity belonging to the fields of services (38.45%) and manufacturing (37.44%). When looking at the market in which companies sold their products, the largest share was the local market in Serbia, as much as 92.52%, while other companies were listed as the main users of the product (64.5%). 6.22% of the total revenue was earmarked for innovation, most of which was used for the procurement of machinery and equipment (5.38% of total revenue), which is expected, given that the average age of equipment in enterprises was more than 10 years, in almost 1/3 of enterprises (Figure 4).

***Figure 4**. Average age of equipment in enterprises*



Source: Statistical Office of the Republic of Serbia (2000-2004)

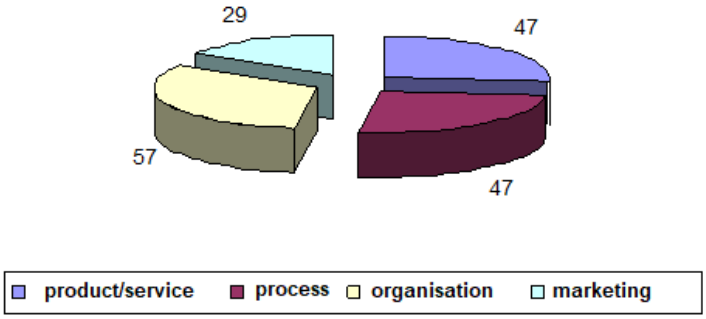
***Figure 5**. Company representation by size*



Source: Statistical Office of the Republic of Serbia (2000-2004)

The most significant source of information on the needs of enterprise innovation was the information received within the company or group to which it belongs (22.99% of enterprises), and the lack of financial support from public funds (34.07% of enterprises) is the most significant aggravating factor for innovation. The most significant effect of the innovations introduced in the organization of the enterprise was the improved quality of products and services in 28.25% of enterprises. The manufacturing sector was the most innovative (Figure 5), as were the small and medium-sized enterprises (Figure 6).

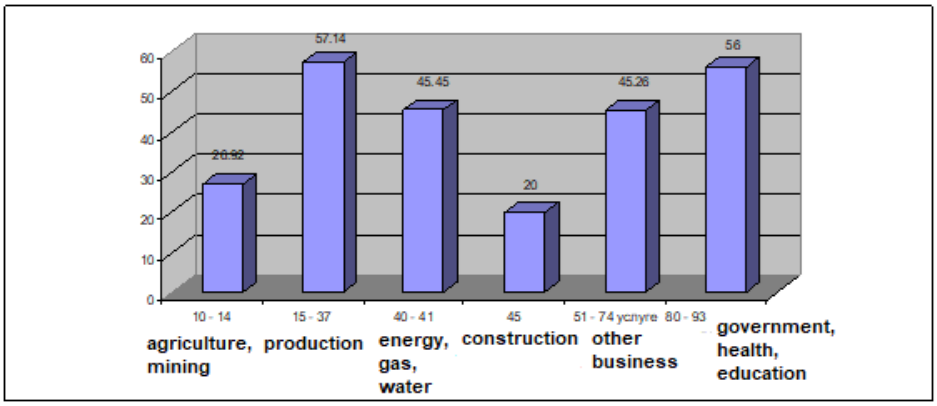
Figure 6. *Innovation activities by fields of activity, size of enterprise and type of innovation*



Source: Statistical Office of the Republic of Serbia (2000-2004)

In the field of activity, the most innovative were the enterprises engaged in production as well as institutions in the field of state administration, education and health (Figure 7).

Figure 7. Business representation by industry



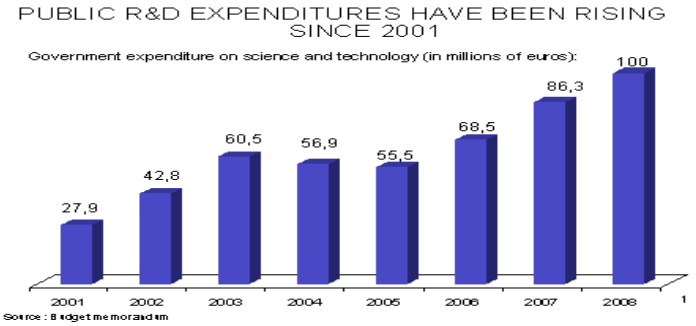
Source: Statistical Office of the Republic of Serbia (2000-2004)

2.3. Analysis of Indicators of Innovation Activities in the Republic of Serbia from 2006 to 2008

The most common drivers of innovation in 2006 were the lack of financial support from public funds (34%) and the cost of financing innovation (26%). According to Statistical Office of the Republic of Serbia, www.rzs.rs, indicators of innovative activities, the most significant effects of innovation in the organization were on improving the quality of products and services. (28%), as well as the reduced time needed for customer response (19%), which is a significant advance.

During this period, investment in science, and therefore in innovation, has increased significantly, according to the available data from the Archives of the Ministry of Education, Science and Technological Development, as given in Figure 8.

Figure 8. *Investments in R&D from 2001 to 2008*

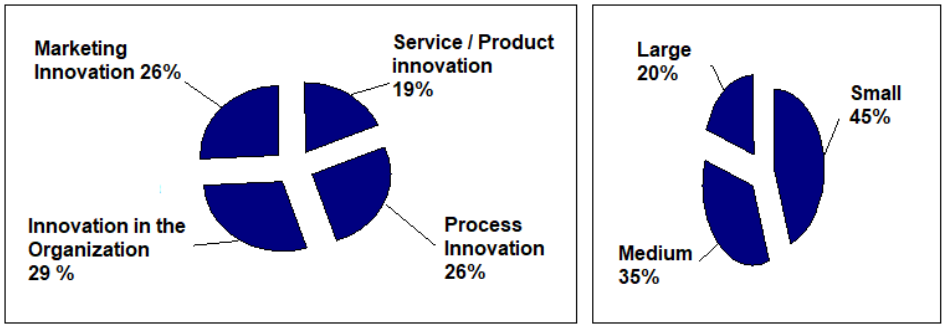


Source: Ministry of Science and Technology Development (2008)

Therefore, innovative activity has been achieved and enhanced. On the basis of data on innovation activity in the period from 2006 to 2008, the highest intensity of innovation was achieved in the organization of enterprises (28.77%) and the lowest in product innovation (18.84%), while the largest number of enterprises that had innovative activity belongs to the manufacturing industry (24.58%), Ministry of Science and Technology Development- "Law on Innovation Projects". The above data represent a new, better direction in the movement of innovation activities compared to the previously analyzed period from 2000 to 2004 (Figure 9).

The representation of a particular type of innovation varied depending on the territory in which it was introduced. In central Serbia (excluding Belgrade), the largest share was introduced by process innovations in the production or mode of delivery of products in the company (41.05%), while the largest share of innovations in the organization of enterprises during that period had enterprises in the territory of Vojvodina (24.93%) and Belgrade (41.92%). In 2008, 23.83% of enterprises are part of a group of affiliated companies, and 92.14% of innovators replied that their company is parent, which is a significant step up from the indicators in the previous period.

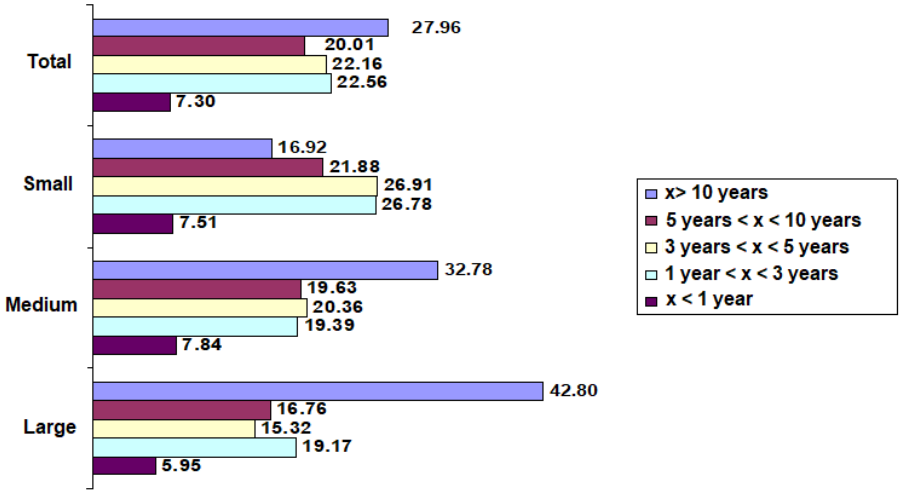
Figure 9. *Innovator companies by size and innovation*



Source: Statistical Office of the Republic of Serbia (2006-2008)

When looking at the markets where the innovator companies were selling their products / services, 97.77% of the businesses were selling goods in local markets in Serbia. The most represented sales market is the regional market (83.22% of enterprises). The new product was introduced by 26.06% of innovators and the new service by 30.05% of enterprises, Ministry of Science and Technology Development- "Law on Innovation Projects". The largest share of equipment in enterprises is over 10 years old and it is 27,96%, which represents a slight improvement for the enterprises in the Republic of Serbia (Figure 10).

Figure 10. *Age of equipment in enterprises*

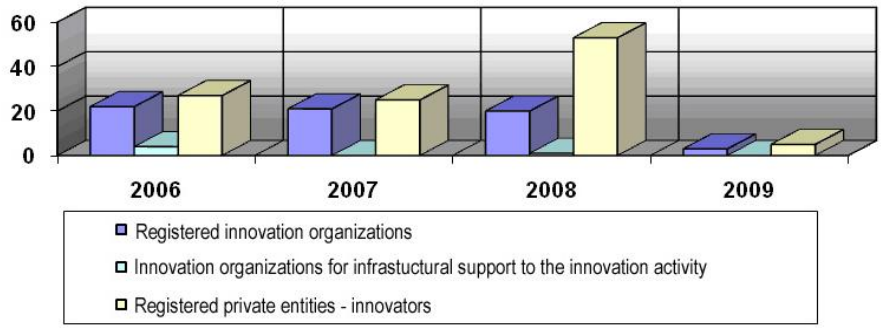


Source: Statistical Office of the Republic of Serbia (2006-2008)

What marked this period was the passage of the Law on Innovation Activity together with the supplementary rules and regulations that finally brought the long awaited legal regulation in this area. According to Djurovic Petrovic and

Lozanovic Šajic (2018) this Law is a crucial starting point for any further action. In accordance with Article 11 of the Law on Innovation Activity, the Ministry of Science and Technology Development established the Register of Innovation Organizations and the Register of Private Entities Innovators, as well as procedures required for the entry of interested organizations and private entities in the Register [3.]. The dynamics of the registration of innovation organizations and private entities innovators by years is given in Figure 11.

Figure 11. *Overview of the dynamics of innovation organizations and private entities innovators registration by years*



Source: Ministry of Science and Technology Development (2006-2009)

Table 1. *Representation of type of innovation in enterprises, by territory (%)*

Territory / size of business	Product / Service Innovation	Process innovation	Innovation in company organizatio n	Marketing Innovation
Republic of Serbia	**100**	**100**	**100**	**100**
Central Serbia (without Belgrade)	36,82	41,05	33,15	36,14
Vojvodina	23,01	22,56	24,93	22,74
Belgrade	40,17	36,39	41,92	41,11

Source: Statistical Office of the Republic of Serbia (2006-2008)

In the Europe 2020 Strategy, the fourth guideline for defining national development goals, objective is to reduce the large regional development gap within Serbia, through the development of new ones and the modernization of traditional sectors. Otherwise, differences in the development of the region would not be narrowed but widened. This logic is based on the data given in Table 1. In this regard, the Europe 2020 Strategy suggests, based on an

innovative industrial policy, to innovate an existing one or formulate a new regional development policy.

2.4. Analysis of Indicators of Innovation Activities in the Republic of Serbia from 2008 to 2010

The analysis of indicators of innovative activities in the Republic of Serbia from 2008 to 2010 showed that the participation of business entities with at least one of these types of innovations is very significant and amounts to about 47%. The size of the business entity is a key factor for their innovative activities. Almost 70% of large businesses are innovative, just over half of medium-sized businesses and more than a third of small businesses. Innovative activities are more prevalent in manufacturing businesses, where more than half of innovations were introduced, while in service businesses, innovations were introduced by more than 40% (Table 2).

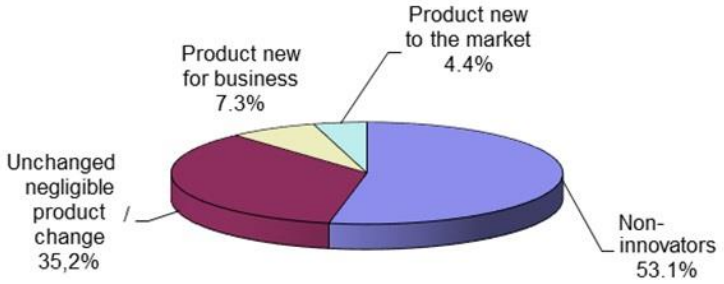
Table 2. *Businesses by Innovation, Activity and Size, 2008-2010.*

	Total	Innovators	Businesses that did not innovate	Innovator participation, %
In total	12141	5812	6329	47.9
Small business entities	9347	4143	5204	44.3
Medium Businesses	2237	1280	957	57.2
Big business entities	557	389	167	69.8
Manufacturing business entities	4141	2314	1827	55.9
Service Business Entities	8000	3498	4502	43.7

Source: Statistical Office of the Republic of Serbia (2008-2010)

The revenue structure of the innovator business enterprises was dominated by the share of sales revenue of unchanged or negligible changed products, which amounts to about 35%, while the share of sales of products that are new to the business entity and the share of sales of products that are new to the market is about 12%. About 13% of innovators introduced a new process to the market for the first time (Figure 12).

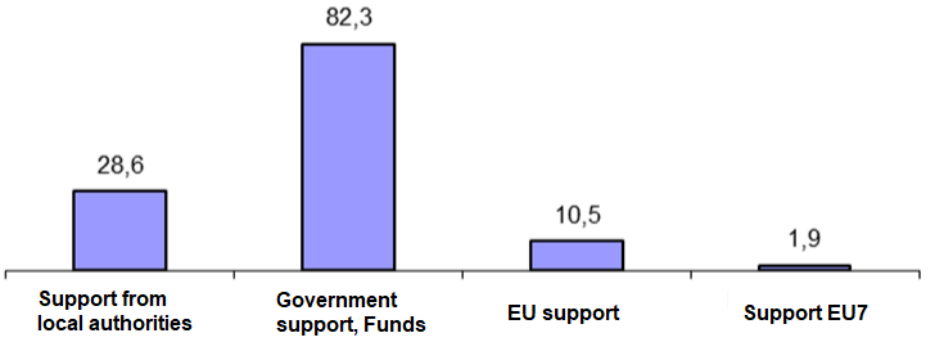
Figure 12. *Innovator revenue structure*



Source: Statistical Office of the Republic of Serbia (2008-2010)

In the observed period, the largest number of innovators received financial assistance from state instances and the least from EU funds (Figure 13).

Figure 13. *Financial support structure for innovators (%)*



Source: Statistical Office of the Republic of Serbia (2008-2010)

In the market for the sale of products or services from 2008 to 2010, the most numerous were business entities selling products in the local market, followed by those selling in the national market, while the market share of EU and EFTA countries is almost three times lower, and the market share of other countries and up to four times smaller (Table 3).

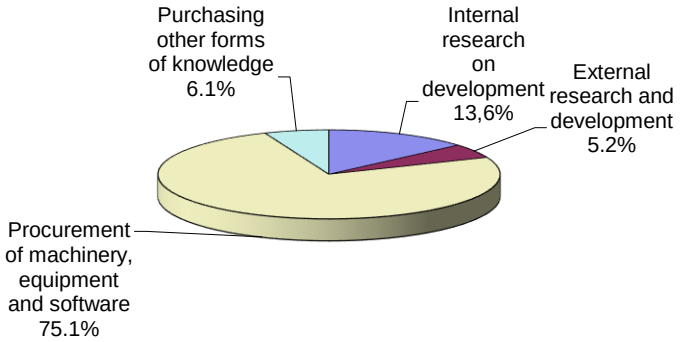
Table 3. *Sales market representation*

Market	Innovators		Non-innovators
	Product and process innovators	Innovators in organization and marketing	
Local / regional market	31.5	34.6	44.5
National market	25.1	27.3	26.6
EU and EFTA countries	13.0	12.9	8.4
Other countries	11.1	10.8	7.6

Source: Statistical Office of the Republic of Serbia (2008-2010)

Data on expenditures for innovative activities, which included expenditures for development of new products, for significant improvement of existing products, as well as current expenditures (salaries, equipment, materials, services, etc.), show that largest share belongs to the procurement of machinery, equipment and software (about 75%), as displayed in the Figure 14.

Figure 14. *Structure of expenditure for innovative activities*



Source: Statistical Office of the Republic of Serbia (2008-2010)

An analysis of methods for stimulating creativity and new ideas of employees in business entities showed that business entities that introduced innovation had a significantly higher percentage of using methods to stimulate creativity and new ideas of their employees than non-innovative businesses (Table 4).

Table 4. *Stimulating employee creativity, %*

Methods	Innovators	Non-innovators
Brainstorming sessions	14.3	1.5
Multifunctional work teams	21.4	3.1
Personnel rotation	28.5	4.5
Financial incentive for employees	28.6	3.8
Non-financial incentive for employees	26.9	4.7
Training employees to develop new ideas and creativity	33.1	4.3

Source: Statistical Office of the Republic of Serbia (2008-2010)

2.5. Analysis of Indicators of Innovation Activities in the Republic of Serbia from 2012 to 2014

The survey of indicators of innovative activities in the Republic of Serbia from 2012 to 2014 showed that the participation of business entities with at least one of these types of innovations was about 40%, and that over 68% of large business entities was innovative, slightly more than half of medium-sized businesses and more than 37% of small businesses.

Table 5. *Businesses by Innovation, Activity and Size, 2012-2014*

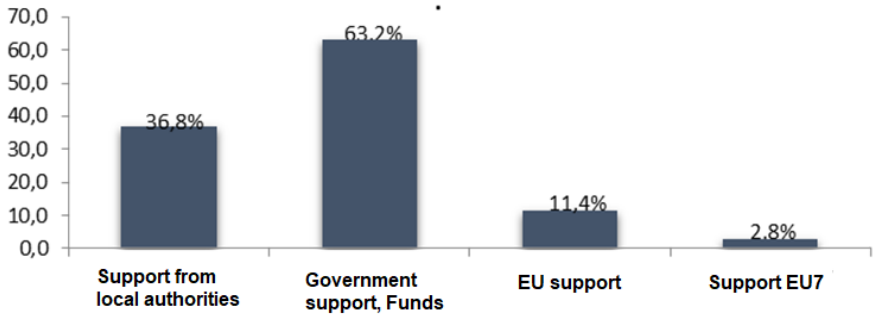
	Total	Innovators	Businesses that did not innovate	Innovator participation, %
In total	**16659**	**6739**	**9920**	**40,5**
Small business entities	13863	5182	8681	37.4
Medium Businesses	2253	1187	1066	52.7
Big business entities	543	370	173	68.1
Manufacturing business entities	4865	1977	2888	40.6
Service Business Entities	11794	4762	7032	40.4

Source: Statistical Office of the Republic of Serbia (2012-2014)

Innovative activities were equally represented in manufacturing and service businesses, where innovations introduced slightly over 40%, which is encouraging data (Table 5). 13% of innovators received financial assistance from state instances (Figure 15), which indicates that the Republic of Serbia was

able to improve the innovative environment in the observed period compared to previous years.

Figure 15. *Financial Aid Structure for Technology Innovators 2012-2014*



Source: Statistical Office of the Republic of Serbia (2012-2014)

Most businesses needed to innovate, but they did not innovate because of excessive costs or lack of their own financial resources for innovation.

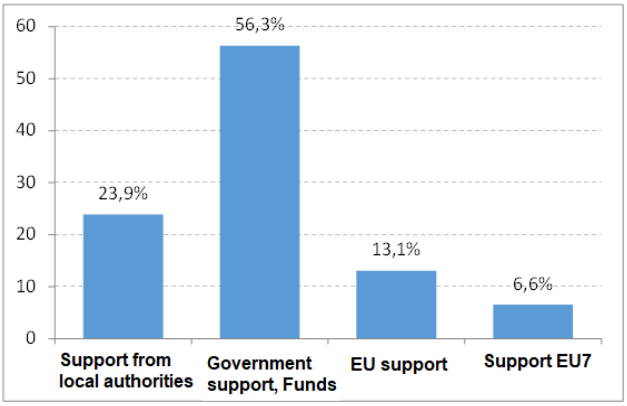
2.6. Analysis of Indicators of Innovation Activities in the Republic of Serbia from 2014 to 2017

In the period from 2014 to 2017, the partial share of funding for innovators changed by significantly increasing EU7 support from 2.8 to 6.6%, and reduced government support from 63.2 to 56.3% and local governments from 36.7 to 23.9% (Figure 16).

Most non-innovator businesses (77%) had no reason to innovate, while 23% had a need but did not innovate due to too many obstacles. As the biggest obstacles to innovation, businesses have assessed the lack of their own financial resources for innovation and the high cost of innovation, which is data that needs to be intensively changed in the coming period.

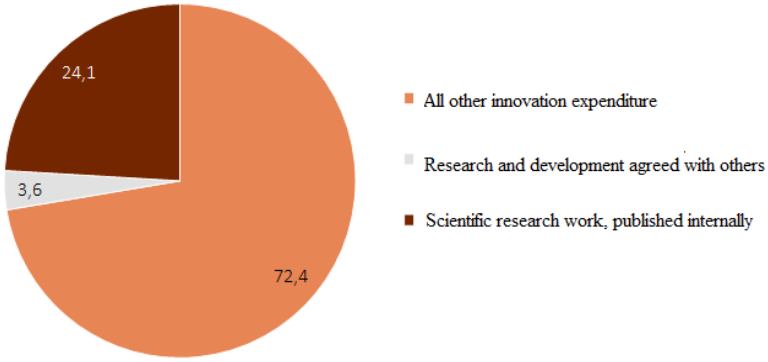
Expenditure on research activities is over 24%, whether internally or in collaboration with another entity, while all other expenditures, except R&D, accounted for over 72% of total expenditures (Figure 17).

Figure 16. *Financial aid structure for technology innovators 2014-2017*



Source: Statistical Office of the Republic of Serbia (2014-2017)

Figure 17. *Structure of expenditure for innovative activities*



Source: Statistical Office of the Republic of Serbia (2014-2017)

CONCLUSION

The role of policy makers in the field of innovation is very delicate, above all in creating the conditions for the development of an innovation environment in the country. Through the cooperation of research institutions and universities in Serbia and their organizational integration, productive results can be achieved in accordance with the Europe 2020 Strategy and its guidelines. In that sense, Serbia's innovation system and its results should be more carefully evaluated, and each one worthy of attention should be put at the function of national development. It is also necessary to define concrete actions for the key initiative "Measuring Progress", so that the performance indicators of the innovation system in Serbia are not only indicatively defined but also measurable and comparing over a long period of 25 indicators for the Scoreboard methodology.

The state of Serbia has achieved its success in the third pillar thanks to a successful innovation policy since the adoption of the Law on Innovation and the establishment of the Register of Innovation Entities, the Innovation Fund and

the establishment of the Cabinet of the Minister in charge of innovation. Such active innovation policy has maintained continuity in the development of innovation potential of the Republic of Serbia, but further emphasis must be put on maintaining human resources in this sector. This implies timely decision making and measures that would prevent stagnation in this area and eventual migration of human potential. This means that in the field of innovation policy, particular attention should be paid in the future to development policies that foster innovation with scientific advancement and policies of openness and attracting highly qualified personnel while preventing their outflow, as well as training researchers for the purposes of national research objectives while providing attractive employment conditions in public research institutions.

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CONTRIBUTION OF ECO-INVENTOLOGY TO THE CONCEPT OF SUSTAINABLE DEVELOPMENT

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Abstract: With the acceleration of technological development, strategy of sustainable development is increasingly more difficult to conduct; otherwise, the ecological accidents would not happen as often and climate change, as their direct consequence, would not be developing so fast. Considering all this, the aim of this paper is to present the potential of eco-inventology as a new discipline whose task is to, provide more efficient eco-innovative problem solving tools in comparison to other methodologies. According to eco-inventology, it is indispensable to analyse eco-innovation through the three phases of its life cycle. Those are the phase of technical product enhancement (comprises inventiveness levels 1 and 2), the radical innovation phase (comprises inventiveness levels 3-5), and the catastrophe phase, as a transition phase between the other two. In each phase, the concept of sustainable product development on the market can be improved.

Keywords: ecology, inventology, economics, technology, technics.
JEL: O10

1. INTRODUCTION

The low compatibility between technological and biological evolution is the main reason for problems that arise as a consequence of frequent interaction between technology and ecology (Rajic, 2016). At the root of each such problem there are salient technical and physical contradictions. Eco-inventology was created due to the need to develop an adequate methodology in order to effectively overcome these contradictions. Therefore, eco-inventology can be included in those scientific disciplines that seek to build a "bridge" between economics, technology and the environment. It encompasses three equal eco-innovative approaches. The first is based on biomimetic, the second on eco-engineering, and the third on the application of the basic laws of evolution of ecological systems (ES) and technical systems (TS) (Rajic, 2019). An ideal eco-innovative system should have all the benefits of TS and ES.

Consequently biomimetic and eco-engineering can be seen as two parts of a unique eco-inventory strategy. The task of eco-inventology is to offer reliable eco-innovative tools, which will interpret and transmit data from ES to TS, and vice versa, in a way that seeks to achieve their ideal. An eco-innovative contradiction matrix is one of the main tools of eco-inventology. Its main mechanism is based on discovering the technical contradictions (TCs) that exist between TS and ES and finding ideas for solving problems using the proposed principles of the Theory of Inventive Task Solving (rus. TRIZ). The matrix simultaneously considers the application of 39 TS parameters, 40 TRIZ inventive principles and 6 types of resources, as well as 7 eco-efficiency elements according to the criteria of the World Business Council for Sustainable Development (WBCSD) (Rajic, 2018). The matrix is very effective in finding solutions to various eco-innovative problems. However, while the principles for removing TC indicate to the innovator a general path and a fairly broad area within which to seek a solution, the standards recommend specific actions necessary to restore the existing TS or to synthesize a new one. This qualitatively increases the possibility of obtaining a more efficient solution to the eco-innovation problem. That is why an eco-innovative matrix based on TRIZ standards has been developed as another powerful tool of eco-inventology (Rajic, 2018). Functionally Oriented Research (FOR) is one of the most up-to-date TRIZ tools that is also used in eco-inventology, and involves the algorithmic use of a successfully applied analogy to solve problems taken from remote areas of technology in relation to the area of origin. In addition to the tools listed above, eco-inventology also contains the inventive task-solving algorithm (rus. ARIZ) as the most powerful TRIZ tool with which it is possible to solve problems of different etiology and complexity at any stage of their emergence.

The concept of eco-innovative design means meeting the highest quality requirements of the product, with the strictest environmental standards. This can only be achieved by using adequate inventive measures at all stages of the product life cycle. Integrative innovation covers all three possible phases of the product life cycle. These are the phase of evolutionary technical improvement of an existing product (includes levels 1 and 2 of inventiveness), a phase of radical innovation (includes levels 3, 4, or 5 of inventiveness) and a phase of catastrophe (involves the transition between them). The example of the Department of Filtering Protection (FPS) will demonstrate the successful practical applicability of these eco-inventory tools to the concept of sustainability in all three phases of this product's life cycle.

2. PRODUCT LIFE CYCLE

All TSs, like biological systems, go through their own life cycle. It consists of birth (emergence), growth (development), maturity (peak) and death (obsolescence) (Krstić *et al*., 2018; Rajic, 2017). It can be represented by a sigmoid (S) curve, with three stages in the development of TS over time. Phase I, the "childhood" of TS lasts considerably. At this stage, the TS is designed, refined, prototype is produced and preparation for batch production conducted. In the batch production phase, most contradictions are overcome. At this stage, the TS flourishes and becomes more powerful and productive. TS quality is improved through constant technical, business improvement etc. After a certain period, the TS upgrade becomes more difficult and less and less satisfying to the growing customer needs. All of its internal resources are depleted, so TS begins to do more harm than good. Phase II emerges, which can be viewed from a mathematical point of view as a catastrophe, bifurcation, or delineation of the development process (Бушуев, 2011). The solution to the problem now is to use a timely disaster management strategy by shifting the S - curve towards new processes and technologies, i.e. to create radical innovation products, to obtain new TS features that are at a much higher production and economic level than the old TS.

2.1. Evolutionary Innovations

Evolutionary innovations are created through the gradual advancement of technology or the refinement of existing products and processes. They contain the first or second level of inventiveness, and are most commonly obtained without the help of science (Rajic, 2019). These innovations represent technical improvements and, in legal terms, are usually protected by a small patent (Rajic *et al*., 2016). One of the best technical improvement systems in the world is being implemented in Japan, and is being implemented through a process called kaizen (jap. meaning "improvement" or "change for the better"). Kaizen management is an element of comprehensive quality control of management, and refers to a continuous long-term approach to change, while respecting human needs and quality (Masaki, 2008). The starting point of improvement is to identify needs. They come from identifying problems. If the problem is not recognized, there is no recognition of the need for improvement. The problem identified once must be resolved. Kaizen, therefore, is, like TRIZ, a problem-solving process, but on a completely different conceptual basis. Kaizen requires the use of a variety of troubleshooting tools. Improvements, after each problem solved, reach higher levels. Improvement must be standardized in order for the new level to stabilize. Kaizen, therefore, requires standardization. In the broadest sense, quality is all that can be improved. This means that quality can be linked not only to products and services, but also to the way people work, how machines work and how systems and procedures are implemented. It includes all aspects of human behavior. The Western term of improvement is more often related to the improvement of equipment. In contrast, kaizen is a generic term

that can be used in every aspect, in any activity. Kaizen creates process-oriented thinking because process improvement precedes improvement in results. Process-oriented criteria are targeted at employee efforts and often require behavioral change. The results-oriented criteria, on the other hand, are more immediate and short-term. The question is which of the two concepts is more effective and which one to follow? There are two conflicting approaches to progress between Japan and the west. The Japanese choose a continuous, gradual driveway, which is often subtle and not overly exciting. In the West, innovation is seen as a dramatic event, a one-off occurrence, a major leap forward, a major change driven by a technological breakthrough or the introduction of the latest management concept or production technique. Improvement is, by definition, slow, gradual, and often invisible, and usually produces long-term effects. There is no internal system in Western management that rewards improvement efforts. Employee performance is considered solely on the basis of results. The emphasis on results has led to the dominance of innovative radical approaches in the west. This is not to say that Japanese management does not care about innovation. Japanese managers are following the kaizen enthusiastically even when they are innovating. These differences in orientation are also reflected in different social and cultural heritage. The Western education system emphasizes individual initiative and creativity, as opposed to the Japanese, which emphasizes harmony and collectivism.

2.2. Catastrophe Phase

Disasters are an integral part of chaos and are defined as the unexpected response of a system to a sudden change of external or internal conditions (Kuzmanovic *et al.*, 2013). Although chaos limits the possibility of long-term prediction, it provides cause-and-effect relationships that cannot be detected by other methods. There is order in chaos because behind it is certain laws of nature. Catastrophe theory is part of chaos theory (Kuzmanovic *et al.*, 2013). It has found application in various branches of science. In the works of Bushev *et al.* (Бушуев, 2011; Бушуев and Литвинов, 2017; Бушуев, 2010; Бушуев, 2008; Бушуев and Петров, 2017; Бушуев and Мансурова, 2003; Бушуев, 2017; Бушуев, 2015; Bushuev, 2004) it was applied to study the innovation process. The basis of catastrophe theory is the seven standard universal perturbations of critical points called: fold, spike, tail, butterfly, elliptical umbilical cord, hyperbolic umbilical cord and parabolic umbilical cord. These are, in turn, the critical points of the following functions: x^3; x^4; x^5; x^6; $x^3 + y^3$; $x^3 - xy^2$; $x^2y + y^4$. The assumption is that in the observed systems quasi-static forces do not produce momentum but cause sudden changes. When the system is stationary at the equilibrium position, a value of x determines the state of the system. The parameters λ describe the dependence of the system on the external forces that cause a change in the equilibrium of the system. The consequence is that the system can suddenly go into a steady state from a steady state, in which the potential energy is minimal. Although phase transitions occur in different

systems in different systems, it is interesting that all types of phase transitions, including innovative ones, have some common characteristics. In the event of a disaster, control parameters change the state of the system, that is, they move from one stationary phase to another. The simplest case is understood to be in the steady state of equilibrium. As the transition process unfolds, it doesn't really matter to the theory of catastrophe. One elemental disaster is different from another by the expression of its potential function. For example, for the simplest wrinkle-type catastrophe, the potential function E (x, λ) is represented by a mathematical expression:

$$E(x, \lambda) = x^3/3 - \lambda x. \quad (1)$$

where x is catastrophe coordinate (a dependent variable) and λ is a controlling parameter.

In a spike-type catastrophe, the potential function has a shape:

$$E(x, \lambda, \mu) = x^4/4 - \lambda x^2/2 + \mu x. \quad (2)$$

It contains two controlling parameters λ and μ, with the help of which the innovation process is described. Both parameters, λ and μ, can vary from -∞ to + ∞. Since stationary states determine points of extreme potential function, they can be found taking the first derivate of the potential function considering coordinate x and its leveling with 0 the following expression is created:

$$0= x_s^3-\lambda x_s+\mu. \quad (3)$$

The root of the algebra expression of the third level (x_s) is formed through dependency of x_s from μ for λ = const>0. The given graph is called a bifurcation diagram. In addition to the bifurcation diagrams, a "set" of the disaster curve was constructed, that is, the dependence of one control parameter on the other is shown (Figure 1).

Collision point, i.e. the tip of the spike represents a sub-critical region in which the potential function has one steady state equilibrium. Despite its simplicity, spike type catastrophe has all the basic properties of higher catastrophes such as modality and hysteresis. It also has two parameters, λ and μ, while x denotes a variable. The face of this type of disaster has the following expression:

$$MF = \{(x, \lambda, \mu): 4x^3 - 2\lambda x + \mu = 0\}. \quad (4)$$

Set of catastrophes, i.e. set of degenerative critical points of function $F\lambda, \mu(x)$ is simply taken from the system:

$$dF(\lambda, \mu)/dx = 0, \; d^2F(\lambda,\mu)/dx^2 = 0. \quad (5)$$

Solving a system of the two expressions with two unknown variables shows:

$$4x^3 - 2\lambda x^2 + \mu = 0; \quad 12x^2 - 2\lambda. \quad (6)$$

From which it follows that λ and μ have to have a following form:

$$\lambda = 6x^2; \quad \mu = 8x^3. \tag{7}$$

Finally there is a set:

$$C_F=\{(x, 6x^2, 8x^3): x\varepsilon R\}. \tag{8}$$

This has a form of a smooth curve. If that curve is projected onto (λ, -μ) surface, it can be seen that the spike starts from the set of bifurcations:

$$B_F=\{(6x^2, 8x^3): x\varepsilon R\}. \tag{9}$$

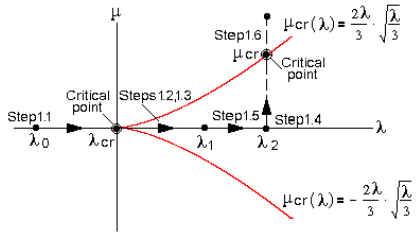
Whose origin is a non-differentiable point.

The term "phase transition" indicates an instantaneous change in the state of a system. That is to say, a well-known transformation between the solid, liquid and gaseous states of water. There are various other types of phase transitions that do not occur due to temperature change. They have in common that the global system properties change abruptly when a key parameter exceeds a critical value. It is fascinating that all types of phase transitions have some common characteristics. The notion of phase transition is also used in the mental process of innovation. The choice of the type of natural disaster, i.e. the expression for a potential function depends on the extent to which control parameters or factors affecting the disaster are to be considered. For physical systems, the potential function coincides with their potential energy. Inventive problems use a spike type catastrophe with two control parameters λ and μ. It exists in two stable equilibrium states. In the first condition, there is some solution of an old product that really exists at the moment of disaster. Then comes a new, innovative solution. The process of getting a new solution is considered a momentary leap of thought, getting an idea, mastering the inertia of thought, or inspiring an innovator. A crucial moment is the time of causing the transition (transition) from one state (evolutionary phase) to another (radical phase). Depending on the calculated ICR of the problem under consideration, the transition can be carried out as a "good" or "bad" disaster, taking into account the Maximum Delay principle or the Maxwell principle (Бушуев and Литвинов, 2017). A spike-type catastrophe (Bushuev, 2004) is also used to model the occurrence of technical contradiction (TC) in the Algorithm for Solving Inventive Tasks (rus. ARIZ). In this case, the function E (x, λ, μ) is considered as the minimum of undesirable property or adverse effect in technical contradiction -1 (TC-1), and there is also another minimal adverse or harmful effect in TC-2. Disaster coordinates x specify the state of the product, with parameter λ taking into account the properties of the tools and parameter μ- the property of some X-element that must be found to resolve the existing contradiction.

For the same values of parameters (λ, μ) the spike has two states of stable balance, which can be called x_t and x_b, such that (λ, μ, x_t) and (λ, μ, x_b) are on a higher and lower layer of M_F surface. This property is called bimodality. In what state the system will be depends on how the system came to be, i.e. its past state.

The absence of reversibility at changing parameters is called hysteresis. Catastrophe curve $\mu_{cr}=\mu_{cr}(\lambda)$ is half-cubic parabola with the point of return (Figure 1), looking like the bird beak. Above-critical domain of catastrophe situated inwardly beak, subcritical domain of catastrophe situated outside of the beak. Then prototype is located on point Step 1.1 ($\lambda=\lambda_0$) of subcritical domain of catastrophe. Increasing the parameter λ means a moving an algorithm along Steps 1.2 and 1.3 ($\lambda=\lambda_1$) to Step 1.5 ($\lambda=\lambda_2$). Technical contradiction appears on critical point ($\lambda=\lambda_{cr}$). Critical point is crossing a moving the algorithm and catastrophe curve.

Figure 1. *Bifurcation diagram of the system $dx/dt=\mu+\lambda x+x^3$ in the parameter space (μ, λ)*



Source: Bushuev (2004)

2.3. Radical Innovation

Radical innovations (revolutionary, discontinuous) are often absolutely new and contain a third, fourth or fifth level of inventiveness, which means that they have a scientific and potentially high market value (Rajic, 2019a). Most successful Tesla inventions belong to these levels (Rajic *et al.*, 2017). These innovations are most commonly achieved in a systematic, scientifically organized manner, and are mainly the result of teamwork involving specialists from different disciplines who, jointly, solve the same technical problem in a multidisciplinary manner. In this sense, the key resources of modern invention are science, technology, education, organization and capital. Radical innovation is protected by a patent in legal terms (Rajic, 2017). It is well known that the development of all TSs is moving towards increasing the degree of their ideality. The ideal is always associated with the maximum utilization of the material and energy resources located within the system, in its sub-systems and in the super-system. When an ideal system is achieved, then its mass, dimensions and energy capacity will tend to zero and the ability to perform the main utility function will not be impaired (Rajic *et al*., 2019). That path to the ideal of a technical system is full of barriers that consist of technical and physical contradictions. Technical contradiction occurs between certain parts of a sub-system or TS parameters. If one of the sub-systems is improved by known methods, then the other sub-system or its parameters are impermissibly degraded. Such situation usually requires a compromise solution or optimization. However, eco-inventology is not satisfied with compromise, but seeks the ideal final solution to the problem.

A clear formulation of technical contradiction can already indicate the direction of the search for a solution, or, ultimately, help to distinguish sub-systems or their conflicting properties. The conflicting subfield (substance + field) suggests the search for a solution that is focused on the case analysis. Any technical system can be described by some of the 39 basic parameters (mass, speed, power, etc.). In order to resolve technical contradictions, 40 principles and a contradiction matrix are used. Principles are actually instruments used to resolve technical contradictions in TS.

Technical problems can be solved at the level of administrative contradiction, if, for example, multi-faceted thinking and cause-and-effect analysis to discover the primary cause of the problem are applied (Rajic, 2017). At the level of technical contradiction, the problem can be solved by applying a table (matrix) of contradiction and using 40 principles (Rajic, 2017). In both cases, success depends on how close the innovator is to the physical contradiction. It is the cause of all TS problems. It can be reached if an ideal final result (IFR) is defined when solving a technical problem (Rajic, 2019). The tactic is based on the application of general principles of resolving physical contradiction. The system properties of the objects and the phase transitions of matter from one state to another are used. When the physics of the phenomena taking place in the operating area is not yet clear, and when the element in which the physical contradiction is manifested is not clearly distinguished, there are complexities in the application of the principles. If the problem is free from redundant elements and if the contradiction is sufficiently clearly expressed, then the ideal final solution can be formulated immediately, directly in relation to the element that is to be changed. If the problem is not clear, then one should first find out and point out the contradiction it carries within itself, then define the cause of the problem and formulate an ideal final solution for it. Each technical contradiction contains at least one or more physical contradictions, using appropriate resources to eliminate them. Available resources can be divided into six different groups: substance resources (material), field resources (energy), space resources, time resources, information resources and functional resources (Rajic, 2017). Material resources or substance resources comprise all substances that exist in different aggregate states (solid, liquid, gaseous, plasma, vacuum), their combinations, and also all technical and natural objects. Field resources or energy resources are all forms of energy, physical fields, and also all forces and interactions among material objects. Spatial resource is the total free space in the operating area, in other parts of the system and in the system as a whole. These include cavities, gaps between components, characteristics of geometric shapes, internal structure of components, etc. Time resources are time intervals before, during, or after a considered conflict event, which can be used to prevent, neutralize, or correct its negative consequences. The identification and use of information resources in the system, the system and in the environment should be realized through the available information on the state and properties of substances, fields, spaces, on

possible changes in the flow of information. In order to solve a technical problem, all available functional resources in the system, the system and the environment should be identified and used. From the above it is clear that resources are what enable the task to be solved. It is necessary to compile a list of resources that are already in the system or easily accessible from the system. When generating a solution to a technical problem (the last step of each iteration), the search for resources from that list begins.

3. A CASE STUDY

The Filtering Protective Suit (FPS) is a filtering means that protects user's body from high toxic materials (HTM) (Rajic *et al*., 2018). This paper deals with experiments that were conducted to test the basic physical and mechanical characteristics of FPS-M1, FPS-M2 and FPS-M4 (manufactured by "Trayal korporacija", Krusevac, Serbia) and FPS-M3 (manufactured by "Proizvodnja Mile Dragić", Zrenjanin, Serbia). Materials used in experiments had the following properties:

- FPS-M1 untreated, the inner layer is double cotton gauze impregnated with activated carbon powder and reinforced with a polyamide fabric;
- FPS-M2 untreated, the outer layer material is oleo phobic and hydrophobic textile material based on a mixture of cotton-polyester; the inner layer material is a powder of activated carbon impregnated with polyurethane foam (PUF) and sandwich two light fabrics;
- FPS-M3 untreated, the outer layer material is an oleo phobic and hydrophobic textile material based on a mixture of cotton-polyester; the material of the inner layer is ACM glued to the fabric and covered with another fabric;
- FPS-M4 untreated, the outer layer is an oleo phobic and hydrophobic textile material based on a mixture of cotton-polyester; the material of the inner layer is the spheres of the active carbon material (ACM) glued to the fabric and covered with another fabric.

FPS was tested for the raw materials, surface mass, thickness, breaking forces, intermittent elongation and ripping forces. Air permeability and water vapor tests were also performed to test the basic functional characteristics of the FPS. The protective power of FPS against HTM was tested using a sophisticated dynamic gas chromatographic method, and the protection time for the effect of HTM drops was determined using S-yperite in dynamic working conditions. The testing of the heat transfer process through various materials embedded in the FPS was carried out in laboratory and field conditions. The appropriate anthropometric and ergometric indicators and measured thermoregulation characteristics were tested as well. This made it possible to compare the materials according to all the relevant thermoregulation parameters of the body. The surface mass of the tested materials was determined using the analytical scales "Libela Preciz" according to an accuracy class of 3 and an accuracy of 20 g, 5 tubes measuring 15 × 15 cm, surface of 100 cm^2, which were brought to the

standard state after 24 h were cut. The samples were dried at 105 ºC to a constant mass and then were measured. Respondents were subjected to physical effort, and thermoregulation tests were conducted, in a hot air environment (30˚C) and in field conditions. The testing methodology in the Climate Chamber consisted of continuous measurement of microclimate conditions by the device of *Ligh Laboratories - Brighton, England, Type MiniLab.* The testing of microclimate conditions was carried out before the start of each heat load test. The thermoregulation was tested by calculating the average skin temperature from the collection of temperatures obtained by measuring from four points on the skin by thermo-elements. This measurement was continuous. The measurement of the internal temperature (Tc) was discontinuous, and it was carried out by introducing the probe into the ear canal every 5 minutes. Each subject had their heart rate continuously monitored using *Biotel 33*. The electrodes were placed on the chest of the subjects and telemetrically sent an electrocardiographic signal. Simulation of different intensities of respondents' work, which corresponds to the performance of the assigned tasks, was achieved at a speed of 5 km/h on the conveyor belt in the climatic chamber. For a subjective assessment of the thermal state (comfort), *McGinnis heat* scales were used. In the experiments, it was envisaged that the test was interrupted if there was a decompression of the thermoregulation, that is, when Tc exceeded 39.5 °C, or when the heart rate exceeded 190 bpm.

4. RESULTS AND DISCUSSION

Results have shown that protective suits FPS-M3 and FPS-M4 present a significant improvement compared to domestic FPS of previous generations: FPS-M1 and FPS-M2. Both FPS models are on the level of modern means of personal percutane protection when all the examined characteristics are taken into account. Testing of the protective properties of FPS against the effects of HTS was conducted by the total process of penetration of S-yperite vapours through their materials. During hours of examination, in all models of FPS, output contamination density did not reach the value of 4 $\mu g/cm^2$, which fulfilled the set request from standards.

Studies have shown that respondents had an ideal (maximum) feeling of warm comfort when wearing FPS-M3 in majority of the experiment (80 min). When wearing FPS-M4, the respondents declared that they felt comfortable for the first 40 minutes, but in the following period a "jumpy trend" of discomfort increase was shown. After finishing the experiment for each respondent in a particular FPS model, a survey was performed on the elements of the comfort state, and the results were given in Table 1. While conducting the physiological suitability test in field conditions, with the performance of specific tasks, it was found that in all subjects during work (in dynamic conditions) there was some "overheating". This phenomenon was absent in the execution of tasks in static

conditions, so it can be concluded that "overheating" was not significantly influenced by the FPS model, but the intensity of performing certain activities.

Table 1. *Rating the state of comfort (1-5) while wearing FPS in a protective position*

Comfort parameters	FPS model			
	FPS-M1	**FPS-M2**	**FPS-M3**	**FPS-M4**
Comfortable- Uncomfortable	3	4	5	5
Mobile - Immobile	3	4	5	5
Elastic- Stiff	3	4	5	4
Light- Heavy	3	5	5	5
Itchy- Non-itchy	4	4	4	4
Dry- Wet	2	4	5	4
Non sticky- Sticky	2	4	5	4

Comparison of FPS-M3 and FPS-M4 in Table 2, in terms of surface mass of outer and inner layer, shows that FPS-M3 has 30 g/m^2 greater surface mass and 80 g/m^2 of the inner layer. This means that the total surface mass of FPS-M4 is smaller by ≈ 110 g/m^2 compared to FPS-M3. Considering that for production of a set of FPS, 5 m^2 to 6 m^2 of material is required, FPS-M4 is of a smaller mass than FPS-M3 by 550 to 600 g. Difference in mass of FPS can represent an important factor for choosing FPS model when equipping an army. The lowest heart rate values were established using FPS-M3, followed by FPS-M4, FPS-M2 and FPS-M3 (Table 2). It is of great importance that during the examination of all four FPS models, the heart rate did not exceed 190 bpm, which would lead to interruption of the experiments. However, from a practical point of view, it is necessary to determine values of key parameters that are important for calculating the IFS. The highest ponder belongs to the heart frequency as the most important physiological parameter which directly impacts the safety (life) of the user, followed by surface mass, wearing comfort and price. FPS-M4 model reached ideality of 75.4%, and model FPS-M3 - 66.9%. This result is surprising, in a way, considering that FPS-M3 average heart frequency, comfort and price were better compared to FPS-M4. Applying the methods of optimization of the listed parameters, FPS-M3 was chosen as an overly better means. However, applying the formula for calculating ideality showed that the difference in mass, as an unwanted parameter, was so much better for the FPS-

M4 that this parameter was the prevailing factor in deciding the greater total ideality of this means.

Table 2. *Quality characteristics of FPS*

Alternative / Criteria	FPS-M1	FPS-M2	FPS-M3	FPS-M4	Ponder
Average skin temp. (ºC)	37.31	36.91	36.68	36.73	2
Average timpatic temp. (°C)	38.24	38	37.77	38.02	4
Average heart frequency (bpm)	131.73	129.99	120.92	124.93	5
Sweating intensity ($L/m^2/h$)	0.3685	0.37221	0.33637	0.35662	2
Air permeability ($m^3/m^2 \cdot min$)	3.3	4.9	8.8	7.1	4
Vapor permeability ($g/m^2 \cdot 24$ h)	3070	3125	3825	3130	4
Surface mass (g/m^2)	590	530	595	485	5
Wearing comfort (1-5)	2.85	4.71	4.85	4.42	5
Price (Euro)	132	147	219	275	5

Increasing ideality of both FPS models can be achieved by increasing their individual parameters. In the case of FPS-M4, constructional changes which would contribute to the lower value of heart frequency (R=62.14%) need to be improved, and in the case of FPS-M3, fixing the parameter of surface mass i.e. total mass (R=52.54%) should be addressed. It is called technical improvement or innovation of a lower inventiveness level.

Increasing ideality of both FPS models can be achieved by increasing their individual parameters. In the case of FPS-M4 the work is needed on constructional changes which would contribute to the lower value of heart frequency (R=67.1%), and in case of FPS-M3 the work should be done on fixing the parameter of surface mass i.e. total mass (R=56%). It is called technical improvement or innovation of a lower inventiveness level. Parameters that have the maximum ponder value from Table 2. were taken for the calculation of ideality in Table 3.

Table 3. *Achieved degree of ideality in construction of FPS*

FPS	Average heart frequency (bpm)	Mass (g)	Comfort, points (1-5)	Price, Euro x100	IFS, %
P (M1)	131.73	590	2.85	1.32	
P (M2)	124.93	485	4.42	2.75	
P (M3)	120.92	595	4.85	2.19	
P (M4)	129.99	530	4.71	1.47	
Pmin-Pmax	89-132	400-600	1-5	1-5	
K	1.0	1.0	1.0	1.0	
L	0.3	0.2	0.3	0.2	
S/% (M1)	11.3	47.3	71.8	97.9	44.0
S/% (M2)	26.8	76.9	96.8	96.9	66.3
S/% (M3)	56	40	98.3	91.5	66.9
S/% (M4)	46	87	93.5	86.6	75.4
R/% (M1)	51.7	30.7	16.4	1.2	
R/% (M2)	71.35	22.51	3.12	3.02	
R/% (M3)	38.53	52.54	1.49	7.44	
R/% (M4)	62.14	14.96	7.48	15.42	

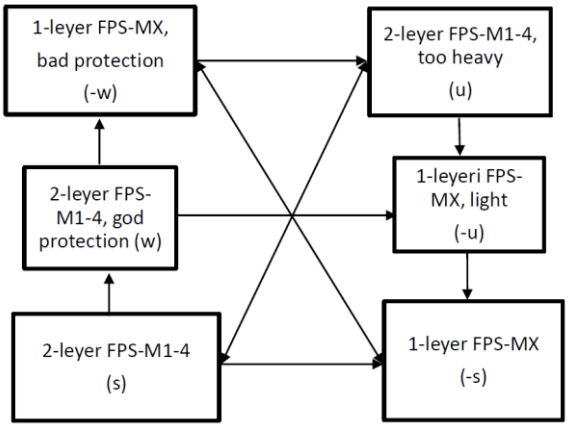
The Butterfly algorithm can systematically find the solution strategy for the problem, and thus help solve contradictions efficiently (Hyun and Park, 2016).

The Butterfly diagram performs a visual role in analyzing physical contradictions and technical contradictions easily. By applying the propositional logic, the Butterfly algorithm derives the right direction efficiently and logically. TC1: If a FPS mass is small (a desirable characteristic), then protection from HTM is weak (undesirable characteristic). TC2: If protection from HTM with the help of FPS is good (desirable characteristic), then its mass is too big (undesirable characteristic). The Butterfly diagram contains the following logic:

$$(s \rightarrow w) \wedge (s \rightarrow u) \text{ and } (w \wedge -u) \rightarrow (-s \wedge w) \qquad (10)$$

A solution is sought after where FPS provides good protection (TC1) and it has a small mass (TC2). In this case there are two possible TC versions which contain conflicts: conflict 1 – intention to eliminate or decrease the harmful function lads to weakening of the useful function, and conflict 2– intention to improve a useful function leads to increase of the harmful function (Figure 2).

Figure 2. *The Butterfly diagram for the FPS-MX problem*
Legend: w is a wanted function of s; u is the unwanted function caused by satisfying a state s, which is a condition for supporting w; -s is a condition for supporting.



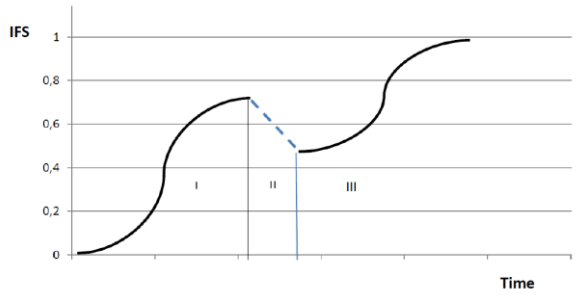
This means that the key parameter to be corrected is no. 2A (mass of the stationary object). If the mass of the stationary object decreases, the parameters no. 23A, C (loss of matter), 36D, F (device complexity) and 37F (control complexity) all worsen (Table 4). Thus there are three different contradictions: TC1 (2Ax23A, C), TC2 (2Ax36D, F) and TC3 (2Ax37F). To overcome TC1, the use of several standards is suggested, among which the following principles 5; 8; 13 and 30. In this case, more promising solution is to eliminate the inner protective layer from the existing FPS system which is impregnated with spherical particles of activated carbon, and instead introduce a new TiO_2 compound. This substance is able to decontaminate HTM in the presence of sunlight (Bauk *et al*., 2012). The choice of self-contamination material of the external layer impregnated with nanoparticles of TiO_2 (Senic *et al*., 2013), or some other nanomaterial, presents a completely different conceptual approach to the development of FPS. The eco-innovative principle of the FPS-MX could be based on one of the two possible solutions: using a cooling system, using a temperature sensor or impregnating the outer layer of the FPS fabric with TiO_2. Of course, the application of TiO_2 is closer to the concept of ideality. Namely, in view of the previous preliminary investigations carried out (Bauk *et al*., 2012; Senic *et al*., 2013; Senic *et al*., 2013a), it has been found that textile substrates are being created by modification of the standard military textile with TiO_2 nano-particles, and that those substrates have a property of self-decontamination under certain experimental conditions.

Table 4. *The part of Eco-innovation Matrix of Contradictions used for case analysis*

PARAMETERS (1-39)			Worsening			PRINCIPLES (1-40)	
			23A,C	**36D,F**	**37F**	**Name**	**No**
Improving	**2A**	Weight of stationary object	5;8;13; 30	1;10;2 6;39	25;28; 17;15	Consolidation	5
						Counterweight	8
						Equipotentiality	13
						Flexible membranes	30

In order to increase the life cycle of a product it is necessary to innovate it continually in order for it to stay relevant on the market. Abscissa in Figure 3. presents time of the system development, and ordinate of the system quality properties is expressed through IFS (IKR). The decision of transfer from evolutionary innovation (FPS-M1-4) to radical innovation (FPS-MX), has been reached when IFS was calculated to be 76.8% for FPS-M4.

Figure 3. *„Life Cycle" FPS*
Legend : I – evolution phase (FPS-M1-4); II – catastrophy phase; III – radical phase (FPS-MX)



CONCLUSION

The ideal eco-innovative TS should have all the advantages of the TS and ES. Therefore, biomimetic and eco-engineering can be considered as two parts of a unique eco-inventology strategy. On this basis, the worst starting point of the TS is taken to be repaired. It is renamed in one of the 39 parameters of TRIZ, and then used in the further analysis the Eco-innovative Matrix of Contradiction. In it, the main mechanism is based on the discovery of the TC that exists between TS and ES and finding an idea for solving the problem using the proposed TRIZ principles. At the same time, the matrix simultaneously considers the application

of 39 TS parameters according to TRIZ, 7 elements of eco-efficiency according to WBCSD and 6 types of resources according to TRIZ.

Integrative innovation encompasses all stages of the product life cycle, both of the old TS (including its improvement through kaizen or technical improvement), and of the new TS (embraces radical innovation), but also of the disaster phase, which is a transitional link between them. In the case of FPS, FPS-M1-4 was found to belong to evolutionary innovation and FPS-MX to radical.

Instead of developing new materials, each time new functionalities are desired; existing materials that are already available should be adapted and combined. The promising high potential of nanotechnologies should also be acknowledged and understood, as confirmed in this paper using TiO_2 nanoparticles.

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DOMESTIC TOURISTS' MOTIVES FOR VISITING RURAL DESTINATIONS IN SERBIA

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Abstract: In recent years, rural tourism has proven to be a form of tourism for which our country has a lot of potential. In order to create an adequate tourist offer that will meet the needs of an increasingly sophisticated tourism market, it is necessary to first identify the segment of tourists who would be interested in this type of tourism, and then explore their preferences and motives for visiting rural destinations. The aim of this paper is to find out what motivates and attracts domestic tourist to visit rural destinations. The research was conducted during August and September 2019 using an anonymous questionnaire. The research findings provide valuable information about preferences and motives of domestic tourists, which is of high importance for creating an adequate offer of rural tourism in Serbia.

Keywords: rural tourism, Serbia, domestic tourist, preferences, motivation
JEL: L83, Z32

1. INTRODUCTION

The tourism and hospitality industry is facing new challenges and undergoing changes (Pavlović & Čelić, 2018). Modern trends in the society bring about these changes. This is why tourists are becoming more advanced and sophisticated. According to Štetić (2002), there is an increase in more frequent and shorter trips which are replacing longer ones. Sophisticated travelers take two short-term trips during the year (Alejziak, 2002). Tourists highly regard "mini trips" to rural destinations (Botezatu, 2014). Shorter trips can be connected with Čelić *et al*. (2019) conclusion that people have a fast pace of life today. According to the Tourism Development Strategy of the Republic of Serbia, one of the expected changes in international tourism is the decrease in the duration of trips (Bošković & Mihajlović, 2016). Thus, it is necessary to develop a diverse offer to satisfy the increasing number of market segmentations. Serbia can offer tourists a wide range of appealing things. Here, there is room for different types of tourism, including cultural, enotourism,

medical, religious, rural, etc. These types are becoming mass and one should devote a lot of attention to them while creating a tourism offer (Pavlović & Simić, 2019). This paper will shed light on rural tourism.

Rural tourism, as a type of selective tourism, is defined by a myriad of authors. Radović *et al*. (2012) define rural tourism as a type that includes all attractions which are available in rural destinations. These can be a part of the tourism offer of a particular destination. Also, rural tourism is a collective term for different activities and tourism types which are present outside of the urban areas and those parts which boast mass tourism (Cvijanović & Ružić, 2017). Based on this definition, we can conclude that rural tourism requires people to shift their attention from popular destinations to our beautiful villages. The countryside can offer good food, clear air, peace, and silence. One of the characteristics of rural tourism is that it causes generosity and builds strong relationships between guests and hosts (Christou & Sharpley, 2019). This is where unbreakable bonds and close friendships occur which last for years.

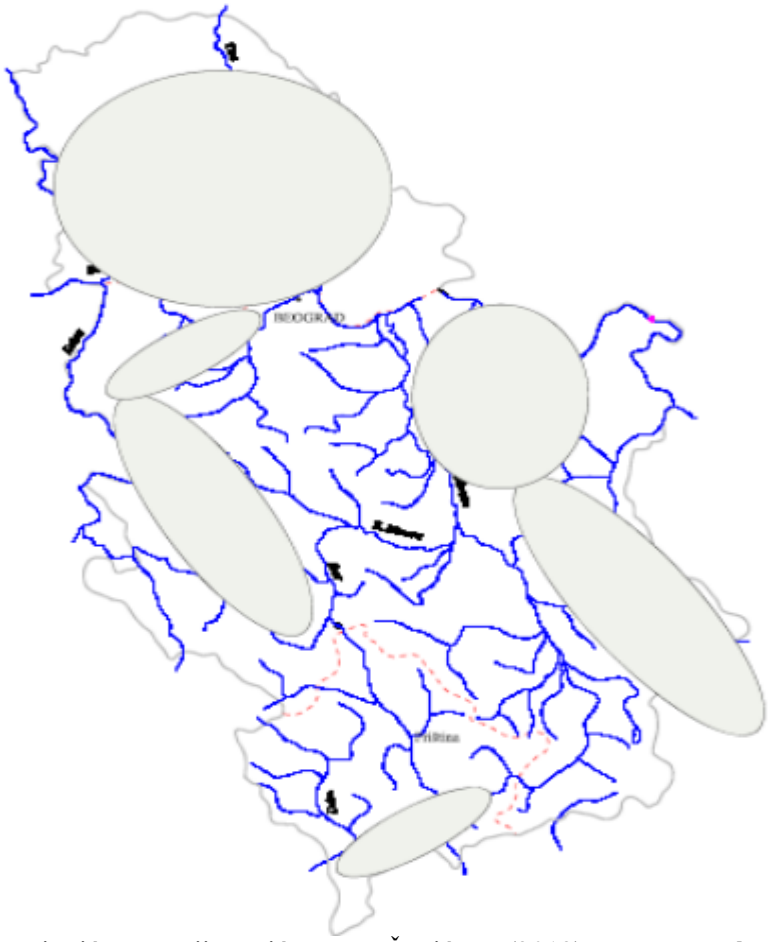
2. LITERATURE REVIEW

We can develop our country and return to the devastated rural areas by creating a rural tourism offer on the state level. In order for tourism to contribute to the development, it needs to be planned and managed in a way that enhances the quality of life of the local population and helps to protect both the natural and cultural environment (Popesku, 2016). This chapter will delve deeper into the development and characteristics of rural tourism in Serbia, and the motives of tourists and their preferences.

2.1. Rural Tourism Development in Serbia

Rural tourism has started to develop in the mountain Golija, near the town of Ivanjica. Locals in the Devići village mimicked Scandinavian villages to create a tourist offer. Consequently, they initiated rural tourism development in Serbia (Gašić *et al*., 2015). Rural tourism has already been developed in some parts of Serbia. Here, the leaders are areas in Vojvodina, Western and Central Serbia (Cvijanović & Mihailović, 2016). Today, the number of rural households has increased. The households are located in all parts of Serbia. According to Vujović *et al.* (2012) and Figure 1 we can see in which areas in Serbia rural tourism is represented. The data from the National Tourism Organization of Serbia revealed that there were 207 rural households in 2016 (Cvijanović & Ružić, 2017). Rural tourism accounts for 6% of the total number of stays in the Republic of Serbia (Vujović *et al*., 2012). This proves just how underdeveloped this tourism type is in the country.

Figure 1. *Areas in Serbia where rural tourism development activities are implemented*



Source: Vujović, S., Cvijanović, D., & Štetić, S. (2012). *Destinacijski koncept razvoja turizma*. Institut za ekonomiku poljoprivrede, Beograd.

2.2. Rural Tourism Characteristics in Serbia

Rural areas in Serbia differentiate economically, socially, and demographically. This is due to the geomorphological differences (mountains, hills, and plains), differences in the population, economical structures, infrastructure, environment, and transport system (Milošević-Đorđević & Milovanović, 2012). The research carried out by Đenadić *et al*. (2016) notes that some of the characteristics of rural tourism in Serbia are resources and low levels of development. Radović *et al*. (2018) believe that financing is one of the major drawbacks to the development of rural tourism in the Republic of Serbia. Many residents in Austria, France, Spain, Scandinavia, and other countries, used an opportunity to add their households to the state's tourism offer.

In Serbia, there are some cultural, natural, and sports attractions that are appealing to tourists from all over the world. We should make use of our cuisine, home canning, spring water, domestic animals, and work in the fields. This is something that almost every village in Serbia can offer to its guests. These things also motivate tourists to visit rural destinations. The state should support these activities because it has to assume the leading role in improving the business environment. Also, it should make investing easier, and develop infrastructure and human capital (Milićević & Đorđević, 2015). Antić *et al*. (2015) say that domestic tourists are more prone to choosing rural areas than urban.

The Tourism Development Strategy of Serbia states that the chances and opportunities of entrepreneurs in the field of rural tourism are high (Ministry of Trade, Tourism and Telecommunications, (2016). According to the Ministry of Trade, Tourism and Telecommunications (2016), the strategy also states that „In 2014, according to EUROSTAT, only 506 foreign tourists visited facilities of rural tourism. It is necessary to support commercial training programmes for rural households that are interested in rural tourism, in compliance with the Strategy and the Development Programme of Sustainable Rural Tourism in the Republic of Serbia, and with various models of partnerships with the registered rural households which will connect resources, knowledge and skills. We should especially highlight the option to use the incentive funding programme for rural tourism development from the EU IPARD programme which provides 18 million EUR for the development of rural tourism"(p. 89).

Čomić (2002) stresses that there is a wide range of conditions which can create a diverse and top-notch offer of rural tourism in Serbia:

- Low population density and small neighborhoods,
- Traditional agriculture,
- Area's attractiveness as a mirror of nature,
- Ecosystem conservation,
- Biodiversity,
- Traditional social structure and values that don't exist in the urban areas,
- Friendliness, kindness, and hospitality,
- Communicating and socializing with hosts,
- Recreational activities in preserved areas,
- A chance for tourists to engage in agriculture on the property (traditional cooking, making a fruit brandy and wine, etc.), collection of forest fruits, medicinal, and aromatic plants,
- Healthy and diverse Serbian food,
- Production or supply of domestic crafts (rugs, lace, embroidery, clothing).

According to Đenadić *et al*. (2016), these are the most important elements of rural tourism in our country:

- Insufficient use of accommodation facilities which are already modest.
- The lack of upscale apartments and accommodation facilities which result in lower prices.
- A significant number of rural households (around 40%) do not offer food, thus, they do not produce any revenue from it.
- Inadequate and underdeveloped promotions. Also, inadequate channels of sale which are restricted to the Internet. And limited participation of tourism organizations in this type of tourism.
- Low cost of accommodations and food. They result in lower revenue (average price of bed and breakfast is around 10 euros, half-board is 14 euros, and full-board is 16 euros).
- A limited range of other services in rural households (sports, shopping, transport, embroidery, etc.).
- Poor investment in accommodation facilities which hints that there is no need to expand them.

Cvijanović & Ružić (2017) state that there are different types of rural tourism such as farm, residential, sports, health, cultural, hunting, culinary tourism etc. Tourists have numerous activities at their disposal in the rural area. Pavlović & Berleković (2018) research shows that people can engage in swimming, hiking, horse riding, cycling, playing tennis, fishing, playing golf, and hunting in the rural areas.

2.3. Tourist Characteristics and Motivational Factors in Rural Tourism

The behavior of tourists is the most important indicator or predictor of future tourist behavior (Juvan *et al.*, 2017). In order to attract as many people as possible, it is paramount to create a high-quality tourism product. We can develop that product if we discover what motivates tourists to visit rural destinations.

Njegovan (2016) separates the motives into two groups – sociopsychological (escaping from our everyday life, researching and assessing one's personality, vacation, status, enriching family relations) and cultural (gaining new experiences and education).

A tourist in rural tourism is family togetherness seeker, passive tourist, want-it-all seeker, and learning and excitement seeker (Park & Yoon, 2009). According to Streimikiene & Bilan (2015), these are the motives to visit a rural destination:

- The desire to escape from routine,
- The desire for pleasure and relaxation,
- The search for a memorable lifetime experience,
- The search for adventures,
- The pursuit of intellectual enrichment,
- The desire to learn more about local nature,
- The desire for safety,
- The search for beautiful landscapes,
- The search for quiet,
- Low noise and clean environment.

The differences among tourists in rural tourism exist even if we examine the time and duration of the visit. So, the most suitable periods to visit rural destinations are weekends and holidays. The duration of the stay is one night (Chen *et al*., 2013). Another characteristic of tourists in rural tourism is that they usually travel with their families (Fleischer & Pizam, 1997; Chen *et al*., 2013).

There are numerous reasons to visit rural destinations. Frisvoll *et al*. (2016) highlight that local food play a prominent role. The research conducted by Antić *et al*. (2015) shows that healthy food is the main reason for staying in rural areas. On the other hand, Rid *et al*., (2014) single out heritage and nature as the most important motives. The most significant activity in a rural destination is swimming (Fleischer & Pizam, 1997; Pavlović & Berleković, 2018).

3. RESEARCH METHODOLOGY

The research was carried out through an online survey in July 2019. A total of 72 respondents participated – all of whom were domestic tourists. The survey included 13 questions – eight of them were close-ended and the respondents had to choose one of the provided answers. Two questions relied on a Likert scale which had five levels. Also, there was only one open-ended question and it concerned the responders' residence. The remaining two questions were semi-opened and they asked the respondents to either choose one answer or provide their own. The questionnaire featured two categories of questions. The first group included questions regarding the demographic characteristics of interviewees. As for the second group, it asked them to reveal the preferences and motives of traveling to rural destinations. We used SPSS software (SPSS 22) to analyze the data. Frequency analysis and descriptive statistics were used to show the results.

The aim of this research was to determine the preferences and motives of tourists in rural tourism. To reach a conclusion, we used the hypotheses to closely establish the preferences and motives. The proposed hypotheses are the following:

- **H1:** Domestic tourists opt for rural destinations rather than for urban.
- **H2:** Domestic tourists visit rural destinations once a year.
- **H3:** When they do visit them, their trips are short.
- **H4:** The primary goal of visiting a rural destination is healthy food, and their favorite activity is swimming.
- **H5:** The most interesting parts of Serbia for domestic tourists are Vojvodina, Western, and Central Serbia.

4. RESEARCH RESULTS AND DISCUSSION

The research was conducted with the help of 72 respondents. The demographic structure of interviewees (Table 1) show that females (69.4%) and those aged between 20 and 30 (58.3%) prevail in the study. The largest number of responders has a bachelor degree (43.1%).

Table 1. *Demographic Characteristics of Respondents (n=72)*

		Number of Respondents	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Sex	Male	22	30.6	30.6	30.6
	Female	50	69.4	69.4	100.0
	Total	72	100.0	100.0	
Age	20-30	42	58.3	58.3	58.3
	30-40	13	18.1	18.1	76.4
	40-50	10	13.9	13.9	90.3
	51 and more	7	9.7	9.7	100.0
	Total	72	100.0	100.0	
Education	High School	26	36.1	36.1	36.1
	Higher School	5	6.9	6.9	43.1
	Faculty	31	43.1	43.1	86.1
	Master's Degree	9	12.5	12.5	98.6
	PhD	1	1.4	1.4	100.0
	Total	72	100.0	100.0	

Source: Author's Research

Table 2 indicates that the biggest number of responders come from Vrnjačka Banja (20.8%) and Trstenik (12.5%).

Table 2. *The Place of Residence (n=72)*

		Number of Respondents	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
The Place of Residence	Belgrade	4	5.6	5.7	5.7
	Kragujevac	6	8.3	8.6	14.3
	Kraljevo	8	11.1	11.4	25.7
	Kruševac	5	6.9	7.1	32.9
	Niš	2	2.8	2.9	35.7
	Novi Sad	2	2.8	2.9	38.6
	Area Around Kruševac	2	2.8	2.9	41.4
	Raška	2	2.8	2.9	44.3
	Trstenik	9	12.5	12.9	57.1
	Užice	2	2.8	2.9	60.0
	Vrnjačka Banja	15	20.8	21.4	81.4
	Other	13	18.1	18.6	100.0
	Total	70	97.2	100.0	
	Missing Responses	2	2.8		
	Total	72	100.0		

Source: Author's Research

Table 3 reveals responders' answers regarding their preferences for going and staying in rural destinations in Serbia.

Table 3. *The Respondents' Answers Regarding Their Preferences for Going and Staying in Rural Destinations in Serbia*

Preferences	Provided Answers	Number of Respondents	Percentage (%)
Preferred Destination	Urban	30	41.7
	Rural	42	58.3
	Total	72	100.0
Frequency of Visit	Once a Year	18	25.0
	2-3 Times a Year	33	45.8
	4 Times a Year or More	16	22.2
	Never	5	6.9
	Total	72	100.0
Duration of Stay	One Night	18	25.0
	Two Nights	24	33.3
	Three Nights	13	18.1
	Four Nights	6	8.3
	Five Nights	1	1.4
	More than Five Nights	10	13.9
	Total	72	100.0
Preferred Time of Visit	Weekdays	16	22.2
	Weekends and Holidays	56	77.8
	Total	72	100.0
Who Do You Travel With	Alone	6	8.3
	Friends	17	23.6
	Family	46	63.9
	Business	3	4.2
	Total	72	100.0

Source: Author's Research

According to their responses, 58.3% of them prefer rural destinations for their vacation. Additionally, those who visit a rural destination 2 or 3 times a year (45.8%) and stay for two nights (33.3%) make the largest part of the survey. They are more prone to travel to these places during the weekends and holidays (77.8%). The overwhelming number of interviewees goes to a rural destination with their families (63.9%).

Table 4 depicts the descriptive statistics of the reason for visiting. Some of the reasons were irrelevant for the respondents, while some were important. For example, the interviewees gave the biggest grade to healthy food (4.08), whereas the lowest went to recreational activities (2.99%).

Table 4. *Descriptive Statistics of the Reason for Visiting*

	Number of Responders	Min.	Max.	Median Value	Standard Deviation
Clean Air	72	1	5	3.42	1.480
Healthy Food	72	1	5	4.08	1.135
Recreational Activities	72	1	5	2.99	1.316
Homely Atmosphere	72	1	5	3.14	1.427
Stress Relief	72	1	5	3.42	1.461
Staying Away from Crowd and Noise	72	1	5	3.39	1.420
Valid Number of Responders	72				

Source: Author's Research

Table 5 displays the frequency of answers based on the preferences for activities and types of rural tourism in Serbia. As a dominant activity in a rural destination, the responders single out swimming (45.8%), and nostalgia tourism (36.1%). A lower percentage of the respondents (2.8%) chose "other" for both the type of tourism and their preferred activity. Here, they wrote domestic work and rakija-making. The most interesting type of rural tourism selected in "others" is religious tourism.

Table 5. *The Frequency of Answers Based on the Preferences for Activities and Types of Rural Tourism in Serbia*

Preferences	Provided Answers	Number of Respondents	Percentage (%)
Preferred Activity in Rural Tourism	Swimming	33	45.8
	Hiking	30	41.7
	Horse Ridding	1	1.4
	Cycling	3	4.2
	Tennis	1	1.4
	Fishing	1	1.4
	Hunting	1	1.4
	Other	2	2.8
	Total	72	100.0
Preferred Types of Rural Tourism	Sports	14	19.4
	Cultural	9	12.5
	Health	5	6.9
	Hunting	1	1.4
	Culinary	7	9.7
	Rural Tourism in a Rural Household	8	11.1
	Nostalgia	26	36.1
	Other	2	2.8
	Total	72	100.0

Source: Author's Research

Table 6 includes descriptive statistics for preferred rural destinations in Serbia. According to the submitted answers, the respondents express a strong interest in rural destinations in Central and Western Serbia (average grade is 4.21), and a slightest for Southern Serbia (2.65%).

Table 6. *Descriptive statistics for Preferred Rural Destinations in Serbia*

	Number of Respondents	Min.	Max.	Median Value	Standard Deviation
Vojvodina	72	3	5	3.99	1.239
Western and Central Serbia	72	1	5	4.21	1.020
Eastern Serbia	72	1	5	2.89	1.273
Southern Serbia	72	1	5	2.65	1.313
Valid Number of Responders	72				

Source: Author's Research

The shown results indicate that domestic tourists have different preferences and motives for visiting rural destinations in Serbia. The suggested hypotheses, **H3, H4** I **H5** were confirmed, but the hypothesis **H2** wasn't.

H1: Domestic tourists opt for rural destinations rather than for urban.

The research confirmed hypothesis 1 because as many as 58.3% of responders prefer rural destinations. This also proves the conclusion of Antić *et al*. (2015) that domestic tourists will rather choose rural destinations than urban.

H2: Domestic tourists visit rural destinations once a year.

Hypothesis 2 wasn't proved because the results of the research indicate that domestic tourists visit rural destinations 2 or 3 times a year (45.8%). Both Štetić (2002), who states that there is an increase in frequent trips today, and Alejziak (2002), who says that sophisticated tourists go on two short trips a year, noticed this.

H3: When they do visit them, their trips are short.

The research supported hypothesis 3. Around 33.3% of interviewees said that their trips usually last two nights. Also, we proved Štetić's (2002) statement that short-term trips are more frequent, replacing one long-term visit.

Furthermore, we also confirmed Botezatu's (2014) observation that mini trips in rural destinations are respected by tourists. The statement of Chen *et al.*, (2013) that the preferred duration of a trip is one night wasn't proved.

H4: The primary goal of visiting a rural destination is healthy food, and their favorite activity is swimming.

Hypothesis 4 was proved as well. According to the answers, the main reason for visiting is healthy food (average grade 4.08), and the primary activity is swimming (45.8%). These results confirm the ones from the research of Pavlović & Berleković (2018), but they refute the opinion of Rid *et al.*, (2014) that the most important motives that drive tourists to rural destinations are heritage and nature.

H5: The most interesting parts of Serbia for domestic tourists are Vojvodina, Western, and Central Serbia.

The answers suggest that the most interesting regions for rural destinations are Western and Central Serbia (average grade 4.21), and then Vojvodina (average grade 3.91). These results prove hypothesis 5.

Additionally, they confirm the statement that leaders in rural tourism development in Serbia are Vojvodina, Western and Central Serbia (Cvijanović & Mihailović, 2016). We can conclude that the results indicate that they are sought after because they have a good offer and are developed.

CONCLUSION

Characteristics, preferences, and motives of tourists should be the basis for the creation of a proper tourism offer. Not only is this important for rural destinations, but also for all others if they want to get into the market. An offer that is adjusted to the wishes and preferences of tourists will contribute to the

development of individual tourism and hospitality facilities and the whole industry.

Villages in Serbia offer a myriad of attractions which are located in them or their vicinity. They provide a good basis for attracting both domestic and international tourists. It is necessary to use the existing resources to create an adequate offer which will bring more tourists to our villages.

The goal of the research was to determine the preferences and motives of domestic tourists in rural tourism of Serbia. Based on the results, we can conclude that domestic tourists have an array of preferences and motives. The biggest number of respondents are those who prefer rural destinations and visit them 2 or 3 times a year. They go there with their families, during the holidays or weekends and stay for two nights. The most interesting activity in a rural destination is swimming and the type of tourism is nostalgia. As for the region, the most appealing ones are Western and Central Serbia, and Vojvodina.

This paper has certain limitations which should be eliminated in the next research. The research did not include respondents from all over Serbia. So, the next study should increase the number of interviewees. In particular, the preferences and motives of those living in Vojvodina and Southern Serbia should be researched.

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IMPACT OF INFORMATION TECHNOLOGY ON TOURISM DEVELOPMENT

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Abstract: Tourism as a global phenomenon of the 21st century requires accurate, correct, complete, up-to-date, and constant information. The greatest influence on tourism is – technological development that initiates changes in the environment, especially in communication media. Information technology has to facilitate the process of conducting business for one company. On the other hand, it should show the quality of some products. Also, it should support a company in its endeavors to fulfill the needs and wishes of consumers. Vast number of papers deal with the issues of modern tourism and the efforts the employees put in in this industry. They do so to establish better interaction with increasingly demanding tourists. The prospect of tourism development under the influence of information technology lies in interactive technology. Namely, it is highly likely that this technology might become practical and change over time.

Keywords*:* tourism, tourism supply, and demand, information, information technology, interactive technology
JEL: F01; M12; M15

1. INTRODUCTION

You can say with certainty that tourism is a phenomenon which has acquired global dimensions in the 21st century. In other words, tourism is the fastest growing industry that employs 313 million people worldwide. Also, it accounts for 10.4% of global GDP (World Travel and Tourism Council, 2019).

A huge number of tourists traveling to domestic and international destinations are the basic characteristic of tourism. In fact, the tourism market is becoming dominant when compared to others across the world. In this market, tourism supply and demand are facing each other in order to exchange goods and services which come with a set price. Some unique characteristics of tourism, that is of its basic elements (exchange, supply, and demand), have to be a starting point for the creation of computerized systems.

The tourism expansion has been developing some new ways of exhibiting tourism demand which yields changes in supply (Pavlović, 2017). It's essential to perceive this complex situation through a marketing concept. This concept respects different characteristics of a particular tourism market, focuses on the demands and wishes of consumers, and strives to satisfy them. In this way, it achieves the ultimate goal of a business. This complex industry and its heterogeneity, together with the uniqueness of the tourism market, present a favorable field in which one might apply information technology.

The development and globalization of business in tourism has brought about a need for connecting those providing services, and tourism demand and supply. The emergence of digital currency, interactive television, information kiosk, teleconferencing, smart cards, and intelligent agents has improved the communication of the participants on a tourism market (Krstić, 2016).

These new media are completely turned towards the consumer. They offer new ways of communicating and can be used as new channels on which a tourism product can be distributed – both a partial and integrated one. All business activities will be undertaken differently. This is due to interactive media, database and the adjusted technology.

As per the introduction, we could say that the goal of this paper is to show how information technology impacts the interconnection of all participants who are engaged in the creation of a modern tourism product. It will also look at how it influences their association with tourism demand. Taking into account the importance of tourism, the topic of this paper is the influence of information technology on tourism development.

The research is expected to show all the opportunities the new media offers in communication. Namely, it's inconceivable for participants to communicate and manage tourism demand without the implementation of modern computer technology. The significance of this will increase as interactive technology becomes important for a number of companies. It will lead to major changes in the distribution of tourism.

2. THE OVERVIEW OF LITERATURE

2.1. The Implementation of Information Technology on Tourism

Information technology was created through the development of computer and telecommunication technology. At the same time, the role of information technology in tourism is to provide consumers with countless and useful information about the numerous elements of tourism supply. The development and globalization of business in tourism has brought about a need for connecting those providing services, and tourism demand and supply (Agag & El-Masry, 2017).

Tourism and its heterogeneity, together with the uniqueness of the tourism market, present a favorable field in which one might apply this technology. Information technology on the tourism market is used by those working on it – travel agencies, airlines, hotels, and companies providing rent-a-car. Apart from this, the organizations participating in the creation of a tourism product and those that are directing tourism development globally also use information technology (Choi & Turk, 2011).

Different companies in tourism have shifted from manual to computerized labor. In this way, they have automatized different activities and operations. Most importantly, they have automatized their ways of doing the books and keeping track of their employees (Mitrović, 2013). These jobs are conducted within a company which is why they are referred to as internal or backroom jobs. Shortly after this, the key providers of tourism offers in the developed countries introduced information technology in every aspect of their business (Pavlović, 2016).

Primarily, we are referring to those jobs which are unique to tourism, i.e. external or front room jobs. With them, a company connects with the environment in tourism (Terras *et al.*, 2013). One of the roles of information technology is to closely integrate the individuals who are creating a tourism development. Also, it works on integrating them with a tourism supply using the support of information technology (Filipović, 2016).

"Through the use of information technology one could standardize certain operations and enable yield management which allows for flexibility in the different aspects of business policy, and especially in the policy of the price discrimination" (Bakić, 2000). Furthermore, this technology enables fast, extensive, and prompt communication between those providing information and those using them. Thus, it's unthinkable to manage a tourism product or offer without modern computerized technology (Bakić, 2001).

The development of the communication systems produces a solution to the question of how to transfer information to distant locations through the use of state-of-the-art resources which should be operated accordingly (Affe, 2019). This technological development permits some functions and data to spread over some connected units. This is a distributed analysis of information. The appropriate use of the key technological trends in the development of information technology and its opportunities is the basis for remaining on the tourism market. Also, information technology has become a general characteristic of tourism (Buhalis, 2008).

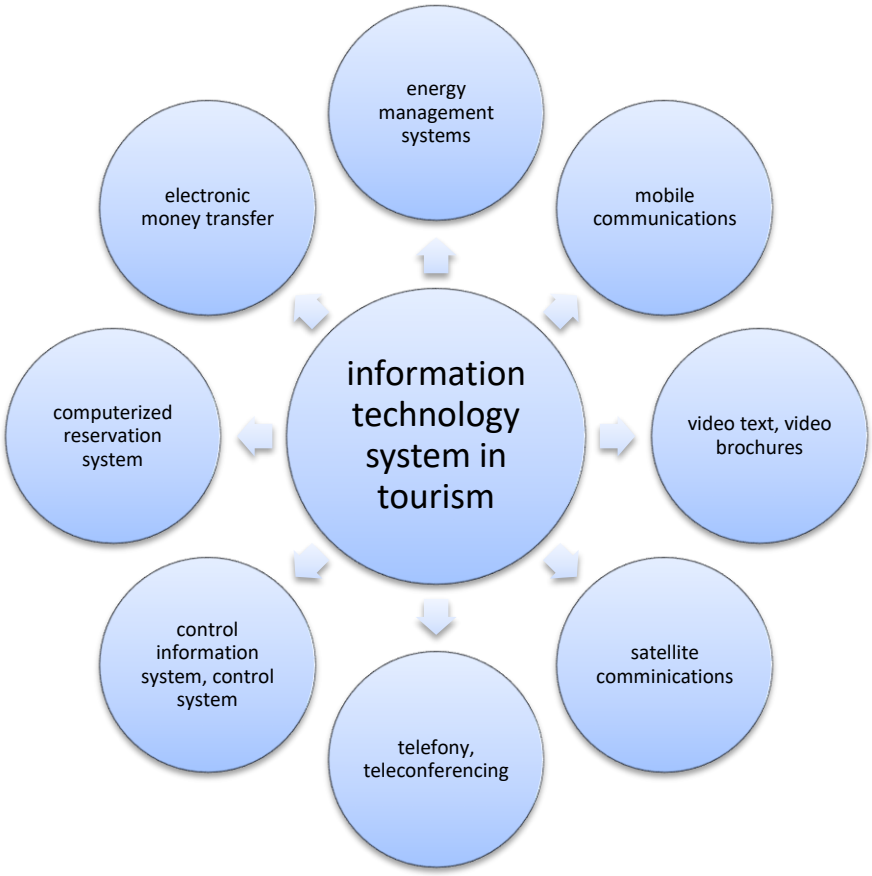
For this reason, information technology exerts a major impact on the work methodology in tourism. However, it doesn't influence every function and sector in tourism in the same way. Its biggest impact is on marketing and distribution. In this case, it barely touches upon other fields in which the need for communication is more pronounced (Mowforth & Munt, 2015). Similarly, some sectors, like airlines, introduced information technology and used it in order to control and motorize their operations for a strategic gain. Others, like the hospitality industry, were less than enthusiastic, but gradually they began to understand the advantages of information technology.

Specifically, it helps them stimulate their market, improve efficiency, maximize their profitability, improve their service, and generate and maintain long-term profitability. It didn't take long for digital marketing and distribution to become accepted in tourism. The previous sentences are relevant for tourism where one of the most powerful means of marketing, digital distribution, is rapidly developing (Kanamori & Motohasni, 2009).

One thing the expansion of this evolution and its emerging trend should enable is the realization of the full potential of tourism. In the same way, computer reservation systems are a part of information technology which is used in tourism and are not separate parts. You can see the thing in figure 1 (Bakić, 2000). These technologies are tightly integrated.

The advancement of computer reservation systems in some companies operating in tourism (airlines, hotels, travel agencies, etc.), the implementation of the satellite connections, and faster growth of the network for data usage, has provided a new quality to the instruments of marketing. In addition, the emergence of digital currency, interactive television, and teleconference has improved communication between those in tourism.

Figure 1. *The system of a new information technology in tourism*



Source: Bakić, O. (2000). *Marketing in Tourism*. Ekonomski fakultet, Beograd.

2.2. The Newest Tourism Forms under the Influence of Information Technology

Along with the evolution of information technology, one can see the evolution in the field of distribution of a tourism product (Pavlović, 2018). This evolution depends on how they use interactive media to react to the changes in the market which have been brought about due to the adjustments in the technological environment. These adjustments were caused by the development of information technology (Manić, 2008). The new media is following the evolution of tourism. They offer new communication models and channels for product distribution.

The Internet takes the central role among the new media. In this day and age, the gradual commercialization of the Internet has shown that the "old" media are more expensive and less effective in this different setting (Liu, 2010). The Internet is the most important part of interactive media, such as online services,

interactive kiosks, interactive television, etc. All business activities will be conducted differently. This is because of the new interactive media and the technology which has adjusted to them.

The upcoming interactive technologies will become crucial in determining which company will keep operating and which won't in tourism. Some forms of tourism which have been created due to the influence of information technology are interactive kiosk, armchair shopping, vacation channels, automated ticket machines, teleconferences, smart cards, interactive brochures, intelligent agents, man-made reservoirs, and virtual mobility (United Nations World Tourism Organization – UNWTO, 2011).

2.3. Interactive Kiosk

Many travel agencies have introduced an interactive kiosk, i.e. information terminals. They contain more detailed information than your average commercial data systems.

The interactive kiosk promotes a tourism product by showing a map of the area first. This map can be divided into four or five parts (Kiosk marketplace, 2019). Firstly, a consumer selects a destination for which they want to find out some information. In this way, a special software starts to automatically search through its database, looking for the news which might be of interest to the consumer.

Shortly after this, a menu appears which showcases some characteristics of a selected area. Secondly, consumers choose what they want to do, then the category of a venue, and then go through different lists and advertisements of each host. Most systems offer their consumers a chance to print pages, maps, and other promotional materials that they can bring with them (Kingsley & Fasenmaier, 1995).

When a kiosk is connected to the main system of a destination or to a different channel, then some data, like the available accommodations and prices are displayed on it. This allows a kiosk to deal with queries, booking, and shopping and charge everything through the credit card reader.

There are numerous advantages of allowing two information terminals to connect. Because of the interactive kiosks, the results are immediate and visible. In essence, an interactive kiosk is valuable only if a consumer gets the information that is easily obtained in this way. Among other things, these systems should use animation in order to attract consumers and retain them when they give them information. Also, it's crucial that they boast a perfect content that has products. Also, this content should be linked with their presentation.

2.4. Armchair Shopping

Armchair shopping is not a new type of shopping. However, when it comes to tourism, the issue does not arise in technology, but in the consumer's habits. People love to go shopping because this is a common part of their social experiences and they love to compare products based on quality, color, and price. While this refers to goods, the situation is different if we look at the goods and services provided during traveling.

A tourism product is not bought immediately or often for that matter. It demands effort, i.e. you should find additional information, compare them, etc. Honestly, in many cases, these are the desired steps because a traveler needs time to read and choose data. Also, they require some time to contemplate everything with their family members. Apart from this, shopping for a tourism product is not all about the effort, but it also entails satisfaction.

The development of information technology with a view to improving the image transfer, enriching the content which the multimedia channels can deliver, bettering the software in order to simplify the use of automated booking systems can contribute to the rise in the appeal of buying a tourism product from the comfort of your own home. In this way, it can pose a threat to the classic sellers in the future (E-shopping and its interactions with in-store shopping, 2019).

Undoubtedly, armchair shopping using some device will become a usual thing as consumers become better in technology. This might strengthen a consumer's will to haggle. Although, armchair shopping systems will not revolutionize the classic purchase of goods and services (Kangaspunta, 2018). An effective production can be limited by the complexity of the actual product, especially a tourism one.

When a product is relatively simple, consumers can easily, without any help, book something using an interactive media. On the other hand, the practice shows that it's impossible to replace the personal contact with a travel agent, especially for distant trips. In most cases, a consumer expects to get help while they are buying some products. In tourism, this means assistance in choosing a hotel, restaurant, and other things – they are not available in this interactive media as of yet.

2.5. Vacation Channels

Vacation channels are merely designed as channels for advertisements that plan a vacation on the TV. The concept is both simple and promising. Namely, by combining a travelogue, inserts from tourism and offers, a viewer should be encouraged to interactively react and use their phone to book their vacation. This is the so-called "Travel TV".

2.6. Ticket machines

Computer reservation systems of airlines are connected with the available machines which print tickets. These can be found at the airport, hotels, and shopping malls. They allow a direct sale. Although they are useful for a specific category of a traveler, these machines are becoming sophisticated. Apart from printing cards and boarding passes, you can even use them for booking.

Automated Ticket and Boarding Pass (*ATB*) is a ticket that has a magnetic stripe which entails details about the passenger's travel. It can be encrypted from the database of computer reservation systems. One could get it from a satellite printer in a travel agency, company, airports, banks, shopping malls, and hotels. You can read and copy the information by using a printer during check-in and boarding.

This technology can change the experience of a passenger as they have a chance to obtain a ticket and confirm their seats through a self-service option. They can board a plane faster, and have better control over their luggage as it would be electronically connected to specific owners. Apart from this, with the Automated Ticket and Boarding Pass, the systems can show information about hotels, rent-a-car, and general details of your travel (visa, medical requirements, etc.) (Bakić, 2001).

2.7. Teleconferences

Teleconferences are the methods with which one could engage in different discussions, such as seminars, conferences or meetings between schools, organizations, etc. This is done using a phone or a video. Thereby, one or more participants can see each other speak (Zečević, 1994).

Teleconferences linked by a telecommunications system reduce the need for traveling and allow an individual to participate in a business meeting or conference from the comfort of their own office. And, compared to other technologies, teleconferences can directly decrease the sale of tourism services. In other words, companies offering transport lose their potential passengers, while hotels lose their potential guests if they all decide to have a teleconference.

2.8. Smart Cards

Plastic cards have become intelligent and can offer more to their respectful owners. This offers interesting advantages for software that connects consumers in tourism. Smart cards are a special form of credit cards that are used while traveling. They are computerized, plastic, information s card. Also, they are pocket-sized cards that can store extensive data.

Similar to them are the basic cards that are used in ATMs that hold certain information. For instance, they have a security code, the name and the address of

the owner and a personal identification number that needs to be entered before any transaction is accepted. Every card has a fixed limit and all transactions are directed towards and get declined on the bank account (Gilbert, 2006). Also, these cards have their own keyboards. Nevertheless, it's paramount to establish some global standards so that they could be used worldwide.

The smart card system is competing against the electronic fund's transfer at point of sale system. The latter decreases the volume of paperwork which comes with the usual transactions from the credit cards, and it also speeds up the transactions. The main reason is that the transaction is automatically transferred from the buyer's to the seller's account. In tourism, this system is also used, especially when transferring funds from the account of a tourist to the account of a travel agency. Aside from this, it can be applied when moving funds from the account of a travel agency to the one of a tour operator.

2.9. Interactive Brochures

Instead of a paper catalog, a consumer gets a small, silver *CD*. Not only does the content on it appears, but also it can be animated and simulated. A traveler who's booking a ticket on a plane can also choose accommodation in some hotel. It displays different combinations of tourism products and services until it creates a complete picture.

A brochure of the future is electronic and interactive. A paper filled with information doesn't offer plenty of opportunities that can be explored in an interactive brochure. Looking through this type of brochure is still not available to many because some don't have suitable devices. The advantages of this media are the broad range of products which can be launched without any issues on the *CD*.

2.10. Intelligent Agents

Communication channels produce a vast number of different information. For instance, the Internet is a home of a lot of information which are constantly growing so that the users can get confused during their search. Therefore, it might take hours for you to locate the information you actually need. This goes to show that plenty of information can make shopping harder on this network and not easier. One experimental technology, known as intelligent agents, enables the user to go through a lot of information quickly and easily over the computer. Given that the people in the 21st century already suffer from information overload, they will soon realize that without an intelligent agent they are left to their own devices (Krstić *et al*., 2018).

The software manufacturers have shown that they support all progressive solutions and activities which will become meaningful in the future. The new generation of software should act like a personal electronic or virtual assistant of every user. We're talking about the systems which gather details from one or a

number of fields in which a user shows interest. In this way, they shape a computerized way of thinking and syncing.

The aim of this system is to find a vast number of information in order to fulfill some task. These software launch programs, known as the agents, which can be shaped as one sees fit. The agents search through a network in order to find the desired details. They do this by visiting virtual markets, post offices, or banks where they execute any command they receive. They learn because of the information they obtain about the person they're assisting.

This means that the agent learns by getting to know the user and, then, it is able to fulfill a task. Thus, it's more than obvious that the characteristics of the agent depend on the user. Its profile is built using certain information, like the name and the address of the owner, their personal interests, needs, special requests, etc. In this way, every decision an agent reaches instead of its owner actually reflects the one the owner would have made (Krstić & Krstić, 2015).

In the future, the intelligent agents should be connected, through an advanced version of the Internet, with the other agents. Even those who are assisting people providing services or some organizations. A decision about some purchase will be made in agreement with the user. In this way, the agents make a purchase based on the user's wishes (Smart meetings, 2019). Regardless of any difficulties, this technological approach indicates that there is already significant progress in the intelligence simulation.

The types of intelligent agents are intelligent agents for research, filtering, then serviceable and automatization agents (Bakić, 2001). The intelligent agents for research can be programmed to search on the "information superhighways". Then they can find information which matches the user's request and, in the end, they can return the discovered details to the user.

The agents for filtering should filter the information they get from the agents for research. At the same time, they should follow and control other products that might be of interest to the user on the Internet. The serviceable agents can save any information they get from the previous agents. Therefore, they create and show an appropriate plan while keeping in mind any requests the user has made for meals, seats, payment methods, and checking the plans of other users. At the end of this syncing, the user gets the final details of their travel.

2.11. Man-made Reservoirs

The new consumer world is characterized by a number of possible options which one has during the leisure time, search for electronic information, and other activities. However, this world is becoming more complex for work, technology, society, ecology, and vacation. It requires that the society is integrated into the

mentioned structures which have a tendency to change fast. This world is always searching and questioning the position that the owner has in these structures. The increased discretionary income and leisure time will prompt people to "buy experience" (during their leisure time and recreation), and not to own things (Bakić, 2003).

The mobility of leisure time leads to pure stress today. The congested traffic, crowded beaches or long queues in front of a ski lift always irritate people. The society of leisure time has reached ecological, spatial, and physiological limits. A car has become a real issue. It's clear that many destinations will become unreachable for this vehicle. Namely, they will be closed for traffic in order to prevent any environmental degradation. Seeing as a man is almost not welcome in nature, some drastic limits will need to be imposed so that they could spend time in it (Grant & Mason, 2003).

Paradoxically, the mobility might be subject to tough restrictions despite all the possibilities one has for their vacation and leisure time. Public transport, including airplanes and trains, is a plausible choice. Because of them, there are new trends, such as visiting distant destinations which are becoming popular. However, there are some limits here and the longer vacations are replaced with shorter ones, including the weekend getaways or limited short trips (Đelić, 2004).

One thing is for sure, the mobility and willingness to travel keep everyone interested. The changed conditions imposed, however, other requests for someone's leisure time. This is in order to meet the people's needs for an authentic experience. These requests are developing in two directions: the use of man-made reservoirs and virtual mobility (Zheng Xiang *et al.*, 2014).

In the future, mass tourism will be possible only if man-made reservoirs are created. The resorts are a good example of this. Tourists can find themselves in man-made worlds such as resorts, villages, or the limited man-made world under a roof (Javed, 2017). This development is followed by the application of some solutions. Wireless networks allow people to take with them their phone and a Personal Digital Assistant. What's more, a phone and a computer have been merged. They help you stay connected with the outside world even when you're in a distant world (Sinha, 2012).

2.12. Virtual Mobility

The mobility is spreading across a virtual field. By using a computer, a person can keep in touch with some distant destinations all from the comfort of their own home. People all over the world are communicating together without having met each other. This is mobility in an artificial space. In virtual reality, one can come up with different scenarios that offer a free authentic experience.

This artificial mobility can come across as off-putting and alienated from reality, but some circumstances are aiding its development. Regardless of whether this will be in the future which creates a space in which nothing is "real" (Bauder & Freytag, 2015).

The virtual mobility means that the data in a computer are processed so as to simulate an artificial space that one might feel through their senses. In order to achieve this, it's necessary to have a "socket" in the brain which might stimulate other parts of the brain (Zmund, 2014). Virtual reality uses some aspects of immersive reality – an illusion in which a person can completely engage. Namely, it uses a headset that comes with goggles and has two screens which show an illusion in 3D. This is achieved through some small pieces of the screen, a glove that has sensors and optical fibers that help a person move virtual objects and make them feel like they're touching something. Those participating are moving in some imaginary scenes and feel like they're really there. In this way, consumers might get offered some virtual vacations.

Virtual vacations add a new dimension to leisure time, and travelers do not even need to leave their home country. By simulating a vacation, a person is able to try out some desired destination, its attractions, and the theme parks. Also, they can tour a museum or a gallery, visit a restaurant, walk on a beach, and visit ski centers before actually traveling.

The combination of a computer and a laser has brought about an emergence of another type of animation and stimulation – holography. It can provide an unforgettable experience to a tourist who will be able to see everything their desired destination has. They can hear a wave or feel a breeze; relax as if they are doing physical activity (sailing, surfing, flying a plane, etc.). In the future, this might be a useful tool in the hands of a travel agency (Bauder and Freytag, 2015).

3. DISCUSSION AND CONCLUSION

When it comes to the influence of technology in tourism, the authors mainly agree that it is crucial to introduce new offers. They need to be enriched with available technological innovations. There is an agreement that the ever-demanding tourists will ask for a virtual experience in tourism. Specifically, this is because of the development of information technology.

Namely, the author Ognjen Bakić (2003) thinks that it is inconceivable to manage an offer if it is not based on modern computer technology. Also, the author Affe R. Braun (2019) maintains that the development of the communications system is creating a solution for the information flow to distant destinations by using complex devices that need to be handled properly.

The World Tourism Organization finds that those tourism types which have been established due to the influence of information technology are the interactive kiosks, armchair shopping, vacation channels, automated ticket and boarding pass, teleconferences, smart cards, interactive brochure, intelligent agents, man-made reservoirs, and virtual mobility (World Travel & Tourism Council, 2019)

On the other hand, the authors Michael Bauder and Tim Freytag (2015) think that the combination of computer and laser technology is a starting point for the animation and simulation technique – i.e. holography. Here, a tourist can travel virtually without leaving the comfort of their home.

The author of this paper has concluded that the analyzed authors dealing with the impact of information technology on tourism are right. He concurs that all business activities will be conducted differently because of these new interactive media, databases, and technologies which have been adjusted according to them. In addition, the management of offers in tourism will be far-fetched if one does not use modern computer technology.

This is going to be even more important because the upcoming interactive technologies will become crucial for the existence of a vast number of tourism companies. They will also start significant changes in the channels of distribution in the tourism industry.

However, the author of this paper wonders about the personal experience of a tourist. In other words, this gives rise to the following question: will the virtual trip, which excludes leaving the comfort of your own home, provide the same genuine experience in regards to traveling? Will it create the same feeling you get when you change the environment, touch the sand, or breathe the fresh mountain air?

4. THE STUDY LIMITATIONS

The primary limitation of this paper is the lack of literature which deals with this topic. Some information was obtained on the websites that talk about tourism. However, the data pertaining to tourism is changing rapidly so one should follow them so that an employee or a tourist could be acquainted with this area. Due to the length, we couldn't mention all types of tourism which are influenced by information technology (Krstić, 2012).

5. FINAL THOUGHTS AND THE POSSIBILITY OF A FURTHER RESEARCH

We can conclude that tourism is undergoing changes because of the impact of information technology. The analyzed types of tourism are connected with the increasing need of tourists for non-traditional vacation and the use of technology

in tourism – especially in communication. People demand virtual vacations and want to experience different destinations from their own homes.

The opportunity to connect with people on the Internet might revolutionize human information and communication behavior in the future. The new and developed interactive technologies will become important so much so that a company's destiny will depend on them. So it needs to be prepared to satisfy a future tourist.

We couldn't help but notice that the lack of papers on this topic might make those working in tourism disinterested in developing this industry which might have major consequences. Research should be aimed at things which will help us find answers to some of the questions, such as: what does a modern tourist find interesting? What do they desire, and which technological innovations they want to have during their vacation?

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BĂILE FELIX: A TOP ROMANIAN SPA DESTINATION

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Abstract: Spa tourism, one of the first known forms of tourism, has been maintained and developed over time, relying on the natural resources existing in an area. In Romania there has been evidence of the use of the thermal and thermal-mineral waters for therapeutic purposes since ancient times. One of the places with tradition in this respect lies in the north - western part of the country, being known as Băile Felix. The physio-chemical properties of thermal waters have led to the development of the resort and to its international recognition. The number of tourists registered in recent years has increased, being influenced by many factors.

Keywords: spa tourism, resort, thermal waters, tourists
JEL: L83

1. INTRODUCTION

Tourism is the activity that surprises by the annual increase of the number of people travelling for their own pleasure. Europe is and still remains in the top of tourists' preferences; in this regard several aspects can be noticed. Contemporary tourism in the world is manifested as an extremely significant spatial phenomenon. Tourism and a certain geographical space with their attributes become an inseparable concepts in the realization of tourism trends (Urošević *et al.*, 2018).

Sava & Stanujkić (2018) point out aspects that could influence European tourism: "Intensive promotion of tourism by each country; The emergence and increase of competition between different tourist destinations; The emergence of amusement parks with various themes; Increase in "low cost" flights' number and routes; Increase of the market share of large European tour operators; Desire to return to nature; European culture; Increase in the number of single people; High share of third-age population; Increase in the number of internet users; Existence of tourism sites."

"The WTO predicted a world record of 1.4 million tourists for 2020 and 1.8 million tourists for 2030. The motivations of the people that will contribute to reaching this number of tourists would be: satisfaction of hobbies (generally sports); enriching the knowledge in a field; discovering the ancestral birthplaces; faith and desire to see holy places; the attention paid to the state of health, to its maintenance or improvement; short-term relaxation, especially during the weekend; participation in various cultural events, congresses and sports events; the discovery of other until recently inaccessible destinations; the growing appreciation of the beauty of unpolluted nature; more frequent business trips; appreciation for traditional and specific gastronomy services" (Sava & Stanujkić, 2018).

People's need to treat their tiredness or various illnesses has led to the discovery of natural curative resources. Thermal waters have been appreciated since ancient times by Egyptians, Etruscan Carthaginians, Greeks, and Romans. The latter used to pay special attention and importance to these waters, setting up numerous baths. Testimonies of their use are found on the territory of several European countries such as Italy, Germany, Romania, Switzerland, France and Hungary, whose territories were part of the Roman Empire. In order to treat certain illnesses, the Romans used mud baths, showers and inhalations, so we can say they valued health and had enough knowledge in this field.

Spa tourism means the form of tourism that aims to treat, recover or prevent illnesses. The spa resort is the territorial administrative unit with therapeutic or climatic natural resources that have been scientifically proven and recognized for curative effects and in which accommodation, public catering, treatment, recovery or prophylaxis of some illnesses are available to the guests. Spa tourism is the travel of people of different ages, sexes and professions to spa resorts, with natural factors for health care, rest, cure with natural spa substances, rejuvenation, beauty or tourism (Ţigu, 2003).

The motivation of travel in the spa tourism has an important place, as there can be: prophylactic cure; therapeutic cure; and recovery cure. The natural resources used in the spa tourism are mineral waters, therapeutic mud, mofette, salines, and bioclimate. Their quantity and quality are decisive in the establishment and development of a spa resort and, implicitly, of this form of tourism. Over time, within the spa tourism, there was an evolution of the use of natural resources and applied procedures by defending the concepts of thermalism, crenotherapy, thalassotherapy, balneo therapy, balneo climatic therapy, spa, and wellness.

Spa tourism presents the following main features: the permanent practice of spa tourism without being influenced by seasonality, so it has a regular character; periods are medium and long; tourists are mostly elderly people; rates are lower, but compensate for the time spent in the resort; there is a need for specific

infrastructure and facilities for the proper conduct of recovery and health care activities; most tourists come from urban areas.

The main factors contributing to the development of spa tourism are: the current state of health of the population influenced by mutations in people's lifestyle, physical and psychological demands, pollution, inactivity, etc; the increase of the average life span; the concern over health care and disease prophylaxis; the preoccupation for maintaining beauty and youth. Having a relatively stable clientele, the spa tourism is considered to be one of the most constant forms of tourism.

The present tendency in the health and wellness tourism evolution is determined by the action of specific factors among which we mention: the deterioration of the health of the population, following the mutations in the lifestyle of the people, physical and mental stress, pollution, sedentary life, etc.; the increase of the average life-time as a cause of the reduction of the effort and adaptation capacity of the human body during the third age at the appearance of nutrition, cardiovascular, rheumatism affections; the increase of the individual and of the society interest for health care and disease prevention.

"The spa is the concept rediscovered and developed of what the Romans named „Salute Per Aqua" or „Sanitas par aquam". The original concept existed from the Romans time, but in Europe it only fell into place in the 17th century, when people understood the curative benefits of water, and it started developing by emphasizing prevention more than treatment.
The benefits of the spa are: providing a very good health condition; dynamism, good mood, high physical and mental tonus; increasing performances in work; increasing employee motivation; implementation and consolidation of the „Wellness" concept.
Wellness shows an equilibrium condition between body, mind and spirit, the term being introduced in the alternative medicine by Dr. Halbert L. Dunn. According to the National Wellness Institute in Wisconsin this is: „an active process in becoming aware and to make decisions towards a better existence" (1977). The objective of wellness is to reduce the effects of the physical, chemical and mental stress, so as to create a health state without medicine treatment. Both concepts emphasize the traditional, natural methods of cure and prevention of certain affections (Sava, 2012)."

2. SPA TOURISM IN ROMANIA

Romania is one of the European countries located in the northern hemisphere, in south-eastern Central Europe, more precisely, on the lower course of the Danube and on the north-west shore of the Black Sea.

Figure 1. *Map – Romania's location in Europe*

Source: http://www.harti.jurnaldevacanta.ro/harta_europa_mare1.php

Romania's surface is 23.8391km^2 plus the 23.700km^2 of the Black Sea platform. On its territory one can notice an almost equal distribution of the main landforms, namely 30% of the total area is plains, 35% mountain, and 35% hills together with plateaux. The Romanian Carpathians stretch on 910 km and form a ring in the interior of which lies the Transylvanian Depression. They present a series of fragmentations, and the maximum altitude is reached by the Moldoveanu Peak (2.544 m) from the Făgăraş Mountains, the Southern Carpathians. They „have several particularities that differentiate them from the other mountains in Europe", namely: Landscape diversity; Complexity; Accessibility; Remarkable speleological resources - over 10,000 caves (Sava & Stanujkić, 2018)". Romania's climate is a temperate continental transition with four distinct seasons, with an average annual temperature decreasing from south to north, as well as in altitude.

The hydrographic network is well represented; it has radial arrangement inside the country and circular on the edges, due to the arrangement of the main landforms. On Romania's territory we encounter both groundwater and surface waters (rivers, lakes, seas). The Danube, its lower course measures 1.075 km, is a state border with Serbia (235,5 km), Bulgaria (469,5 km), Republic of Moldova (0,6 km) and Ukraine (53,9 km) and it flows into the Black Sea through a delta, the Danube Delta. The Black Sea is an intercontinental sea; its

bordering countries are, apart from Romania, Bulgaria, Georgia, Russia, Ukraine and Turkey. The Romanian seaside stretches over 245 km.

Vegetation and fauna are varied, closely related to landform and altitude, with rare and endemic specimens. Throughout the country there are a number of natural and anthropogenic tourism resources that have led to the emergence and development of several forms of tourism, including leisure and recreation tourism, spa, seaside, mountain tourism, agritourism, religious, cultural, scientific tourism, etc.

Table 1. *Evolution of accommodation facilities (number)*

Indicator	Year 2000	Year 2010	Year 2015	Year 2016	Year 2017	Year 2018
Accommodation facilities in spa resorts	400	386	479	486	577	594
Accommodation facilities in seaside resorts, excluding Constanţa	764	1014	686	701	776	766
Accommodation facilities in mountain resorts	702	1038	1822	1878	2270	2374
Accommodation facilities in the Danube Delta area, including Tulcea	76	127	138	136	125	286
Accommodation facilities in Bucharest and the cities, excluding Tulcea	426	1063	1450	1433	1472	1545
Accommodation facilities in other places and tourist trails	753	1594	2246	2312	2685	2888
Total accommodation facilities	3121	5222	6821	6946	7905	8453

Source: www.insse.ro series of data Tempo Online

Classified accommodation facilities in Romania have experienced an appreciable increase in the last 18 years, practically reaching more than double. In the case of the existing accommodation facilities in spa resorts there was an increase, but a slower one. This can be justified by the number of existing spa resorts, the capacity of treatment facilities and the interest of the population in such destinations. At present, spa resorts account for 7,02 % of the total accommodation facilities in the country. The accommodation capacity in the spa resorts registered a decrease compared to the reference year 2000, due to the increased degree of comfort of accommodation facilities (Table 2). In 2018, the spa resort accommodation facilities accounted for 10.22% of the total number in the country.

Table 2. *Evolution of the accommodation capacity (number of beds)*

Indicator	Year 2000	Year 2010	Year 2015	Year 2016	Year 2017	Year 2018
Accommodation capacity in spa resorts	43186	36706	35342	35786	36631	36173
Accommodation capacity in seaside resorts, excluding Constanţa	119410	121003	83353	81635	80618	80665
Accommodation capacity in mountain resorts	35626	35426	55774	57282	63921	65025

Accommodation capacity in the Danube Delta area, including Tulcea	2485	4287	3907	3690	3890	7645
Accommodation capacity in Bucharest and the cities, excluding Tulcea	42617	71877	86565	85826	87901	91800
Accommodation capacity in other places and tourist trails	36681	42399	63371	64669	70759	72527
Total accommodation capacity	280005	311698	328313	328888	343720	353835

Source: www.insse.ro series of data Tempo Online

The natural resources that support the Romanian spa tourism are the mineral waters, both cold and warm, the therapeutic mud, the therapeutic gases, the therapeutic salts, the Black Sea coast and the bioclimate.

Existing mineral waters in Romania comprise almost all types of known waters (Table 3), with a great diversity in temperature, mineralization and chemical composition, representing 1/3 of the total thermal and mineral waters in Europe.

Table 3. *Therapeutical mineral waters of Romania*

Types of water	Variants of water	Example
Cold waters	- oligomineral	Călimănești, Căciulata, Olănești
	- alkaline and alkaline-earthy	Bodoc, Malnaș, Borsec, Zizin, Buziaș, Lipova
	- chlorine-sodium	Sovata, Praid, Ocna Sibiului
	- carbonated	Geoagiu Băi, Tinca, Vatra Dornei
	- sulphurous	Govora, Herculane, Pucioasa
	- sulphate	Vața de Jos, Amara
	- ferruginous	Tușnad, Biborțeni
	- iodine	Bazna, Olănești, Călimănești, Sărata Monteoru
	- arsenic	Șaru Dornei, Covasna
	- radioactive	Herculane, Sângeorgi Băi, Lipova, Băile Felix, Borsec, Tușnad, balvanyos, Slănic Moldova
Warm waters	- geothermal and thermal-mineral	Herculane, Băile Felix, 1 Mai, Moneasa, Geoagiu Băi, Călan, Călimănești
Therapeurical lakes	- salty, flatland, shore	Techilghiol, Amara, Lacul Sărat, Ocna Sibiului, Balta Albă, Ursu

Source: Master-Plan for the development of spa tourism phase I and II page 5

Therapeutic muds are of three types: sapropelic (Amara, Salt Lake, White Balt, Techirghiol, Sovata, Ocna Sibiului), mineral (Govora, Geoagiu Bai, Turda, Sărata Monteoru, Săcelu, Bazna), and peat (Poiana Stampei, Mangalia, Imeni).
The therapeutic gases are in the form of mofette, present and used in external cures in Tușnad, Balvanyos, Borsec and Buziaș resorts and in the form of sulphation (Turia - Pucioasa Cave, Băile Harghita). Salines for therapeutic

purposes in Romania are Praid, Turda, Târgu Ocna, Cacica, Slănic Prahova. The natural therapeutic factors of the Black Sea coast that lead to free balneotherapy are the waves, sand and marine aerosols.

Bioclimate supports the main therapeutic factors and is based on atmospheric circulation, solar radiation, temperature, humidity, aero ionization, geomagnetic field, microclimate of salines and caves. Taking these bioclimatic factors into consideration, we highlight throughout the country all the types of bioclimate encountered in Europe (Table 4).

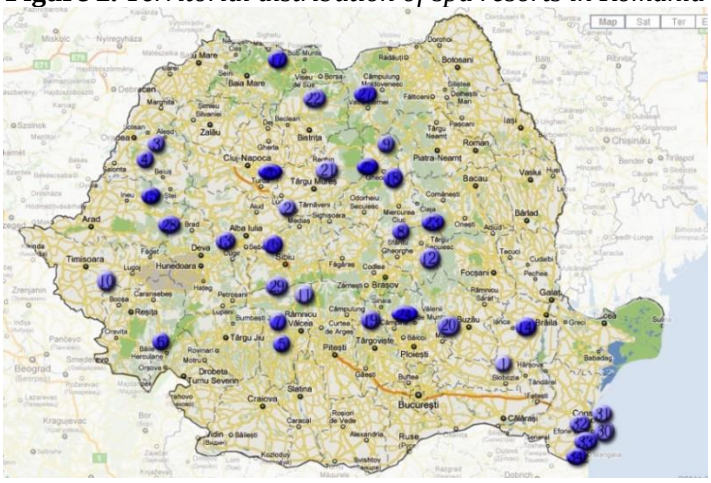
Table 4. *Types of bioclimate in Romania*

Type of climate	Type of bioclimate
mountain	- tonic - incentive
hills and plateaus	- relaxing - sedative
plain	- exciting - demanding
marine	- exciting - demanding
microclimate from salines and caves	- interior microclimate with constant temperatures

Source: Master-Plan for the development of spa tourism phase I and II page 6

The territorial distribution of the spa resorts in Romania is predominant in the mountain and sub-mountian areas (Figure 2).

Figure 2. *Territorial distribution of spa resorts in Romania*



Source: https://statiunibalneare.wordpress.com/harta-balneo/

Spa resorts can be classified using different criteria, such as geographical location, territory, spa-climatic resources, use profile, area of interest. (Table 5).

Table 5. *Classification of spa resorts*

Classification criterion	Type of resorts
Geographic location	- mountain and depression; - hill; - plateau; - plain; - seaside;
Territory	- isolated; - mixed up with the locality; - occupy a well-delimited area in the locality; - nuclei within the locality; - neighbouring the locality;
Spa resources	- spa; - spa-climatic; - climatic;
Use profile	- with complex profile; - with mixt profile; - with specialized profile;
Area of interest	- local; - national.

Wellness and spa resorts can be classified, as shown in table 6.

Table 6. *Types of wellness and spa resorts*

Classification criterion	Type of wellness and spa resorts
- on a general scale	- of great tourist interest (international level); - of tourist interest (national or regional level); - of low tourist interest (regional or local level);
- on pathology profiles	For illnesses: - of the locomotor system; - peripheral neurological system; - cardiovascular; - respiratory and ENT; - of the digestive and hepatobiliary systems, and illnesses of the kidney and the urinary system; - gynecological; - nutrition and metabolism; - dermatological; - professional illnesses.

Source: Sava (2014)

The development of tourist activity on Romanian territory is regulated, and in the case of spa tourism the Government Decision no.852 of August 13, 2008 approves the norms and criteria for the attestation of tourist resorts, published in the Official Gazette no. 613 of August 20, 2008, as well as the Government Order no. 415 of September 5, 2016 for the modification and completion of the Methodological Norms regarding the issuance of certificates for the

classification of the tourist accommodation establishments with functions of accommodation and public catering, licenses and tourism certificates, approved by the Order of the President of the National Authority for Tourism no. 65/201 and published in the Official Gazette no. 708 of September 13, 2016.

In order to certify a tourist resort there are groups of mandatory minimum criteria regarding: the natural setting; natural factors of cleanliness and environmental quality; access and roads to / in the resort; urban and public utilities; tourist information and promotion; and other additional criteria.

"The balance between the tourist and urban functions of wellness resorts needs a careful process of territory organization and management as many of them have become towns.

Considering the configuration of the areas and the requirements of urbanism more solutions of equipment placement are distinguished, having localizations: as „chess board" (the tourist and wellness equipment alternate with the urban equipment, being the simplest form of space organization); as „spider web" (gives the advantage of a focus point of activities); radio-centric (represents the most evolved method of wellness arrangement, it has a circular or amphitheatre placement, being present in the new resorts).

The minimum compulsory conditions of bordering a place in the wellness resort category are the existence of exploitable mineral substances, technical equipment necessary for their extraction and use, accommodation capacity, public food, treatment and leisure as well as arrangements, minimum urban equipment. According to the International Federation of Hydrotherapy and Climatology (FITEC), that activates at international level for the classification of these resorts on categories (I, II, III), we must follow a series of eight criteria as we can see in table 7.

Table 7. *Classification criteria of wellness resorts*

No.	Criterion	Minimum compulsory points		
		Category I	Category II	Category III
1.	Quality and quantity of natural factors	20	18	15
2.	Comfort and functionality of material basis	20	15	10
3.	Organization and equipment of wellness medical care	20	15	10
4.	Quality of equipment and urban arrangements	20	10	5
5.	Organization and materialization of environmental and specific protection	20	17	15
6.	Organization and equipment of wellness parks and leisure spaces	15	10	5

7.	Cultural, commercial and administrative organization and equipment	20	15	5
8.	Accessibility, means of transport	15	10	5
	Total	150	110	70

Source: FITEC (1978).

Thirty-seven national interest tourist resorts and forty-six local interest tourist resorts were attested at national level. The first criterion, the quality and quantity of the mineral substances, comprises data about mineral waters, therapeutic mud, mofette gas, salt mines, as it can be noticed below:

- **Mineral waters:**
  - From a qualitative point of view:
    - total mineralization;
    - content of minimum necessary chemical elements;
    - content of dissolved gas;
    - emergency temperature;
    - osmotic pressure;
    - radioactivity;
    - therapeutic indications;
    - morbidity incidence.
  - From a quantitative point of view:
    - homologated reserves;
    - reserves in the B and C balance category.
- **Therapeutic mud:**
  - From a qualitative point of view:
    - density;
    - pH;
    - rH coefficient (oxide-reduction potential);
    - specific warmth;
    - texture;
    - resistance to slipping;
    - content of organic substance;
    - discomposure degree of peat;
    - mineralization and ionic composition of the soaking solution;
    - content of hydrogen, sulphate and sulphides;
  - From a quantitative point of view:
    - homologated reserves;
    - reserves in the B and C balance category.
- **Therapeutic mofette gas:**
    - content of CO_2;
    - content of H_2S;
    - content of other gas;
    - radioactivity.
- **Therapeutic salt mines:**

- thermo-hydro-baric indicators;
- air quality indicators;
- physical indicators;
- air ionization;
- concentration of aerosol particles;
- radioactivity;
- content of gas (CO_2,F_2S, N_2, O_2, SO_2);
- content of chemical elements (Na, Cl, K, Ca);
- microbiological indicators (air-microsphere, fungi).

As for the comfort and functionality of the material basis we focus on:

- **Accommodation:**
  - unit type;
  - number of rooms;
  - number of places;
  - comfort category (from 1 to 5 stars);
  - physical and moral depreciation degree;
  - number and structure of staff;
  - qualification degree of staff.
- **Public food service:**
  - unit types;
  - number of table places;
  - comfort category (luxury, I, II, III);
  - physical and moral depreciation degree;
  - number and structure of staff;
  - qualification degree of staff.
- **Treatment:**
  - unit type;
  - capacity;
  - number of basic procedures;
  - number of adjuvant procedures;
  - types of equipment;
  - physical and moral depreciation degree;
  - number and structure of staff.
- **Leisure:**
  - types of equipment;
  - capacity;
  - physical and moral depreciation degree;
  - number and structure of staff;
  - period of use.

When ensuring and equipping the wellness medical care we take into consideration the following elements: the cure pavilion; the cure hotel; the number of doctors; the interdisciplinary expert teams; the wellness clinic; EKG service; the radiology cabinet; the emergency cabinet; the physiotherapy service;

the electrotherapy service; the massotherapy service; the medical recovery service; the nutritional services; the additional medical services.

For the criterion regarding the quality of urban equipment and arrangements we must take into consideration: the communication and transport ways; the water supply; the sewerage system; the heat and gas supply; the electrical energy supply; the sanitation; telecommunications. Another criterion, the structure and materialization of environmental and specific protection has in view: the sanitary protection perimeters; the geological protection perimeters; nature preservation; the space of the resort.

The coordination and equipment of wellness parks and leisure spaces provide: therapeutic parks; field cure tracks; arrangement and equipment of aerosols; arrangement and equipment of marine beaches. The cultural, commercial and administrative organization and equipment criterion takes into consideration: the existence of a club, cinema, theatre, library, museum, disco; the commercial equipment; the administrative equipment.

Important in the classification of a resort is the last criterion, the one regarding the accessibility and transport means that takes into consideration: roads; railroads; distance from the airport; water ways. The technic-material basis of resorts with this profile comprises accommodation units, public food services, leisure and treatment. The latter can be found either solitary (independent constructions, specific to the beginning periods), or integrated in the accommodation units (tourist complexes). Various compartments can function within the cure bases like kineto, electro, hydro, mechanic, pneumo therapy, all equipped with the necessary installations (Sava, 2012)."
At national level, 37 tourist resorts of national interest and 46 tourist resorts of local interest have been certified. The number of tourists arriving in these locations is increasing (Table 8), but still low, accounting for only 7.73% of the total arrivals at national level.

Table 8. *Evolution of the number of tourists in spa resorts (no. of persons)*

Indicator	Year 2000	Year 2010	Year 2015	Year 2016	Year 2017	Year 2018
Number of tourists in spa resorts	677495	568257	779325	851040	945257	1018721
Total tourist arrivals in Romania	4920129	6072757	9921874	11002522	12143346	12905131

Source: www.insse.ro data series Tempo Online

There is a tendency to increase the total number of tourists in Romania, as well as of those who choose the spa resorts in the country. It can be said that the interest in restoring and preserving the state of health is real, even if the

accommodation capacity is low and in large part in low category accommodation facilities - 2 and 3 star hotels.

3. BĂILE FELIX

Bihor County, whose surface is 7.544 km2, is located in the north-western part of Romania, along the Crişul Repede and Crişul Negru rivers. It is a border county, thus in the western part it is bordered by Hungary. This county has a great tourist potential, both natural and anthropogenic. Băile Felix Resort is located in the north-western part of Romania, in the Crișului Plain, at an altitude of 140 m in a hilly area with beech and oak forests, at a distance of 8 km from Oradea - the Bihor county residence and at a distance of 22 km from Borș border. The GPS coordinates of the resort are 46^0 99" 44" North latitude and 21^0 98' 53" East longitude. The climate is temperate continental, with mild winters and summers free of excessive heat, low rainfall and low intensity winds, while the bioclimate is a sedative one.

A proof of the existence of the thermal waters near the Oradea Citadel is a Vatican Diploma of 1221, where they are named Termae Varadienses. Humanist Nicolaus Olahus reminds us of the beneficial effects of these waters in his writings (Hungary - about Romanians) from 1536. According to the Monasteriologia regnii Hungariae, between 1700 and 1721, the monk steward of the Sânmartin monastery, Felix Helcher, discovers and uses a geothermal water spring, the Felix spring. The first analysis of the thermal waters in order to know the curative properties was made in 1731. Since 1763, a doctor's notes have been kept regarding the construction of a wooden basin for bathrooms, which in 1771 is replaced by a stone one, besides which they built bathrooms. One year later, the first bathroom building (1766 -1772) was completed and the hotel was inaugurated in 1832. The development of Felix resort begins in 1885, after the first modern drilling, the Main Spring. The resort has as its symbol the lotus flower discovered by the botanist P. Kitaibel (1789), declared a monument of nature in 1931. The international recognition of the curative effects of the waters of Băile Felix resort took place in Budapest in 1896, at the "International Millennium Exhibition", the Golden Diploma and the Diploma of Honor.

According to the analyses carried out by the specialists of the Mineral Waste and Therapeutic Mud Laboratory, mineral waters in the territory of the resort are oligomineral, hypotonic and thermal, low radioactive (Table 9).

Table 9. *Physio-chemical indicators of the waters in Băile Felix*

Indicator	u.m.	Balint Spring	Probe 4087
Temperature	^0C	49	38,2
pH	Unit.pH	7	7
Cl	mg/l	7,1	11,1
SO_4^{2}	mg/l	251,7	165,4
HCO_3	mg/l	405,7	451,4

Na	mg/l	55,3	83,8
Ca^2	mg/l	147,2	121,0
Mg^2	mg/l	26,9	17,5
Rn	pCi/l	390	160
Mineralization	mg/l	986,7	865,8

Source: S.C. Turism Felix S.A (processed data), 2011.

In Băile Felix resort the following groups of diseases are treated by external cure: degenerative rheumatism; biologically stabilized inflammatory rheumatism; abarticular rheumatism; post-traumatic injuries of the locomotor apparatus; chronic peripheral neurological affections; chronic gynaecological diseases; metabolic and nutritious diseases. The procedures used to treat these diseases are: physiotherapy; hot baths in bathtubs and pools; electrotherapy; hydrotherapy; aero heliotherapy in thermal water pools; medical gymnastics; baths of light; aerosols; sauna; cosmetics; baths and mud wraps. This resort has accommodation facilities of various categories, which meet the needs of tourists. The annual evolution of the accommodation facilities in Băile Felix and the tourists accommodated in this resort (Table 10) is clear, not including the data from Sânmartin commune, the villages under its administration and the 1 Mai resort. Over the past six years, smaller (pensions) or bigger (hotels) accommodation facilities have been built at a fast pace.

Table 10. *Evolution of accommodation facilities, beds and tourists in Băile Felic resort*

Indicator	u.m.	2010	2015	2016
Accommodation facilities	Number	31	74	77
Accommodation capacity	Number of beds	3650	4740	4894
Tourists	Persons	81065	123706	151598

Source: Statistical data base of Băile Felix resort and Sînmartin commune

In 2016 there were 77 accommodation facilities on the territory of the resort, to which 25 locations were classified into rooms for rent at home to authorized persons. The number of rooms available in the 77 accommodation facilities was 2.605, the existing capacity being 4.894 beds. Most of the accommodation facilities (3.480 facilities, i.e. 71.11% of the total number of beds) are in the 14 hotel accommodation facilities. They are rated from 2 to 5 stars, thus meeting the requirements of the various tourists. The number of hotels classified as 2 stars (lower category) is three, and they are older hotel units, those classified as 3 stars, the most numerous, is eight, they are addressed to middle-income people. There are only two hotels classified as 4 stars in Băile Felix and one single rated 5 stars hotel for those with high incomes (table 11).

Table 11. *Accommodation facilities – hotels in Băile Felix*

Name of hotel	Classification - no. of stars	No. of beds
Mureş	2	650
Someş	2	344
Unirea	2	292
Ami	3	56
Hyperion	3	117
Nicoleta	3	32
Nufărul	3	148
Padiş	3	392
Poeniţa	3	302
Termal	3	303
Vital	3	58
International	4	340
President	4	184
Lotus Therm	5	262
Total	14	3480

Source: Băile Felix data base

In 2016 the average stay in the resort was 7.5 days, and the occupancy rate was 63.65%. A monthly distribution of tourists arrived and accommodated in 2016 (Table 12) highlights the fact that August is the most requested month and the least demanded month is March.

Table 12. *Monthly distribution of the tourists arrived and accommodated in Băile Felix in 2016*

Month	No. of tourists
January	8444
February	8550
March	7186
April	9490
May	11734
June	14073
July	18685
August	23097
September	17290
October	13204
November	11234
December	8611

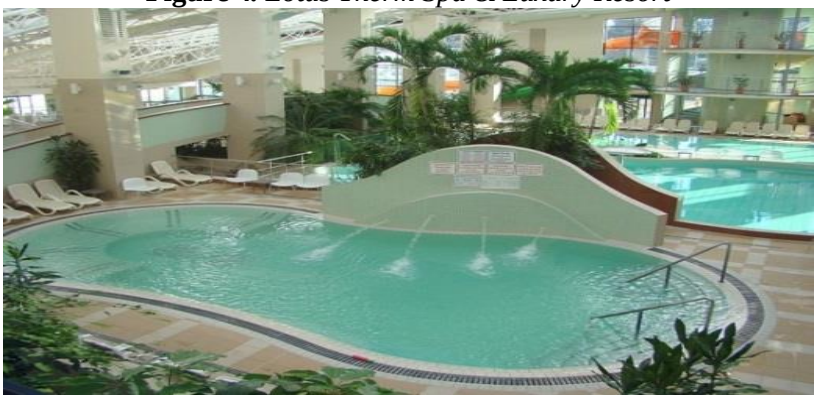
Source: Băile Felix data base

In 2016, the proportion of tourist arrivals in Băile Felix accounted for 36.81% of the total number of registered tourists (411823 tourists) in the Bihor County. In the same year, there were 851.040 tourists in the spa resorts in Romania, the tourists from Băile Felix contributing with 17.81% to this figure. The tourists arriving at this Romanian resort have at their disposal the Apollo Pool with 4 pools (figure 3), Felix with a total of 6 pools and Padiş with 3 pools, the pools of the existing hotels, the Aqua Park President complex and the Lotus Therm Spa & Luxury Resort (figure 4).

Figure 3. *Apollo Pool*

Source: https://www.felixspa.com/ro/

Figure 4. *Lotus Therm Spa & Luxury Resort*



Source: https://www.felixspa.com/ro/

On the territory of Băile Felix resort, tourists can also enjoy the lakes with water lillies and lotuses, turtles and exotic fish, the special Baroque architecture of a monastery of Saint Vincent built in the 18th century, which now houses a pharmacy, the Orthodox church from Brusturi (figure 5) built in 1785, which was moved to the center of the resort and declared a historic monument (IMI code BH-II-mB-01104), dedicated to the Archangels Mihail and Gavriil, and the Greek-Catholic wooden church with the dedication of the Holy Spirit (figure 6).

Figure 5. *Băile Felix Orthodox Church*

Source: https://pensiuneadory.wordpress.com/obiective-turistice/biserica-ortodoxa-din-lemn/

Figure 6. *Băile Felix Greek-Catholic Church*

Source: https://ideal-escapes.com/project/bihor/

The tourists who want to know the whole area, i.e. Sînmartin commune, can enjoy the 1 May resort, where the 107-year-old pool is located, the "Peţa Pârâu" Nature Reserve, which shelters three protected natural species: Nymphaea Lotus Thermalis (unique variety in Europe, the relic of the tertiary era), the fish of the „Roșioara lui Racoviță" (endemic species) and Melanopsis Parreyssi snail

(glacier era survivor), the Betfia Abyss or the 'Hudra Bradii' Abyss on the Șomleului hill, the churches in the villages under the administration of Haieu (the 14th-century chapel) and Rontău (the Orthodox church from the 15th century). Băile Felix Resort offers tourists the opportunity to spend a pleasant stay throughout the year, in which the old, the traditional and the modern blend harmoniously in a green, peaceful natural environment, whose forests maintain a clean and less polluted air.

CONCLUSIONS

The role of spa tourism is becoming increasingly important, both nationally and globally, especially under the current conditions, where it is desirable to gradually and wherever possible replace allopathic treatments with natural treatments. Another trend is linked to the attempt of preventing the onset of illness and the maintenance of health, not just to treat. The demand for the wellness component has a positive evolution. In Romania, there are many natural resources for the development of spa tourism, but only a few of them are exploited and there are few locations where there is a specific, modern material base and quality services. To improve this situation, there is a master plan at national level that runs until 2020. Băile Felix resort is one of the traditional spa resorts in Eastern Europe. Its location gives it easy accessibility and the climate supports the activity throughout the year. The waters are oligomineral, hypotonic and thermal (410-490C), slightly radioactive, which have beneficial effects on several illnesses. In the resort there are accommodation facilities, public catering, leisure, spa and treatment for both low-income and high-income people. The 63.65% occupancy rate of the resort in 2016 is acceptable, above the occupancy rate recorded in the same year in Romania, which was 30.5%, but it must be improved in the future. Increasing the number of Romanian and foreign tourists in Băile Felix resort is possible by offering higher quality services with lower tariffs, more aggressive promotion, renovation of obsolete technical and material base, employment of skilled labor force and sustainable use of thermal waters.

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APPELLATIONS OF GEOGRAPHICAL ORIGIN IN FUNCTION OF NATIONAL ECONOMY POSITIONING

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Abstract: The scientific justification of this paper is reflected in the fact that the field of protection of appellations of geographical origin in function of positioning of the national economy, is insufficiently or very little studied in our economic theory. The protection of appellations of geographical origin worldwide mainly refers to agricultural and food products and the leading countries in the number of registrations of appellations of origin are: France, Italy, Islamic Republic of Iran, Czech Republic, Bulgaria, etc. Considering that the protection of appellations of geographical origin in Serbia is mainly related to agricultural and food products, and the fact that we have 60 domestic and only 3 internationally protected appellations of origin, these could be used as a powerful tool to support the growth of exports in agriculture of certain regions as well as of the entire country. Appellations of geographical origin have a collective ownership and represent a kind of national resource.

Keywords: appellations of geographical origin, appellations of origin, intellectual property, positioning, agricultural products
JEL: 031, 034, 038

1. INTRODUCTION

At the time of economic globalization the tradition and proven values are gaining more and more importance. Therefore, when promoting the quality of a particular product in the market it is insisted on specific natural factors or traditional production method which is used in the area from which the product originates and which give a special, specific quality to that product.

Products that bear the appellations of geographical origin, the protected products enjoy certain competitive advantage compared to the same kind of anonymous products. Thus, the reputation gained thanks to the natural conditions and the skills of people of a particular region, contribute to an increased demand for

these products, and have a strong economic impact. Therefore, the protected appellations become a significant competitive tool between the products of the same or similar types and encourage market competition between the different manufacturers of the same type of product.

According to (Simin *et al.,* 2016), appellations of geographical origin as an integral part of intellectual property rights could become the main promoters of the Serbian economy and the country's expression of identity because the notion of quality of products is directly transmitted to the country's reputation. Export promotion with an emphasis on non-price forms of competition, such as constant quality of the product, health safety of the product, visual identity of the product, collective trademarks and appellations of geographical origin are the imperatives of modern business. A product bearing appellation of geographical origin acquires significantly greater reputation in the international market, and also achieves a higher price than anonymous product. In Serbia there are many unprotected nationally recognizable products that should be protected in the near future such as: Valjevo raspberry, kajmak from Zlatibor, Pester Lamb and others

2. DATA SOURCES AND METHODOLOGY

This paper does not deal with the analysis and proposal for improvement of laws and legal regulations in the field of intellectual property, although they have been kept in mind throughout the paper. Regarding to (Simin *et al*., 2016) the protection of appellations of geographical origin in Serbia is an area of law which is harmonized to a very large extent with the European Union and the TRIPS Agreement (Agreement on Trade Related Aspects of Intellectual Property Rights). Due to the fact that the laws in this area are relatively recent, today we can talk about the work related to continuation of harmonization. The problem of our economy is the low level of protection of domestic and especially international appellations of geographical origin, and consequently the lack of awareness and willingness of economic entities to implement and enforce the law from this field.

The scientific justification of this paper is reflected in the fact that the field of protection of appellations of geographical origin in function of competitiveness of the national economy, is insufficiently or very little studied in our economic theory. This research offers a very objective presentation of the situation because the entire analytics is based on the actual data from the public registries of the Intellectual Property Office of the Republic of Serbia and the World Intellectual Property Organization (World Intellectual Property Organization - WIPO).

From general scientific methods for processing quantitative data we used statistical methods and modeling method. Through statistical analysis we explained the structure, dynamics, mutual conditioning and impact of protection of appellations of geographical origin on enhancing competitiveness through the

increased export volume of agro-industrial complex in our country and abroad. Given that this research deals with phenomena from the sphere of social sciences and in order to explain certain facts, trends and to check certain positions we also used the method of modeling to establish a connection and to determine the importance of the protection of appellations of geographical origin for the growth and development of the economy as a whole (Simin *et al.,* 2016).

From the special scientific methods we used the method of analysis and synthesis for the comparison of development of the national competitiveness by the subject of appellations of geographical origin protection and geographical coordinates (Serbia and the member countries of the Lisbon Agreement for the Protection of Appellations of Origin) in the period from 1958 to 2018. The most frequent forms of analysis in this paper are: structural, functional, genetic and comparative analysis.

3. THE SUBJECT OF PROTECTION

While trademarks refer to a company that sells one particular product on the market, the appellations of geographical origin point to a geographical area whose reputation, quality or similar characteristics are attributable to that particular place of origin. Regardless of difference in the subject of protection, appellations of geographical origin are similar to trademarks by its effect and power, and can be used to support regional and national economic development, and also as part of the marketing strategy of the economy for the promotion of its products (Simin *et al.,* 2016).

Legal protection for appellations of geographical origin shows the interdependence between specific qualitative characteristics of the product or services and production areas (climate, soil composition, water, etc.). Agricultural products are conditioned by the qualities that originate from the place of production and are most influenced by local factors such as climate, soil composition, water and others. This indicates that the subject of protection cannot be a appellations of geographical origin which has no relation to the actual place of origin of goods.

Regarding to the protection conditions, only small countries are acceptable as a protected name, such as 'Cuba' for tobacco or 'Ceylon' for tea. A geographical indication communicates to consumers that a product is manufactured in a particular place and that it has certain desirable characteristics that can only be found in that place.

The subject of protection is appellation of geographical origin, actually the name of a certain geographical area. The geographical area may be a settlement, mountain, forest, highland, island, region, but also the entire country. Examples of this are numerous, appellation ”Champagne” in France is registered for the

sparkling wine produced in the French province bearing the same name, appellation ”Cognac” in France is registered for the type of brandy that is produced in the homonymous town and its surroundings, appellation ”Roquefort” is registered in France for the type of cheese that is produced in the homonymous town and its surroundings, appellation ”Tequilla” is registered in Mexico for the type of cactus brandy that is produced in the homonymous town and its surroundings (Markovic, 2000).

According to (Simin *et al.*, 2016), protection of product by appellations of geographical origin makes sense only if prevents such product from becoming generic or commonly known name of the product on the market and if prevents use by the unauthorized users.

4. ECONOMIC IMPORTANCE OF PROTECTION

Regarding to (Savić & Đurić, 2010) in the European Union, the total annual turnover in trade of products with protected geographical origin is about 40 billion Euros. Some countries within the European Union in recent years significantly lead in trade of these products. France reached a turnover of around 19 billion Euros in over 138,000 enterprises engaged in the production and trade of these products. Almost 84%, or 16 billion Euros of total turnover is generated from the sale of wine and other spirits, 85% of the total quantity of wine that is exported from France, bears the protected geographical origin. The rest of the total turnover of exports of products with protected geographical origin, 16% or EUR 3 billion is generated from other food products. Italy achieves a turnover of 12 billion Euros from the sale of products with protected geographical origin, and Spain almost 3.5 billion.

Appellations of geographical origin help producers to obtain a premium price for their quality products made in accordance with traditional methods in specific places but also facilitate a better redistribution of the added value in the production chain: from the raw-material producer to the manufacturer. A study conducted on French products shows that the average price difference between products with and without appellations of geographical origin is about 30% for cheese and up to 230% for wines, the price of a liter of milk destined for the production of cheese with a appellations of geographical origin is twice as highs as the price of milk for other cheeses (GI and challenges for ACP countries, www.agritrade.cta.in).

The economic importance of appellations of geographical origin is multiple:

- They are used as part of the marketing strategy for the promotion of products of the country or region.

In support of this claim (Idris, 2003), the Australian wine experience is a good example of the strategic use of appellations of geographical origin to promote the local industry. Australian wines have grown in popularity over the last 10 to 15 years and have gained a reputation for their high quality and good taste. This

reputation led Australia to conclude a wine contract with the European Union, as well as to the implementation of legislation for the protection appellations of geographical origin. One wine company used a 'marketing badge' as an Australian wine label to speed up its exports to the UK from 5,000 boxes in 1986 to 1 million boxes in 1994. It was named the UK's best-selling wine appellations of geographical origin in 1995, exceeding even French and California wines.

- Consumers sometimes more value regional specialties.

This statement is especially true for gourmet food products, so consumers are willing to pay a higher price. For example: Olive oil protected by appellation of origin ”Riviera Ligure” is being sold 30% more expensive from an anonymous olive oil. Free range chickens and fed by natural food, and three weeks before slaughter cereals and dairy products are added in their food, protected by appellation of origin ”Poullet de Bresse” have a four times higher price than industrial-reared chickens (Markovic, 1999).

- Appellations of geographical origin have collective owners because all producers, inhabitants of a particular area have the exclusive right to use certain geographical indications since they are a powerful tool for regional and national development.

Evidence to this claim is an example of the collective trademark ”Melinda ®” which is protected in 1989 and in 2003 grew into a appellations of origin ”Val di Non apples”. Awareness of the importance of the trademark protection appeared in the 80s, when the producers of apples from Val di Non found that in the Italian market three times more apples known as Val di Non apples had been sold annually compared to the amount they produce. This was the reason of foundation of Melinda Association which gathered all producers of apples from Val di Non, using traditional manufacturing techniques, advanced packaging techniques, modern marketing techniques etc.

Melinda Association specializes in producing and selling apples from 16 cooperatives with approximately 5,000 members whose annual output is 300,000 tons of apples, which represents 60% of total production in Trentino area, 10% of production in Italy and 5% in the European Union. Consumers recognize the appellations of geographical origin which indicate qualitative connection between the product and production area. One quarter of production is destined for export and turnover of Melinda Association increases by 200 million Euros per year (Melinda: The First Italian Designer Apple, www.wipo.int).

A product bearing the appellation of geographical origin is synonymous with quality in the market. Quality of a product is determined by its natural properties, as unpolluted water or soil, mild climate and the knowledge and skills of people from that area. Appellations of geographical origin opens a free market competition between the different manufacturers of the same product

types and thus contributes to increasing the competitiveness of domestic products.

5. SOURCE OF LAW AND TERM

At the beginning of the twentieth century, in France, a country famous for its production of high quality wines, suffered an epidemic of phylloxera which destroyed the entire grapevine. Wine producers from Spain and Italy took advantage of the situation to sell their wines with the appellations of geographical origin of France in order to achieve a higher price due to better quality of French wines at that time (Simin, 2011).The Association of French winemakers, after several years of efforts to recover vineyards made a decision to protect the quality of French wines and established appellations of geographical origin as a form of intellectual property. Legal regulations defining appellations of geographical origin are the newest in the evolution of the legislation that protects intellectual property rights. France was the first country to establish the protection of appellations of geographical origin as a form of intellectual property.

The result of these phenomena is a need to protect appellations of geographical origin, as an integral part of intellectual property rights by acts of international character, such as the Paris Convention and the Madrid Agreement for the Repression of False or Deceptive Indications, and later the Lisbon Agreement for the International Registration of Appellations of Origin, which Yugoslavia ratified in 1999.

In our legal system, appellations of geographical origin as a special type of intellectual property rights are regulated for the first time through the Law on the protection of inventions, technical improvements and distinctive signs of 1981. According to this law, there is only one category of rights - the indication of source of goods. The Law on Appellations of Geographical Origin of 1995 established two categories of appellations of geographical origin: appellation of origin as a qualified indication and geographical indication as a weaker indication (Simin *et al.*, 2016).

Regarding to (Dragojevic, 2014), Law on Appellations of Geographical Origin from 2010 year also stipulated two rights: appellation of origin and geographical indication, but compared with the previous law this was more compliant with the TRIPS Agreement (Agreement on Trade Related Aspects of Intellectual Property Rights). According to the Law on Appellations of Geographical Origin in 2018, the definition of geographical appellations is in accordance with the definitions of the EU Regulation 510/2006.

The Law on Appellations of Geographical Origin defines Appellations of geographical origin as rights that protect the appellation of origin and

geographical indication which designate the products produced by natural or legal entity within a specific geographical area. Thus, appellations of geographical origin are used to mark natural, agricultural, food and industrial products, traditional handicrafts products and services (Law on Appellation of Geographical Origin, 2018). Also, appellation of geographical origin used by more authorized users may be subject only to a collective trademark. In practice, collective trademark is often the first step towards establishing appellations of geographical origin (Manigodic, 2001).

According to the Law on Appellation of Geographical Origin, (Simin *et al.*, 2016) there is a difference between the appellations of origin and geographical indications. Appellation of origin is geographical name of a region, locality, or country used to designate a product originating therein, the quality and specific characteristics of which are due exclusively or essentially to the geographical environment, including natural and human factors, and such product is produced, processed and prepared entirely within a specific geographical area. (eg. Honey from Homolje, Pirot carpet, Petrovska sausage, etc.).

The essence of this type of protection through appellations of geographical origin is that all stages in the production process of the product (from the raw materials to manufacturing, packaging and labeling) take place in a defined geographical area. Only the product protected in this way can be protected through the Lisbon Agreement in another 28 countries, out of which 7 are member states of the European Union.

Geographical indication is an indication (Simin *et al*., 2016).which identifies particular good as a good originating from the territory of specific country, region or locality within such territory, where a given quality, reputation or other characteristics of such good can be essentially attributed to its geographical origin, and such good is produced and/or processed and/or prepared within a definite geographical area. The conditions for protection are less demanding. It is enough to fulfill only some of the requirements, for example Jelen beer from Apatin, Bezdanski damask and others.

According to (Marković *et al*., 2013) successful national policies of economic development and youth engagement include, besides the involvement of public authorities, the activism of young people in a process through which they have to do something positive for themselves. To overcome this situation, it is necessary to create prerequisites for development and the most complete achievement of young people in the sphere of economics and entrepreneurship.

Appellation of origin is more complex from the standpoint of intellectual property protection of geographical indication, as it includes mandatory submission of study when submitting application for the protection to the Office.

The study proves that a product produced in a particular geographic area actually meets the criteria, particularly in terms of quality and other set forth characteristics conditioned by geographic environment where production of the protected product takes place. In accordance with the foregoing, the products protected by appellation of origin require a constant control by the competent authority specified in the application which deals with the quality control of the concerned product.

One such appellation of origin is Prosciutto di Parma or Parma ham. For ham to receive the Parma name, it must be produced in the province of Parma – in the Emilia-Romagna region of north-central Italy – using exclusively pigs from that area. Each step in production, from the breeding of the pigs and their diet through processing to the final packaging, is closely monitored and controlled by the Istituto Parma Qualità. Only the Istituto can brand the finished ham with the seal of Parma's five-pointed ducal crown, qualifying the ham as true Parma ham (Famous Appellation of origin, www.wipo.int).

The aim of the Study is to define rules for achieving specific quality, and these rules are intended for manufacturers in the designated area of production. Therefore the Study must describe the special characteristics of the products with appellation of origin, which exist due to the geographical origin of the product, and thus justify the link between the product and the specific territory.

The described procedure, according to (Simin, 2005) can be illustrated by the example of Kladovo caviar where in the description of the geographical area one part of the Danube River is specified or the part of the Danube from 845 km to 1800 km. The line ministry has agreed that for this purpose can be used the zone of the Danube River and fishing farm "Kladovo" in order to control the amount of fish catches in order to protect the environmental conditions and prevent abuse and poaching. The study on method of production of Kladovo caviar contains a detailed description of the species (beluga, sturgeon, starry sturgeon-sterlet) and the method and procedure of production of the product, which can be considered as some sort of business secret.

The goal of establishing an appellation of geographical origin by the natural or legal entity is to become an authorized user of appellation of geographical origin. Once established the appellation of geographical origin lasts indefinitely, and the status of authorized user of a particular appellation of geographical origin is renewed every three years from the date of entry of the authorized user into the relevant register.

6. PROTECTION OF DOMESTIC APPELLATION OF GEOGRAPHICAL ORIGIN

Appellations of geographical origin are especially important for developing countries such as Serbia, (Simin *et al*., 2016) where the greatest part of the export structure is maintained by agricultural food products for which these appellations have a crucial role as a form of non-price competitiveness. Manufacturers and local people can benefit from the appellations of geographical origin and can participate in the creation of its value, if the characteristics of the product are in accordance with local tradition and the expected quality. The competitiveness of such a production system is not based on quantity and price, but on specific characteristics that differentiate it from other products in that group. In this way, it is possible to stimulate economic development and improve the quality of life in the local community, the region and the entire country.

In Serbia until now several dozen agricultural and food products have been protected by the appellation of origin or geographical indication. On the list of protected products are: Leskovac ajvar, Uzice ham, Srem sausage, Rtanj tea, Honey from Homolje, Sombor cheese, Ečanski carp, Zlatar cheese, Fruska Gora, linden honey from Fruska Gora, Sjenica lamb, pork cracklings from Valjevo, fresh and pickled cabbage from Futog, Arilje raspberry, Banat Riesling, Beremet and others. The Intellectual Property Office has so far registered 60 domestic and 15 foreign appellations of geographical origin.

During 2018, the Intellectual Property Office directly received four applications for registration of appellations of geographical origin: Honey from Deliblato, Potato from Ivanjica, Fried pork delicacy and Towels from the District of Sabac.

Table 1. *Protected products in the Intellectual Property Office of the Republic of Serbia until 2018*

Products by Category	Number of registrations	% registration
Wine	9	**15,0**
Alcoholic beverages	_	
Agricultural products	28	**46,6**
Cheese	13	**21,7**
Decorative objects	4	**6,7**
Tobacco and Cigarettes	_	
Mineral waters	4	**6,7**
Beer and malt	2	**3,3**
Total	**60**	**100**

Source: Author's calculation based on data of public registers of the Intellectual Property Office of the Republic of Serbia

(Table 1.) shows that 90% of the registrations of appellation of origin in Serbia refer to the four main categories of food products as follows: agricultural products (46,6%), cheese (21.7%), wine (15%) and mineral waters (6.7%).

Considering that (Simin *et al*., 2016) in Serbia the protection and use of appellations of geographical origin is mainly related to agricultural and food products, these could take the leading position compared to all other types of intellectual property rights, both with regard to the use of the most important advantages of the domestic agro-industrial complex and its improvement, and from the aspect of more equitable participation in the international trade.

Also as they state (Maksimović & Novaković, 2018) tourism undoubtedly represents a significant segment of country's economic development due to its economical, sociological and ecological factor, and which introduces immense changes in the environment. Therefore, tourism industry could be regarded as a branch which has the most dynamic development. Therefore, in the near future the following products should be protected: Valjevo raspberry, Peštar lamb, kajmak from Zlatibor and others. This is of primary importance for Serbia, which has only 3 internationally protected appellations of geographical origin (Simin *et al.*, 2016).

The Stabilization and Association Agreement contains specific provisions on the protection of appellations of geographical origin for agricultural, fishery and food products. These provisions are set out in Article 33 of the Agreement within the chapter on free movement of goods.

Due to the specificity of matter the provisions of protection of appellations of geographical origin of wines and alcohol beverages were singled out in Annex II of Protocol 2 to the Agreement. Although the Intellectual Property Office is primarily responsible for the registration of indications of geographical origin, the entry into force of the Law on Wine the Law on brandy and other spiritsthe responsibility for the registration procedure passed to the Ministry of Agriculture, but the Office is still responsible for the procedure of international registration.

In order to (Simin *et al.*, 2016) enable agro-industrial complex in Serbia to fulfill the tasks stemming from the EU accession process, it is necessary perform harmonization with the European standards, rules and regulations in the field of application of quality control systems and health safety of agricultural food products. Bearing in mind the importance of applying the quality control system and in particular the importance of applying HACCP (Hazard Analysis and Critical Control Points) the Government of the Republic of Serbia in May 2005 adopted the "Regulation on the use of incentives for the introduction and certification of food safety systems in 2005." By the adoption of the "Law on

Food Safety" in May 2009, a chain of control was established to ensure the safety of food and that every consumer in the market is assured that agricultural food products meet all the requirements regarding health and hygiene safety and prescribed quality.

Preparation of the new law on food safety is ongoing and should improve the control in this area. The new law stipulates that the Directorate of national reference laboratories is no longer part of the Ministry of Agriculture, but in accordance with the practice of the European Union is an autonomous and independent body. Also, control of agricultural and food products on the market should be the responsibility of the sanitary inspection of the Ministry of Health.

One of the major economic and social problems in Serbia is high unemployment. Since the process of ownership transformation is at the end, but still incomplete, the process of layoffs will continue in the future. This is based on increased employment that has a basis in launching new products, which in turn cannot be started without substantial capital investment. Large investments in competitive production can create more sustainable economic growth that would be the leader in job creation (Marković *et al*., 2013). Appellations of geographical origin are an excellent method to transfer the comparative advantages into competitive. They are a key factor for strengthening competitiveness and increase in employment, especially in rural areas.

One of the important prerequisites in this process is a well designed policy of development, protection and enforcement of appellation geographical origin that in the long run would provide a more favorable positioning of our companies from the field of agriculture and of the overall economy in the negotiations with the European Union. Creating such policy would require cooperation between potential authorized users of indications of geographical origin, regional chambers and republic Chamber of Commerce, the relevant ministries and the Intellectual Property Office.

7. INTERNATIONAL PROTECTION OF APPELLATIONI GEOGRAPHICAL ORIGIN

Greater harmonization and openness of the multilateral system for the protection appellations of geographical origin can provide easier access of manufacturers and companies from developing countries to the global market that recognize application of the quality systems. Recognition of application of the quality system is a guarantee to the domestic producers to invest financial resources in the protection and application of indications of geographical origin in the traditional agricultural and food products and specialties. A greater use of various forms of geographical labels, including the appellations of origin, geographical indications and collective trademarks offers new opportunities to

the companies from developing countries for successful positioning in the international market (Simin *et al.*, 2016).

In the field of protection of appellations of geographical origin two terms are being applied, the appellation of origin and geographical indication, but since the conclusion of the Uruguay Round, the General Agreement on Tariff and Trade - GATT and the adoption of the Agreement on Trade Related Aspects of Intellectual Property Rights -TRIPS, of 1994, uses the term "geographical indications".

While the Lisbon Agreement for the provision of protection by appellation of origin requires cumulative fulfillment of the conditions for protection, that the quality and characteristics of a product are exclusively or essentially conditioned by the geographic environment, including natural and human factors, while not providing protection to the products with only a certain reputation, but no other quality due to their place of origin. On the other hand, the TRIPS agreement sets the conditions for protection optionally, to either quality or reputation or other characteristics of the product are attributable to its geographical origin.
Protection of appellation of origin at an international level is governed by the Lisbon Agreement for the Protection of Appellations of Origin and their International Registration of 1958, amended in Stockholm in 1967, and amended in 1979.

Serbia has ratified the Agreement, which was published in ("Off. Gazette of SRY" - International Treaties no.6/98). With the entry into force of the Lisbon Agreement on the protection of appellations of origin of June 1999, all domestic legal and natural entity who are authorized users of a domestic appellations of origin, have been enabled to receive by submitting an application, through the Intellectual Property Office, the protection for a particular indication of origin under the simplified procedure in 28 countries (Table 2), does not specify all 28 countries, but only those that have internationally protected products). International protection allows domestic companies to achieve more favorable export prices for its products marked by appellation of origin which enjoys international protection, also representing a powerful promotional factor of the country's economy and tourism. Through the Lisbon Agreement for the Protection of Appellations of Origin of the products, only three Serbian products are internationally protected, honey from Homolje, wine Bermet and Leskovac homemade ajvar (Simin *et al*., 2016).

Appellation of origin represents a qualitatively higher category of geographical indications, because it can be borne only by products that have special properties and qualities that other products of this type do not possess, and thus has a guarantee function (Auby & Plaisant, 1974)

European consumers are prepared to pay a higher price for products with specific geographical origin which they link with the positive experience of previous purchases and high quality products. Origin gives an extra value to Italian Parmesan, French champagne and Portuguese sherry, given that these products guarantee proper and consistent quality, food safety and constant availability on the market (Loureiro & Umberger, 2005).

The application for international registration is filed only for the appellation of origin. By 2018, a total of 1012 appellations of origin were registered under the Lisbon Agreement for the Protection of Appellations of Origin, detailed in (Table 2.). This represents a 2.1% increase on the previous year, mostly driven by strong growth from Italy and the Islamic Republic of Iran. France remains the largest user of the System. It accounted for 50.3% of the 2018 total, followed by Italy (17.3%), Czech Republic (7.4%), the Islamic Republic of Iran (6%) and Bulgaria (3.9%).

Table 2. shows that the leading country in the number of registrations of appellations of origin is France (509), followed by the Italy (175), Czech Republic (75), the Islamic Republic of Iran (61), Bulgaria (39), and others.

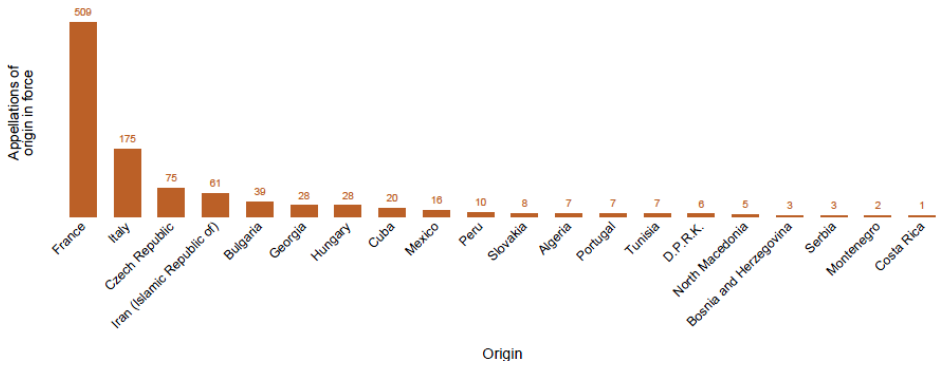
Table 2. *Appellations of origin - Registration in force by country of origin on the basis of the Lisbon Treaty in 2018*

Country of origin	Number of registrations	Percentage of registrations (%)
Algeria (DZ)	7	**0,7**
Bosnia and Herzegovina (BA)	3	**0,3**
Bulgaria (BG)	39	**3,8**
Costa Rica (CR)	1	**0.1**
Cuba (CU)	20	**2,0**
Former Yugoslav Republic of Macedonia (MK)	5	**0.5**
France (FR)	509	**50,3**
Georgia (GE)	28	**2,3**
Hungary (HU)	28	**2,3**
Iran (IR)	61	**6,0**
Israel (IL)	1	**0,1**
Italy (IT)	175	**17,3**
Mexico (MX)	16	**1,6**
Montenegro (ME)	2	**0,2**
Peru (PE)	10	**1,0**
Portugal (PT)	7	**0,7**
Republic of Moldova (MD)	1	**0,1**
Republica Democratica Popular de Corea (KP)	6	**0,6**
Czech Republic (CZ)	75	**7,4**
Serbia (RS)	3	**0,3**

Slovakia (SK)	8	**0,8**
Tunisia (TN)	7	**0,7**
Total:	**1012**	**100**

Source: Bulletin - Appellations of origin 2018, Publication of the International Bureau of the World Intellectual Property Organization (WIPO), Geneva

Figure 1. *Registrations in force by country of origin on the basis of the Lisbon Treaty in 2018*



Source: Bulletin – World Intellectual Property Indicators 2018, Publication of the International Bureau of the World Intellectual Property Organization (WIPO), Geneva

Many manufacturers and companies from the European Union and wider community view the introduction and application of appellations of origin as an important marketing tool which is based on a positive image of the country of origin that favors sale of local agricultural and food products as an import substitution. Appellations of origin can serve as a powerful tool to support the growth of exports of agro-industrial complex of certain countries or regions.
Appellation of origin is gaining in importance worldwide as it informs consumers about the national origin of the product, which can be an important criterion when making purchasing decisions. Those who advocate wider application of appellation of origin in the United States highlight the right of consumers to know the origin of agricultural and food products in order to reduce concerns about the quality, safety and production methods (Anders & Caswell, 2008).

Table 3. shows that 87,8% of the registrations of appellations of origin refers to the four main categories of products such as wine (51.5%), spirits (8,8%), agricultural products (20,5%) and cheese (7 %).

Table 3. *Protected products on the basis of the Lisbon Agreement by 2018*

Products by Category	Number of registrations	Percentage of registrations
Wine	521	**51,5**
Spirits	89	**8,8**
Agricultural products	207	**20,5**
Cheese	71	**7,0**
Decorative objects	43	**4,2**
Tobacco and Cigarettes	36	**3,6**
Mineral waters	27	**2,7**
Beer and malt	18	**1,7**
Total	**1012**	**100**

Source: Author's calculation based on data of Bulletin - Appellations of origin 2018, Publication of the International Bureau of the (WIPO)

Agricultural products are unique because they are related more than other products to the area in which they grow and gradually become a symbol of the whole region, when it comes to cheese the examples are Parmigiano Reggiano - Parma region in Italy or Roquefort - Roquefort city in southern France. Recognition of the sign implies creation of a certain positive attitude of consumers through a recognizable product.

Favorable interdependence between the image of the country of origin and the product appears in the case when a certain dimension of the country of origin is seen as an essential product characteristic. The practice is that producers who intend to sell their goods on the international market, decide whether to indicate the country of origin on the label - Norwegian salmon, New Zealand lamb, Californian grapes, Australian wool, Welsh leek and French onion. In recent years, such labels have become more popular due to the development of the concept of countries of origin in the role of trademarks (Aaker, 1991). Country can be a powerful symbol, especially at the national level, based on its direct connection with the products, materials and possibilities.
Given the fact that more experienced tourists are not prone to opt for the destinations whose products have reached the maturity stage, or the destinations that do not offer a good “money and value ratio”, destinations will increasingly be forced to offer the products that match tourists’ different and multiple characteristics and meet their expectations, which means that they will have to offer a unique offer (Maksimović & Novaković, 2018).

Unfavorable interdependence is expressed when the essential characteristics of the product are perceived as dimensions of a negative image of the country of origin. It is certain that nobody in their right mind will buy Italian whiskey, or Scottish olive oil (Olins, 2003).

Also, the affirmation of protection and enforcement of appellations of origin is essential to prevent infringement of the rights or counterfeiting of products and indications which determine certain commercial, traditional or national interests.

CONCLUSION

Appellations of geographical origin are a key factor for strengthening positioning, and that provides more power or strength to a product, company or economy compared to others. Appellations of origin are of particular importance to developing countries such as Serbia, where the leading part in the structure of exports is maintained by agricultural food products for which these indications have a crucial role as a form of non-price competitiveness. These could take the leading position in relation to all other types of industrial property rights, as from the aspect of use of the most important advantages of the domestic agro-industrial complex and its improvement, as well as from the aspect of more equitable participation in the international trade.

This is of a significant importance for Serbia, which has 60 domestic appellations of geographical origin, but only 3 internationally protected appellations of origin. Specifically, through the Lisbon Agreement for the Protection of Appellations of Origin of the product only three Serbian products are internationally protected: honey from Homolje, wine Bermet and Leskovac homemade ajvar. The study based on data from the Intellectual Property Office shows that 90% of the registrations of appellations of origin in Serbia belong to four major categories of food products: agricultural products (46,6%), cheese (21.7%), wine (15,0 %) and mineral water (6.7%).

Appellations of geographical origin as an integral part of intellectual property rights could become the main promoters of the Serbian economy and the country's expression of identity because the notion of quality of products is directly transmitted to the country's reputation. Export promotion with an emphasis on non-price forms of competition, such as constant quality of the product, health safety of the product, visual identity of the product, collective trademarks and appellations of geographical origin are the imperatives of modern business.

Most manufacturers and companies from the European Union and the wider international community, consider protection and application of appellations of geographical origin as an important marketing tool which is based on a positive image of the country of origin that favors sale of local agricultural and food products as an import substitution. As previously mentioned, the EU countries are taking advantages of protection of products with appellations of origin, reaching in such a way a turnover of a few billion Euros in some countries (eg. France, Italy, Spain,etc.). Appellations of origin can serve as a powerful tool to

support the growth of exports of agro-industrial complex of certain countries or regions.

The paper has proven that the protection and application of appellations of origin worldwide is mainly related to agricultural and food products and the leading countries in the number of registrations of indications of origin are France (509), followed by the Italy (175), Czech Republic (75), the Islamic Republic of Iran (61), Bulgaria (39), and others. By the structure of products 87,8% of the registrations of appellations of origin in the world belong to the four major categories of food products such as: wine (51.5%), spirit (8,8%), agricultural products (20,5%) and cheese (7%).

Appellations of geographical origin opens a free market competition between different manufacturers of the same product types and thus contributes to increasing the competitiveness of domestic products. Appellations of geographical origin have a collective ownership and represent a kind of national resource. This indicates the importance of appellations of geographical origin as an expression of identity of a country, and the notion of quality of some product is directly related to the country's reputation.

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THE ROLE OF TECHNOLOGICAL TOOLS IN STATISTICAL LEARNING

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Abstract: This paper provides a broad overview of the role technological tools can play in helping students understanding and reasoning about important statistical ideas. Statistical packages are software designed for the explicit purpose of performing statistical analyses. For our Statistics course (introductory statistics), we chose the SPSS (Statistical Package for Social Science) program as one of the most represented in the teaching and tested it in class in order to see how they would affect teaching process. The research on students of the second year of the Faculty for Entrepreneurial business and management of non-real estate (45 students) was described. A survey conducted at the end of the research showed that students are very interested in this kind of teaching.

Keywords: IT, software, SPSS, education, lecturing, learning
JEL: C88, I21

1. INTRODUCTION

It is hard to imagine teaching statistics today without using some form of information technology (*IT).* Today's statistics classes may be taught in a classroom with a computer projected on a screen, or may take place in a laboratory with students working at their own computers. This is not so surprising given that technology has changed the way statisticians work and has therefore been changing what and how we teach (Moore *et al.,* 1995).

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

Modern methods in (IT) approach to learning include the whole range of different possibilities applicable in mathematics and statistics lectures for different levels of education and with different levels of interactivity (Herceg,

2009; Milovanovic, 2005, 2014, 2015; Milovanovic *et al.*, 2011, 2012, 2013, 2015, 2016, 2017; Milovanović & Perišić, 2018; Perišić *et al.*, 2014, 2015, 2017, 2018; Takaci *et al.*, 2006, 2008).

The teaching and learning of statistics has pervaded all levels of education, including post-secondary, college-level and graduate-level curricula (Garfield & Ahlgren, 1988). For college- and graduate- level students, statistics has become a requisite course for a wide range of fields. The learning of statistics cultivates students' quantitative and logical thinking, and additionally provides skills necessary for future employment choices. College statistics courses are expected to train students for proficiency in statistical skills. However, students face challenges in these courses. Studies showed that many students did not obtain an adequate understanding of basic statistics concepts in class and were unable to solve applied problems (Garfield, 1995; Garfield & Ahlgren, 1988). Educators have employed multiple technological solutions in teaching, such as visual aids, simulations or animations, with hope of enhancing college student statistics learning (Chance *et al.*, 2007).

Chance describes how technological tools are now being designed to support statistics learning in the following ways (2000, p. 128):

1. Students' active construction of knowledge, by "doing" and "seeing" statistics.
2. Opportunities for students to reflect on observed phenomena.
3. The development of students' metacognitive capabilities, that is, knowledge about their own learning and thought processes, self-regulation, and control.

In addition, technological tools can bring exciting curricula based on real-world problems into the classroom; provide scaffolds and tools to enhance learning; and give students and teachers more opportunities for feedback, reflection, and revision (Bransford *et al.*, 2000).

The types of research studies that explore technology in statistics education can be grouped into three categories:

1. Development, use and study of particular tools (e.g., the creation and use of *Fathom* software – Biehler, 2003; *Minitools* – Cobb *et al.*, 1997).
2. How use of particular tools help develop students' reasoning (e.g., use of *Sampling SIM* software to develop reasoning about sampling distributions – Chance, delMas, & Garfield, 2004).
3. Comparison of tools (e.g., comparing *ActivStats*, *CyberStats*, and *MM*Stat* multimedia – Alldredge & Som, 2002; Symanzik &Vukasinovic, 2002, 2003, 2006).

Different kinds of statistical software programs have been developed exclusively for helping students learn statistics. Several packages have been used by statisticians for many years, including *SPSS* (http://www.spss.com), *S-plus* (http://www.insightful.com), *R* (http://www.r-project.org), *SAS* (http://www.sas.com), and *Minitab* (http://www.minitab.com).

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

SPSS is short for Statistical Package for the Social Sciences, and it's used by various kinds of researchers for complex statistical data analysis.

The SPSS software package was created for the management and statistical analysis of social science data. It was originally launched in 1968 by SPSS Inc., and was later acquired by IBM in 2009.

Officially dubbed IBM SPSS Statistics, most users still refer to it as SPSS. As the world standard for social science data analysis, SPSS is widely coveted due it's straightforward and English-like command language and impressively thorough user manual.

SPSS is used by market researchers, health researchers, survey companies, government entities, education researchers, marketing organizations, data miners, and many more for the processing and analyzing of survey data.

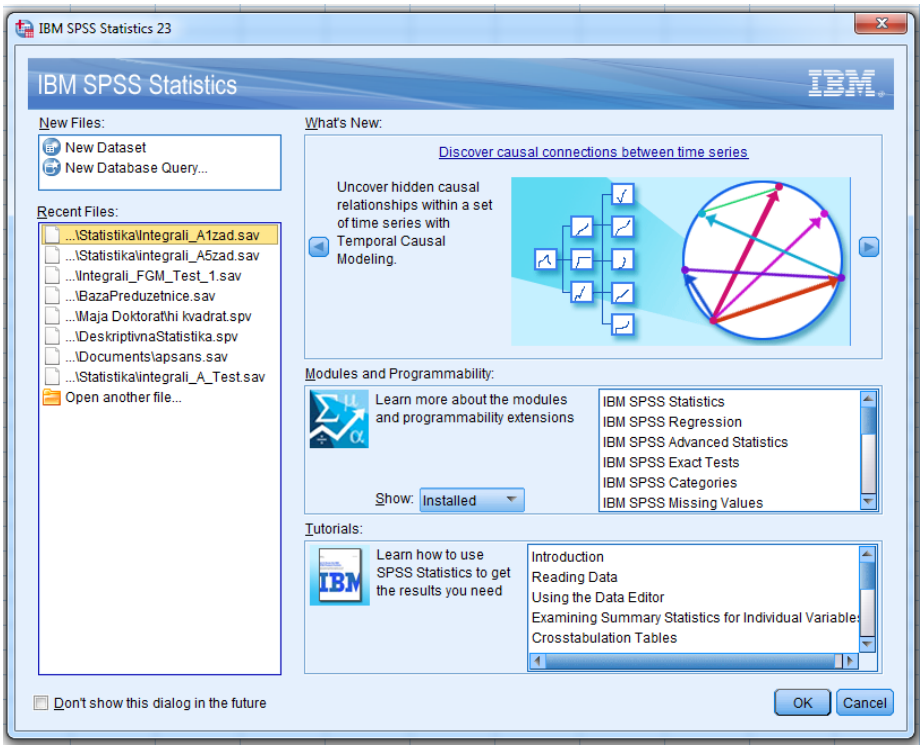
Most top research agencies use SPSS to analyze survey data and mine text data so that they can get the most out of their research projects.

SPSS software enables educators to teach effectively, helps students gain critical analytical skills and supports more accurate and insightful institutional research and decision-making.

2. ELABORATION - COURSE OF STATISTICS WITH SPSS PROGRAM

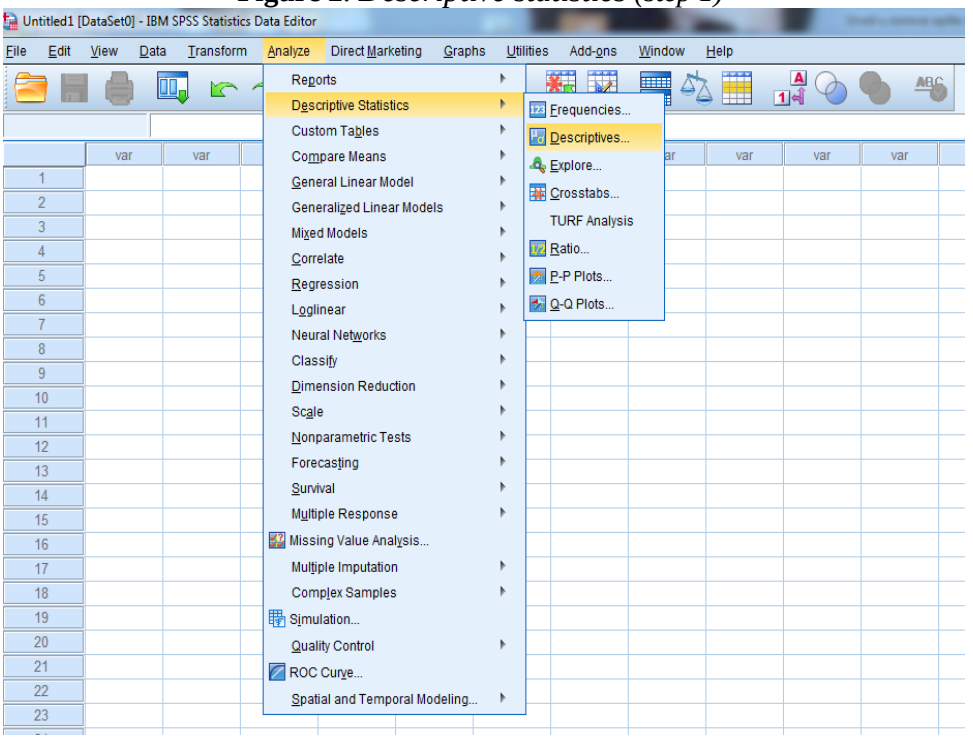
For the Statistics course (*introductory statistics)* we chose the SPSS program as one of the most represented in the teaching, Figure 1. Course of content included *descriptive statistics, frequency distribution, central tendency and variability, hypothesis testing, t tests, correlation, regression and nonparametric statistics (chi-square).* In the paper, the process of data entry to the database (Figure 3), the data processing by the Descriptive method (Figure 2, Figure 3, Figure 4, Figure 5) and the results shown in Figure 6, is shown in the next example.

Figure 1. *IBM SPSS Statistics program*



2.1. Descriptive statistics, frequency distribution, central tendency and variability

Figure 2. *Descriptive statistics (step 1)*

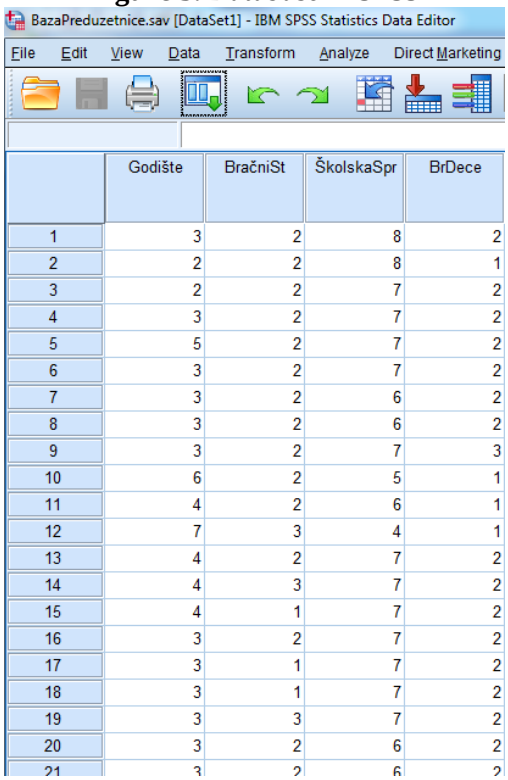


Example 1:

In the example, a part of the research, which involved a total of 100 (100) respondents, descriptive statistics (minimum, maximum, arithmetic mean and standard deviation) for the following variables:

Godište - age of respondents, ranked data with 1, 2, 3, 4, 5, 6, 7, 8, 9;
BračniSt - marital status of respondents, ranked data with 1, 2, 3, 4;
ŠkolskaSpr - school respondents, ranked data with 1, 2, 3, 4, 5;
BrDece - number of children, ranked data with 1, 2, 3, 4, 5.

Figure 3. *Database in SPSS*



	Godište	BračniSt	ŠkolskaSpr	BrDece
1	3	2	8	2
2	2	2	8	1
3	2	2	7	2
4	3	2	7	2
5	5	2	7	2
6	3	2	7	2
7	3	2	6	2
8	3	2	6	2
9	3	2	7	3
10	6	2	5	1
11	4	2	6	1
12	7	3	4	1
13	4	2	7	2
14	4	3	7	2
15	4	1	7	2
16	3	2	7	2
17	3	1	7	2
18	3	1	7	2
19	3	3	7	2
20	3	2	6	2
21	3	2	6	2

Figure 4. *Descriptive statistics in SPSS (step 2)*

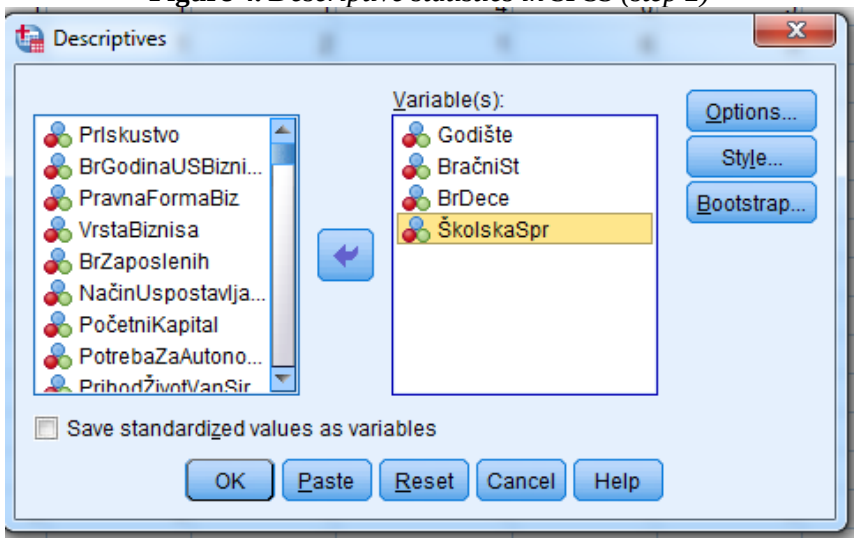


Figure 5. *Descriptive statistics in SPSS (step 3)*

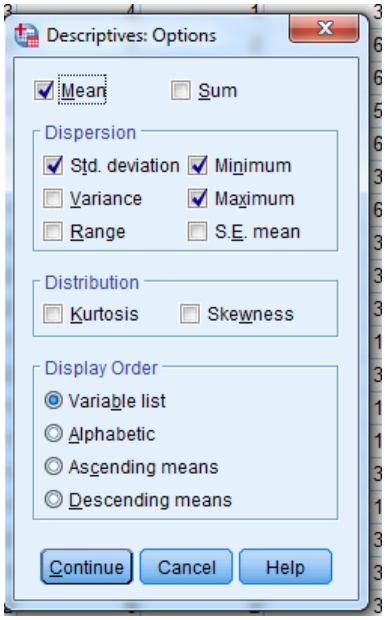
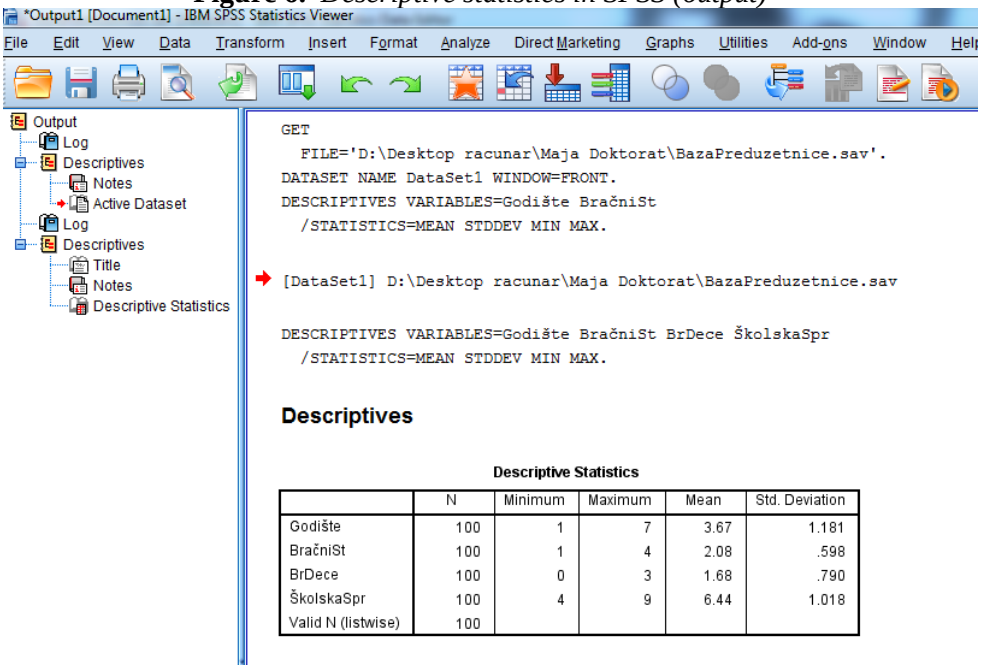


Figure 6. *Descriptive statistics in SPSS (output)*



2.2. Hypothesis testing, t tests, correlation

Example 2:

In this example, a part of the research was presented, in which a total of forty-eight (48) students took part in the Mathematics test. The research was conducted on two groups of 25 students of the first year at the Faculty of the Architecture of the Union University "Nikola Tesla", Belgrade, Serbia. The first group had traditional lectures and the second one had multimedia lectures. Groups were formed randomly, so the previous knowledge needed for the lectures about limited integrals was practically the same, which was confirmed by test. Results were analyzed with Student's t-test for independent samples using SPSS (version 23.0) software. The result was considered significant if the probability p was less than 0.05. Average score in the multimedia group was 76.38 with standard deviation 19.13, and in traditional group, average score was 60.04 with standard deviation 16.20 (Figure 7). Statistical comparison with t-test for two independent samples showed that multimedia group had remarkably higher scores in comparison with the traditional group, with statistical significance of

$p < 0.05$.

Figure 7. *Database and t-test for independent samples in SPSS*

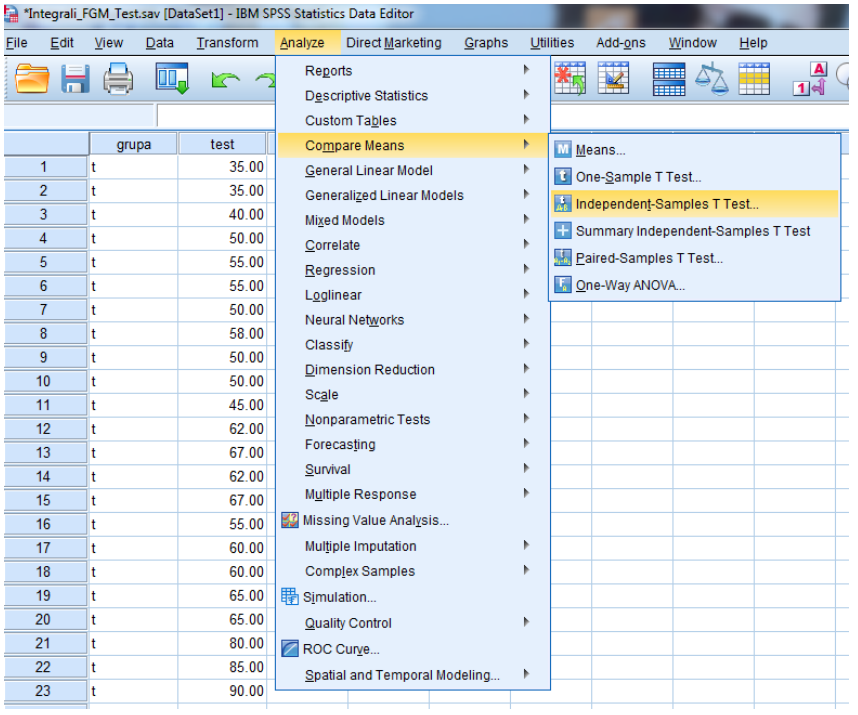


Figure 8. *t-test for independent samples in SPSS (output)*

T-Test

[DataSet1] D:\Desktop racunar\Doktorati Marina\Doktorat KG\Statistika\Integrali_FGM_Test.sav

Group Statistics

	grupa	N	Mean	Std. Deviation	Std. Error Mean
test	t	24	60.0417	16.19844	3.30649
	m	24	76.3750	19.12615	3.90411

Independent Samples Test

		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
test	Equal variances assumed	1.663	.204	-3.193	46	.003	-16.33333	5.11615	-26.63161	-6.03506
	Equal variances not assumed			-3.193	44.786	.003	-16.33333	5.11615	-26.63914	-6.02752

Example 3:

As part of a survey conducted on a sample of respondents at Union University "Nikola Tesla", we examined whether the level of education of respondents affected their cognitive attitudes (measured by a scale from 0 to 5) through the survey. The database view, the application of the Spearman's rank correlation method and the result of the correlation are shown in the following figures.

Figure 9. *Spearman rank correlation method in SPSS*

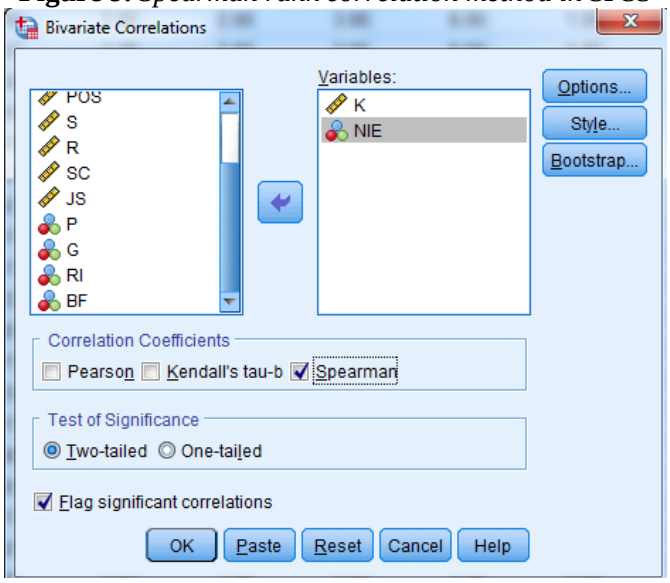


Figure 10. *Spearman's rank correlation method in SPSS (output)*

Nonparametric Correlations

```
[DataSet1] D:\Desktop racunar\Zakic1\Baza.sav
```

Correlations

			K	NIE
Spearman's rho	K	Correlation Coefficient	1.000	.578**
		Sig. (2-tailed)	.	.000
		N	100	100
	NIE	Correlation Coefficient	.578**	1.000
		Sig. (2-tailed)	.000	.
		N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

In this case, $p < 0.01$, so we conclude that the calculated correlation is significant, with a high degree of correlation between the variables (rho = 0.578). We conclude that the level of education of the respondents influences their cognitive attitudes.

2.3. Research Methodology

Aim and questions of the research

Technology should be utilized in the classroom to encourage students to explore data sets more in depth, to allow the data to tell a (possibly unexpected) story to the student, and to consider related conceptual issues (e.g., Erickson, 2001).

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

1. What do students think about technological tools in lecturing and learning Statistics? Do they prefer this or traditional way and why?
2. Do students think it is easier to understand and learn the matter individually used software SPSS?

Participants of the research

The research on students of the second year of the Faculty for Entrepreneurial business and management of non-real estate (45 students) of the UNION "Nikola Tesla" University, Belgrade, Serbia was described.

Methods, Techniques and Apparatus

The students studied Statistics course (introductory statistics), with the help of SPSS software package. The material includes examples that we have dealt with the mentioned software tool. Students could solve problems in a much faster and more efficient way. Students were enabled to make conclusions about dependent variables by changing independent variables (their relationship, correlations,

etc.). Students can modify these parameters and initial conditions to explore and make their own conclusions.

We now have the power to have students analyze real and often messy data, giving students a better idea of what statisticians do by having them go through the process of collecting, analyzing and making conclusions to investigate their own questions. Assessment can focus on giving students data sets and having them complete a full analysis on their own, which may include “cleaning” the data first (e.g., Holcomb, 2004). Such exercises empower students as users of statistics and allow them to better understand and experience the practice of statistics (Ben-Zvi, 2004).

After the courses were finished all students were interviewed after the classes and transcripts of the most characteristic opinions are also included here. In order to get as objective results as possible, participation in the interviews was voluntary and anonymous, and the interviewer was not a member of the teaching staff at any of the faculties.

Students were questioned about their perception concerning the impact of SPSS on their attitude toward statistics and quantitative research, on self confidence, on their meta-cognitive skills, on how SPSS enhanced their understanding of statistical concepts, and on what they perceived as the added value of SPSS as a tool for "doing statistics." The impact of SPSS on attitude was measured by judgments made on a 3-point scale, where I disagree, I agree and I totally agree (Figure 11).

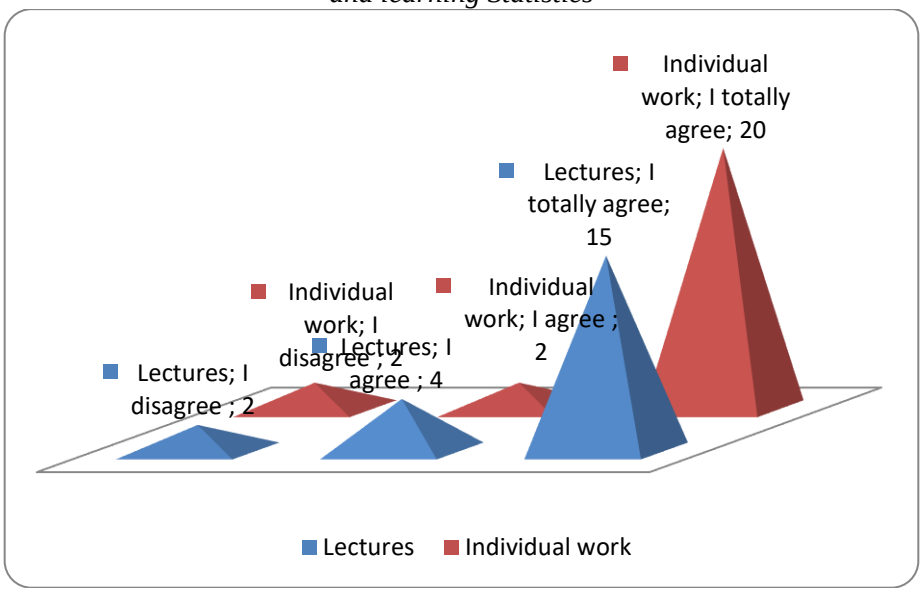
2.4. Results

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

— *Statistical course*:

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

Figure 11. *Students' answers to the question: Should PC be used in lecturing and learning Statistics*



CONCLUSION

Technology enables visualization of statistical concepts and processes (Biehler, 1993), demonstration of complex abstract ideas and provision of multiple examples in seconds. Students are better able to explore and "see" statistical ideas, and teachers are better able to present them to students. Such tools give students and teachers much more flexibility to ask "what if" questions.

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

Integrating technology in the classroom has great potential to enhance teaching and learning, turning that potential into a reality can be a complex and multifaceted task. Some of the key factors for successfully integrating technology in the classroom are well-defined educational visions, curriculum design, and teacher preparation and support (Kleiman, 2004).

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

• Ease of data entry, ability to import data in multiple formats

• Interactive capabilities
• Dynamic linking between data, graphical, and numerical analyses
• Ease of use for particular audiences
• Availability to students, portability.

The information provided by the students concerning the impact of the statistical software package should be treated carefully, because (1) software cannot be isolated from curricular materials; (2) student characteristics could clarify why some benefit and others do not; and (3) the questionnaire used here needs to be refined and open-ended items that probe for how and why explanations should be added. Tentative conclusions are that the software has a positive effect on understanding and doing statistics. It seems to support the component mental activities of statistical thinking. The results concerning the idea that the software enhances intrinsic motivation were not encouraging. Working with their own data helps the students, but their self confidence was not enhanced and their attitude toward quantitative research was not influenced in a positive way.

We believe that no one tool can do it all and that there are many good tools available to use, many of which are free. Therefore, rather than thinking about one technological tool for students to use, we encourage teachers to think about what sets of tools will help student best learn statistics in each unit of the course. What is used to graphically explore data in one unit may not be the best to illustrate sampling in another.

During our research teachers emphasized that technological tools have made students work easier and have proved to be motivating for them. As shown in Figure 11, a great number of them insisted that technological tools enabled easier understanding, learning and implementation of knowledge. Students' remark, and consequently one of this research's conclusions, was that technological tools is an important aspect of teaching and learning process.

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ASBESTOS-CONTAMINATED SOIL AND ASSOCIATED MATERIALS IN THE REPUBLIC OF SERBIA

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Abstract: Environmental degradation is a process that takes place from the formation of life on Earth to this day. Asbestos, which was already known in prehistoric times (1800 BC), is a material which never burns, rots nor corrodes. It insulate from cold and noise, it possesses both high elasticity and tensile strength. Asbestos materials are virtually indestructible. Because of its' excellent characteristics, the mineral asbestos has been used in countless ways in technologies of every kind. As a rule, a distinction is drawn between weakly bound asbestos products and strongly bound asbestos products. Asbestos surveys are required under the duty to manage and the current Construction Design and Management (CDM) Regulations. Where there is a reasonable expectation that asbestos would be, present and could present a risk to workers– surveys must be completed. Area of asbestos analytical work that has been too long ignored, growing dramatically. Asbestos contamination soil and associated material Republic Serbia must be read to gain any proper understanding of the subject. Regulations, Identification and Quantification of Asbestos in Soils and associated material Republic Serbia will be presented in this paper.

Keywords: Sustainable Development, Environment, Asbestos in soil, Asbestos surveys required.
JEL: Q5, Q56

1. INTRODUCTION

Asbestos is the generic commercial designation for a group of naturally occurring mineral silicate fibres of the serpentine and amphibole series. These include the serpentine mineral chrysotile (also known as ‘white asbestos’), and the five amphibole minerals: actinolite, amosite (also known as ‘brown asbestos’), anthophyllite, crocidolite (also known as ‘blue asbestos’), and tremolite (IARC, 1973; USGS, 2001).

So, the term asbestos refers to a group of fibrous minerals (Table 1), found in nature that have been used because of their high resistance, low thermal

conductivity, resistance to chemical substances. Such a combination of properties was not found in any other material, which is why asbestos quickly conquered the world and gained various uses.

Table 3. *Non-fibrous and fibrous type of minerals*

Non-fibrous type of minerals	**Fibrous type of minerals**
Lizardite, Antigorite	Chrysotile asbestos
Riebeckite	Crocidolite asbestos
Grunerite	Amosite asbestos
Anthophyllite	Anthophyllite asbestos
Actinolite	Actinolite asbestos
Tremolite	Tremolite asbestos

Source: Roberts *et al.* (1974)

While some types of asbestos may be more hazardous than others, all are dangerous. Leading health agencies, including the U.S. Department of Health and Human Services, the EPA and the International Agency for Research on Cancer, classify all types of asbestos as cancer-causing substances.

All the identified forms of asbestos can cause asbestosis, malignant mesothelioma, lung cancer, ovarian cancer, laryngeal cancer and other serious diseases.

Some agencies, such as the Health Protection Agency in the U.K., claim amphibole varieties of asbestos are the most dangerous forms. The EPA has abandoned projects aiming to identify which asbestos fiber types are the most toxic, because the overall regulation of asbestos and asbest form minerals is a more pressing priority.

Serpentine asbestos has curly fibers made up of sheets of crystals. The single type of asbestos from the serpentine family, chrysotile, has historically accounted for more than 95 percent of all asbestos used around the world. As a result of asbestos-industry lobbying, some countries that have banned other types of asbestos still permit the "controlled use" of chrysotile.

Amphibole asbestos has needle-shaped fibers. Studies suggest it takes much less exposure to amphibole asbestos to cause cancer, compared to serpentine asbestos. Amosite and crocidolite are the most commercially valuable types of amphibole asbestos, while anthophyllite, tremolite and actinolite are considered noncommercial forms.

2. ASBESTOS-CONTAINING MANUFACTURED PRODUCTS

2.1 Chrysotile asbestos

Chrysotile, commonly referred to as "white asbestos," was used in the vast majority of the myriad asbestos-containing products manufactured (Table 2). The United States and Canada were once major producers of the toxic mineral.

Table 2. *Chrysotile asbestos-containing products*

Chrysotile asbestos-containing products				
Adhesives	Brake pads	Cement	Drywall	Fireproofing
askets	Insulation	Roofing	Vinyl tiles	

Source: *Vučinić et al. (2007)*

Workers in high-risk occupations for asbestos exposure tend to handle asbestos in high concentrations on a regular basis:

- Asbestos miners
- Asbestos-plant workers
- Boiler workers
- Construction workers
- Firefighters
- Industrial workers
- Insulators
- Factory workers
- Power-plant workers
- Shipyard workers
- Textile-mill workers

Notably, construction jobs are a major source of asbestos exposure in the U.S., with demolition crews and home renovators being among the most at risk of exposure.

Approximately 25 percent of people who die of asbestosis worked in the construction industry, according to the National Institute for Occupational Safety and Health.

3. REMOVING ASBESTOS-CONTAMINATED SOIL

Asbestos-contaminated soil (Ljubojev & Krstić, 2014, Krstić, *et al.*, 2014, Krstić *et al.*, 2013) is comprised of non-attached pieces of asbestos cement products and other material containing asbestos uncovered in soil during other work activities.

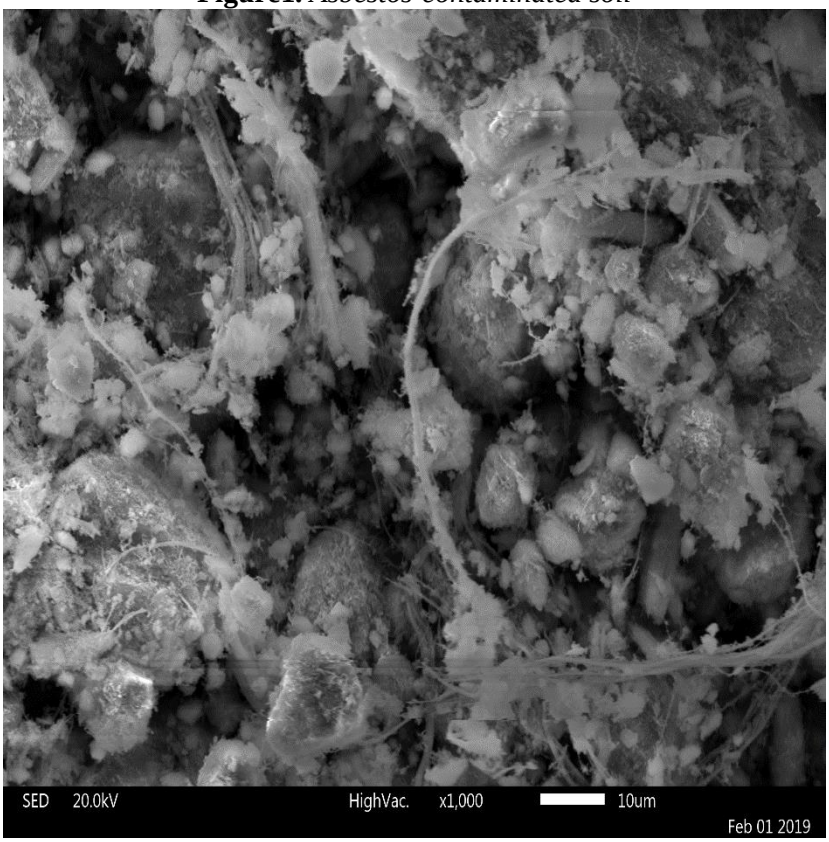
Contamination can be detected during building and road construction and excavation, waste disposal, damage following a severe weather event such as a hail storm, weathering over time or when asbestos is poorly handled or damaged during removal.

A risk assessment by an independent competent person should determine the most appropriate control measures and remediation strategies.

Asbestos-contaminated soil (Figure 1) is also subject to requirements of other regulatory agencies such as the EPA and local authorities.

Removal of asbestos from contaminated soil will require a specialist asbestos contractor for any friable asbestos to be removed for all asbestos removal requiring a specialist asbestos contractor, an air monitoring program must be implemented by an independent analyst to ensure that the control measures do not release airborne asbestos fibres.

Figure1. *Asbestos-contaminated soil*



Source: Krstić, (2019)

When all visible asbestos has been removed and the air monitoring program indicates that the level of respirable asbestos fibres does not exceed 0.01 f/cm^3 (10% of the exposure limit value), the independent analyst must complete the clearance certificate.

All asbestos and any contaminated soil removed must be disposed of as asbestos waste. Immediate action If the soil is suspected to contain asbestos, the person who manages or controls the workplace must assume that the soil contains asbestos and cease work immediately.

A competent person should take samples of the material for analysis to confirm or refute that assumption.

If confirmed, the person who manages (Miletć & Stanojević Šimšić, 2018; Miletić & Conić, 2018) or controls the workplace must ensure that control measures are implemented to minimize the release of airborne asbestos.

The control measures include:

- Preparation of an asbestos management plan for the site,
- Setting the boundaries of the contamination as determined by an competent person,
- Ensuring that there is minimal disturbance of the contaminated soil until the asbestos management procedures have been implemented,
- Isolating and securing the removal work site using signs and barriers,
- Controlling dust with dust suppression techniques (such as water and wetting agents),
- Providing PPE based on the level of contamination and the control measures implemented,
- Sampling and/or air monitoring,
- Providing education and training for workers about hazards and safe work practices to minimize airborne dust exposure, and
- Implementing decontamination procedures for the workers and the equipment.

4. ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

The most acceptable definition of sustainable development is the definition of the UN Commission chaired by former Norwegian Prime Minister Gro Harlem Brundtland, which is "a development that meets the present needs of generations while not denying the needs of future generations" (WCED, 1987).

Sustainability is a concept linked to productivity and the environment, which aims to increase living standards and is considered right at the level of use of natural resources (Ciegis *et al*., 2009).

In general, it links the goals of economic development, quality of life and social equality to the population (Rogers *et al*., 2007), in other words, it represents "triple the value" (GRI, 2006).

Sustainable development supports the principles of sustainable development based on sustainability indicators that create the environment for its creation, namely (Miletić, 2017):

1. Economic;
2. Environmental;
3. Sociological; and

4. Cultural sustainability.

1. From an economic point of view, sustainable development seeks new answers to the challenges of global business in achieving competitive advantage through more efficient use of resources and increased business productivity. The economic aspect requires constant changes in techno-technological development that produce favorable results: job creation and employment, diversification and market penetration, innovation and entrepreneurship development, wages as an existential basis, new investments, economic growth and development.

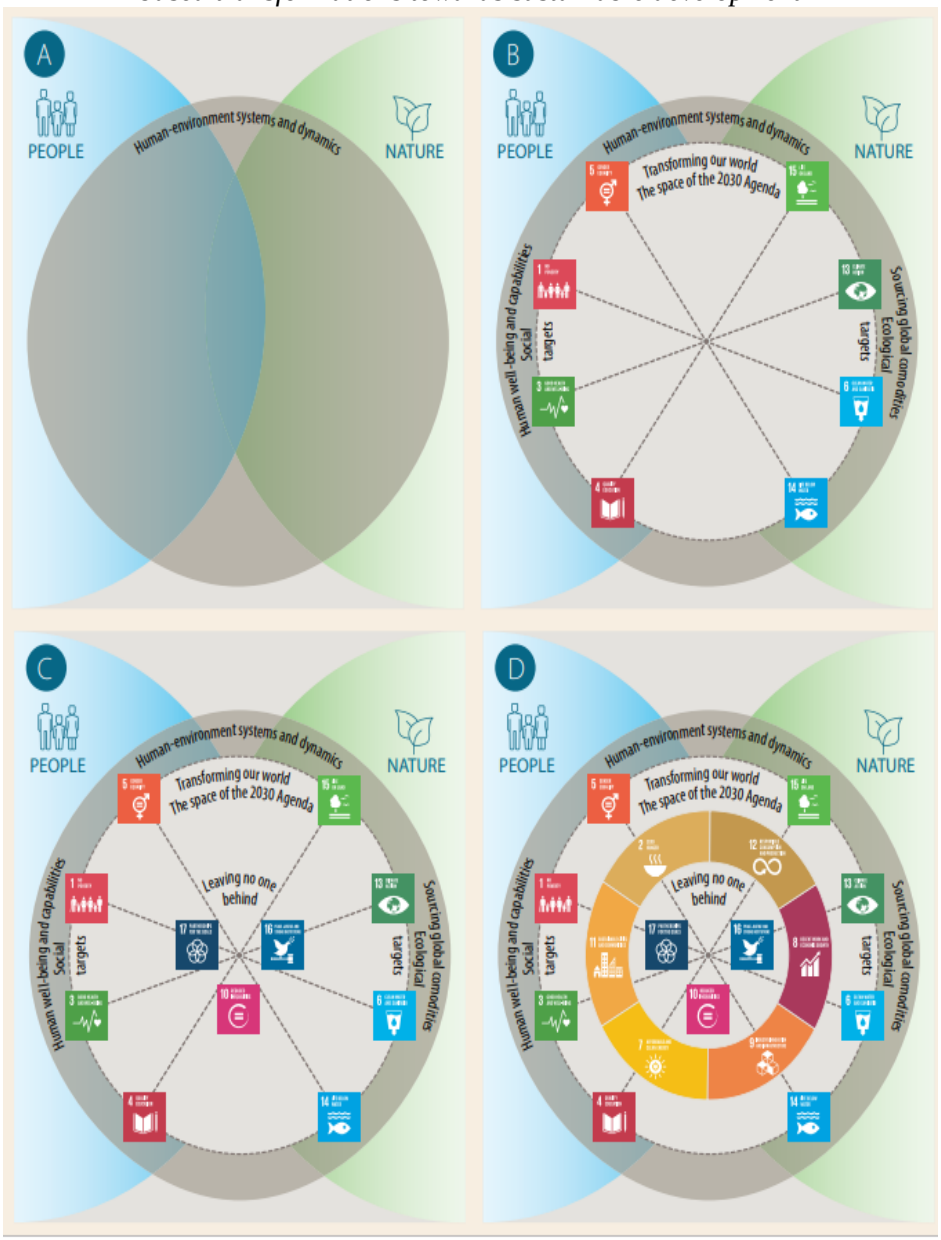
2. The environmental aspect brings to the sustainable development great care in the area of ecosystem integrity and care. This is, in fact, environmental protection, which means that a sustainable business can run smoothly, with constant awareness of its conservation.
   Sustainable development through this dimension includes the care of preserving the quality of water, air and soil, preserving wildlife and preserving human health, which is also a condition for sustainable business.

3. The social dimension of sustainability, viewed through the social dimension of sustainable development, indicates that development cannot be sustainable if it is not fair and does not meet the needs of the majority of the population.Creating productive employment for people, health care available to all, education, constant fight against poverty, rapid and constant change in consumer habits and needs leads to sustainable business.

4. Cultural sustainability is reflected in the understanding of the intercultural difference of global, international business.This dimension is very important for sustainable development and implies an optimal model of organizational culture adapted to national culture.

   Hofstede (Hofstede, 1997) explains the term culture as "the collective programming of a mind that defines one team from another or a group of people from another."Intercultural analyzes are important to show what one culture allows for one people and cannot be acceptable to another people (Hofstede, 1980).

Figure 2. *The Global Sustainable Development Framework for knowledge-based transformations towards sustainable development*



Source: Independent Group of Scientists appointed by the Secretary-General, Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development, (United Nations, New York, 2019). United Nations publication issued by the Department of Economic and Social Affairs

Progress in human well-being is closely connected to the state of the natural environment, and vice versa (Figure 2).

As those social and environmental targets are intractably linked, it is not possible to carry out one intervention without influencing another (Independent Group of Scientists appointed by the Secretary-General, Global Sustainable and Development Report 2019).

In principle, all sustainability goals or indicators (economic, environmental, sociological and cultural) are linked and cannot function separately.

In sustainable development, there are principles that apply to, (Daly, 1990):

• Pollution - do not pollute the environment before innovating eco-systems;
• Consumption - do not waste renewable resources before renewing them and
• Do not waste non-renewable resources before increasing renewable ones.

Literary research to date has shown that a number of papers that focus on both sustainability and its connection to similar, related topics:

1. Faber *et al*. (Faber *et. al*., 2005), examines the principle of sustainability with a particular focus on whether sustainability is inherently sustainable.
2. Glavic & Lukman (Glavic & Lukman, 2007) evaluate different explanations of the concept of sustainability.
3. Shrivastava and Berger (Shrivastava and Berger, 2010) focus on the future sustainability trajectory.
4. Guest (Guest, 2010), looks at the aforementioned economic sustainability, also taking into account climate change.
5. Vos (2007), concludes that the definition of sustainability should have common elements relating to the economic, environmental and social aspects of markets and society.
6. Høgevold and Svensson (Høgevold & Svensson, 2012) argue that business sustainability must be viewed as a continuous process.
7. Miletić *et al*., (2016), provide an assessment of the sustainable operations of mining companies.
8. A relatively recent study by Svensson and Wagner (Svensson & Wagner, 2012), provides a broad definition of business sustainability as an organization's effort to manage the impacts of life on earth and the ecosystem as well as the business network.

This definition places emphasis on environmental, social and economic considerations in the context of sustainable practices in the market and in society.

These three elements should be balanced so that they have a positive impact on each other (Figure 3).

Figure 3. *Sustainable development scheme*

Source: http://macaulay.cuny.edu/eportfolios/akurry/files/2011/12/SDspheres.jpg

Sustainable development is a process where there is a harmonization between the exploitation of resources, the proper channeling of investments, the orientation of institutional change and technological development in order to

improve the potential for meeting human needs both in the present and in the future (UNCED, 1992).

Sustainable development is based on knowing how and how to manage sustainable development goals.

In Serbia like in the other European countries the use of asbestos has been banned in consumer products (and most industrial applications).

When asbestos containing material or products become waste, this waste is defined as hazardous waste (according to the Serbian Rulebook on Categories, Testing and Classification of Waste [PDF], Official Gazette of RS no 56/10).
Such materials have to be handed over to a licensed waste collector or disposer only.

Authorized companies to handle and treat asbestos containing waste are listed in a register on the website of the Serbian Environmental Protection Agency (SEPA, http://www.sepa.gov.rs).

Removal of fixed asbestos products (e.g. insulation with spray asbestos, asbestos containing flooring) and asbestos cement products (e.g. facades, roofing, pipes, etc.) shall be done only by authorized professionals complying with the Regulation about preventive measures for safe and healthy work when exposed to asbestos (Official Gazette of RS no 108/15).

5. ANALYSIS OF SUSPECT ACMS USING POLARISED LIGHT MICROSCOPY (PLM)

Analysis of bulk samples should be carried out in accordance with Appendix 2 of the HSE (UK) technical guidance document HSG 248. Asbestos: The analysts' guide for sampling, analysis and clearance procedures. The analytical method involves initial examination by eye of a suspect material, followed by detailed examination under a low power stereo microscope.

Fibres observed in the course of these examinations are categorised tentatively on the basis of morphology and certain physical properties.

Each fibre type recognised is mounted in a suitable refractive index (RI) liquid. The fibres are then positively identified as one of the six regulated fibres on the basis of their detailed optical properties using polarised light microscopy (PLM).

Analytical bodies should have in-house documented procedures which conform to a recognised quality assurance system such as the international standard ISO 17025: General requirements for the competence of testing and calibration laboratories.

Quality assurance (QA) is critical to ensure that results are both accurate and reproducible.

The following are some of the key requirements of an effective QA programme for bulk analysis is routine QA checks to assess the quality of results produced.

On the basis of the test results, and comaration with the legislation in the field of soil testing (Recommendation of European regulations; and, Document titled Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia (2009), contentrations of ACM Chrysotile asbestos are above of MAC value in testing sample (Stragari, Korlaće, Dragalica), as follows abaut 0.20 % w/w /0.01 % w/w, i.e. 20 times.

Also, concentrations of ACM Chrysotile asbestos are above of remediation values (RV), as follows abaut: 0.20 % w/w /0.05 % w/w, i.e. 4 times.

CONCLUSION

Asbestos is an inert inorganic material. The risk is associated with the generation (and inhalation/ingestion) of fibers.

Thus the improper removal of asbestos (releasing free fibers) may cause more harm than the past use of the material. Different types of asbestos containing material request different precaution in removal and handling of the waste.

1. Removal of movable asbestos containing items.
   Asbestos containing movable items (e.g. cardboard like heat shields, electric lines with asbestos insulation, electric fan with asbestos insulation, etc.) should be packed in a double layer plastic pack, marked as asbestos waste, and handed over to an authorized disposer. Any dust shall be removed using wet whipping material. This material is to be packed as asbestos waste after use (note: The use of a household vacuum cleaner will result in airborne fibers and should be avoided therefore).

2. Removal of strong bound asbestos/asbestos cement (content of asbestos 10% to 20%, density 1,4 or higher).

a) Movable items (e.g. flowerpots): handling - see point 1.

b) Fixed asbestos cement items, e.g. facades, roofing, pipes etc.: Such asbestos cement should be removed only by authorized professionals, applying the necessary precautionary measures. Before the removal of asbestos cement any dust shall be removed with an industrial vacuum cleaner (filter class H13, approved for asbestos) to avoid a spreading of

already released fibers. Then the asbestos cement shall be removed avoiding breaking of the item or other mechanical stress and packed directly in a big-bag marked with the appropriate label. Operators shall use personal protective equipment (single use protective clothing, filter mask FFP3). After removal the site should be cleaned again with an appropriate industrial vacuum cleaner. Used protective equipment shall be packed and disposed as asbestos waste.

3. Removal of weak bound asbestos.
   Weak bound asbestos (spray asbestos, asbestos containing flooring, etc.) poses the highest risk of contamination with fibers. Removal shall be done only by authorized professionals using special equipment to avoid a contamination with fibers.

The working area has to be encapsulated with a dust-tight enclosure (keeping of sub atmospheric pressure and adequate filtering of the exhaust air with a filter class H13).

Work shall be performed with adequate protective equipment (single use protective clothing, mechanical supported mask respirator with H13 filter).
The asbestos shall be immobilized in the working area (e.g. by mixing with cement).

After removal of the asbestos the working area has to be cleaned and the residual fiber concentration in the air shall be measured.
The fiber concentration shall not exceed 500 fibers per m^3 (otherwise a second cleaning shall be performed).

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ECO-INNOVATION INDICATORS AS INDICATORS OF GREEN ECONOMY AND SUSTAINABILITY OF DEVELOPMENT

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Abstract: The concepts of sustainable development based on green economy and circular economy has become a topical and important issue in global environmental management in recent years. However, in the regional policies of the Western Balkan countries, specific indicators are not sufficiently defined to be compatible with existing measurements in the EU. An approach supported by a green economy is production systems that provide natural resources from overexploitation. In order to meet the green economy's assumptions, modern and innovative technologies that enable the renewal of natural resources need to be developed. At the same time, it is necessary to provide reliable systems for defining and measuring eco-innovation. Therefore, a unique methodology should be put in place to compare the level of transition to green economy and circular economy systems. As the focus in the European Union (EU) is on the regions, measuring the level of application of the green economy and circular economy principles through eco-innovation is particularly important at regional levels in the candidate countries. This paper presents proposals for indicators of eco-innovation, based on eco-innovation factors, which were created for EU needs.

Keywords: green economy, circular economy, eco-innovation, sustainable development, green entrepreneurship, regional policies.
JEL: O31, Q01, Q55, Q56

1. INTRODUCTION

Sustainable development is essentially about improving quality of life in a way that can be sustained, economically and environmentally, over the long term supported by the institutional structure of the country. For this reason, sustainable development addresses four major dimensions: social, economic, environmental and institutional. The indicators are divided into three dimensions: social, economic and environmental; institutional questions are largely considered to be responses and not readily quantified as indicators. Although a sound institutional structure is essential for an efficient and reliable

energy system, indicators to reflect this institutional dimension are still being developed and may be incorporated into the EISD (Energy Indicators for Sustainable Development) at a later stage. Availability of energy has a direct impact on poverty, employment opportunities, education, demographic transition, indoor pollution and health, and has gender- and age-related implications. In rich countries, energy for lighting, heating and cooking is available at the flip of a switch. The energy is clean, safe, reliable and affordable. Until recently, sustainable development was perceived as an essentially environmental issue, concerning the integration of environmental concerns into economic decision-making (Duran *et al*., 2013).

UNEP defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2010). In its simplest expression, a green economy is low-carbon, resource efficient, and socially inclusive. In a green economy, growth in income and employment are driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. The Eco-Innovation Scoreboard (Eco-IS) and the Eco-Innovation Index illustrate eco-innovation performance across the EU Member States. They aim at capturing the different aspects of eco-innovation by applying 16 indicators grouped into five dimensions: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency and socio-economic outcomes. The Eco-Innovation Index shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. The Eco-IS and the Eco-Innovation Index complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance (https://ec.europa.eu/environment/ecoap/indicators/index_en). There are various bibliometric analysis of disparate interpretations and applications of sustainability - Circular economy and Green economy aimed to clarify the wide variation in underlying assumptions, overall aims and objective, specific focus, level of detail in policy guidance and operationalization of sustainability (D'Amato *et al.*, 2017). The aim of this paper is to underline the significance of indicators for measuring eco-innovation, based on eco-innovation factors, as an reality reflection of economic benefits.

2. MISUNDERSTANDINGS AND BENEFITS OF ECO-INNOVATIVE APPROACH

The use of renewable energy generates a wide range of economic benefits. Job creation is an important attribute of a healthy economy and a significant part of economic development activities. When there are more people working, the utility exceeds the income of the all working positions. Additional benefits occur when earned money and part of their income have been invested in local economies, creating an effect called spin-off benefit, known as the multiplier effect. This increased spending, also, results in economic activity (jobs and income) in other sectors, such as retail, restaurants, and providing quality leisure and entertainment area. Renewable energy systems have the ability to create more jobs per unit of cash invested projects based on conventional energy systems. The number of jobs also depends on how the stages of production take place in the observed region (Duran, 2011).

Given the complexity and globalism of modern business, and taking into account a number of problems and disagreements in terms of global trends and priorities for development, sustainable energy management cannot be defined through a series of stringent actions to be undertaken, but modern science and practice show that the activity in the field of strategic and operational management, and improving quality, and socially responsible behaviour in general, became imperative when it comes to the realization of the concept of sustainable energy development in practice (Golušin *et al*., 2012).

2.1. Potential misunderstanings in conceptualisation of green economy and circural economy

According to Kirchherr *et al*. (2017), the circular economy concept is of great interest to both scholars and practitioners because it is viewed as an operationalization for businesses to implement the much-discussed concept of sustainable development (Ghisellini *et al*., 2016; Murray *et al*., 2017). The latter concept has been called too vague to be implementable and has thus started to lose momentum (van den Brande *et al*., 2011; Peltonen, 2017, p.2 ff.) with Naudé (2011, p.352) even calling it a "theoretical dream [rather than] implementable reality" and Engelman (2013, p.3) writing that "we live today in an age of 'sustainababble', a cacophonous profusion of uses of the world 'sustainable [development]' to mean anything from environmentally better to cool". Notable concepts also supposed to operationalize sustainable development for businesses are the green economy and green growth concepts (UNEP, 2011; OECD, 2016), whereas the CE concept is argued to be the one with most traction these days (Ellen MacArthur Foundation, 2014; EY, 2015).

„Green economy (in its various forms) has been proposed as a means for catalysing renewed national policy development and international cooperation

and support for sustainable development. The concept has received significant international attention over the past few years as a tool to address the 2008 financial crisis as well as one of two themes for the 2012 UN Conference on Sustainable Development (Rio+20)''(UNDESA, 2012, p. 5.)

An economy „in which material flows are either made up of biological nutrients designed to re-enter the biosphere, or materials designed to circulate without entering the biosphere" is the circular economy (UNEP, 2012). The circular economy is economy in which reuse and technical recycling are key strategies. What aims a circular economy is eliminating wastes (Vukadinović & Ješić, 2019).

We note that this abundance of circular economy conceptualizations, this 'circular economy babble', constitutes a serious challenge for scholars working on this topic. Knowledge accumulation regarding the CE is difficult if scholar A conceptualizes the 'how-to' of CE as recycling, while scholar B considers the 'how-to' as reducing, reusing and recycling, to provide an illustrative example. If scholars are not aware of their conceptually different understanding of CE, knowledge accumulation attempts may lead to misleading results. Dacin *et al*. (2010, p. 38) has found that "the current state of conceptual confusion [on social entrepreneurship] serves as a barrier to […] advances in the field". An issue of great topicality and media interest that characterizes this period and exerts a strong impact on our life and on the company's management concerns the sustainability and the Green Economy. The themes of the Green Economy and of the Circular Economy, in fact, are increasingly recurring and the European Directive of 2014 deems the Green Economy and the Circular Economy as a governance model able to grant a sustainable growth for the European Union and the entire world. The Green Economy, in particular, is defined as "a system of economic activities connected with the production, distribution and consumption of goods and services that results in a better human wellbeing in the long term, to avoid exposing the future generations to significant environmental risks and to the ecologic shortage", while the circular economy represents "a development strategy that provides for the economic growth without increasing the consumption of resources and reducing the impact on the environment" (http://www.wiretechworld.com/green-economy-and-circular-economy-targets-and-prospects/). On 4 March 2019, the European Commission adopted a comprehensive report on the implementation of the Circular Economy Action Plan. The report presents the main achievements under the Action Plan and sketches out future challenges to shaping our economy and paving the way towards a climate-neutral, circular economy where pressure on natural and freshwater resources as well as ecosystems is minimized (https://ec.europa.eu/environment/circular-economy/).

2.2 Circular economy indicators

The basic concept of a circular economy depicts a production and consumption system that relies on the recycling, re-use, repair, remanufacturing, sharing of products, changing the consumption patterns and new business models and systems. There is no indicator that can be a single measurement for the Circular Economy. However a number of existing indicators can help to measure performance in several areas that directly or indirectly contribute to the Circular Economy development. They can be grouped into the following groups (https://ec.europa.eu/environment/ecoap/indicators/circular-economy-indicators_en):

1. Sustainable resource management - This set of indicators examines the performance of the EU Member States in transforming their economies toward circularity by lowering resource demands, thereby increasing resource security and lowering pressures on the environment domestically and abroad.
2. Societal behaviour - This set of indicators reflect citizen awareness, engagement and participation in the circular economy. Citizen engagement, behaviour change and social norms are integral to the success of a circular economy transition. This means that people participate in new forms of consumption (e.g. sharing, product-service systems, willingness to pay more for durability), re-use (requiring changed mindsets regarding repair and refurbishment), and disposal (separating waste streams and bringing ""waste"" to remanufacturing/recycling/sorting sites).
3. Business operations - This set of indicators depicts eco-innovation activities toward changing and adapting business models according to the principles of a circular economy. Businesses are the engine behind the circular economy transition. They foster circularity across the life-cycle of material use, beginning with how and what materials are sourced (quality, environmental and health standards). The design stage is particularly crucial to enabling re-use / re-manufacturing / recycling and raising the durability of goods for keeping within the economy longer. Remanufacturing and recycling are key business operations critical to scaling up the circular economy.

2.3. Measuring framework for eco-innovations

Indicators for issue identification are instruments that help decision makers identify and priorities problems that might undermine the path towards sustainable development. Four steps are proposed for the use of indicators in the issue identification phase, namely (https://www.un-page.org/files/public/content-page/unep_indicators_ge_for_web.pdf):

1. Identify potentially worrying trends;
2. Assess the issue and its relation to the natural environment;
3. Analyze more fully the underlying causes of the issue of concern;
4. Analyze more fully how the issue impacts society, the economy and the environment.

The combination of different indicators for the analysis of simultaneous environmental, social and economic trends is essential to identify potential issues (present and/or upcoming), and clearly determine their causes and effects within and across sectors.

The Eco-Innovation Scoreboard (Eco-IS) and the Eco-Innovation Index illustrate eco-innovation performance across the EU Member States. They aim at capturing the different aspects of eco-innovation by applying 16 indicators grouped into five dimensions (https://www.eco-innovation.eu/index.php/eco-innovation-index):

- eco-innovation inputs
- eco-innovation activities
- eco-innovation outputs
- resource efficiency
- socio-economic outcomes

The Eco-Innovation Index shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. The Eco-IS and the Eco-Innovation Index complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance. In Table 1 we present all contemporary dimensions, thematic areas and indicators which are composing the Eco-Innovation Index, according to Eco-Innovation Scoreboard (Eco-IS).

Table 1. *Eco-IS thematic areas and indicators*

ECO-INNOVATION INPUTS	Eco-innovation inputs comprise investments (financial or human resources) aiming to trigger eco-innovation activities. **The indicators in the Eco-IS include:** - Governments environmental and energy R&D appropriations and outlays (% of GDP) - Total R&D personnel and researchers (% of total employment) - Total value of green early stage investments (USD/capita)
ECO-INNOVATION ACTIVITIES Eco-innovation activities includes indicators to monitor the scope and scale of eco-innovation activities undertaken by companies. The component focuses on efforts	**The indicators in the Eco-IS include:** - Firms declaring to have implemented innovation activities aiming at a reduction of material input per unit output (% of total firms) - Firms declaring to have implemented innovation activities aiming at a reduction of energy input per unit output (% of total firms) - ISO 14001 registered organisations (per mln

and activities rather than on actual results of innovation activity.	population)
ECO-INNOVATION OUTPUTS Eco-innovation outputs describe the immediate results of eco-innovation activities. Indicators in this component are used to monitor the extent to which knowledge outputs generated by businesses and researchers relate to eco-innovation.	**The indicators in the Eco-IS include:** - Eco-innovation related patents (per mln population) - Eco-innovation related academic publications (per mln population) - Eco-innovation related media coverage (per numbers of electronic media)
ECO-INNOVATION SOCIO-ECONOMIC OUTCOMES Socio-economic outcomes of eco-innovation depict wider effects of eco-innovation activities for society and the economy. This includes changes in employment, turnover or exports that can be related to broadly understood eco-innovation activities.	**The indicators in the Eco-IS include:** - Exports of products from eco-industries (% of total exports) - Employment in eco-industries and circular economy (% of total employment across all companies) - Revenue in eco-industries and circular economy (% of total revenue across all companies)
ECO-INNOVATION RESOURCE EFFICIENCY OUTCOMES Resource efficiency outcomes relate to wider effects of eco-innovation on improved resource productivity. Eco-innovation can have a twofold positive impact on resource efficiency: it can increase the generated economic value, while at the same time decrease pressures on the natural environment.	**The indicators in the Eco-IS include:** - Material productivity (GDP/Domestic Material Consumption) - Water productivity (GDP/Water Footprint) - Energy productivity (GDP/gross inland energy consumption) - GHG emissions intensity (CO2e/GDP)

Source: https://ec.europa.eu/environment/ecoap/indicators/index_en

For example, environmental taxes are an economic instrument that entirely supports the principles of sustainable development and has impact on balanced improvement of all its four pillars (economic, ecological, social, and

institutional). Environmental taxes provide a flexible and cost-effective means for reinforcing the polluter-pays principle and for reaching environmental policy objectives. Enforcement of environmental taxes (and penalties) simultaneously generates multiple values—it stimulates ecologically acceptable production, generates budget revenue, and stimulates socially responsible behavior (Golušin *et al*., 2013).

2.4. Measuring the Eco-innovation index in EU

As we presented in previous chapter, The Eco-innovation index in EU, according to Eurostat and Eco-Innovation Observatory, is based on 16 sub-indicators from eight contributors in five thematic areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes. The overall score of an EU Member State is calculated by the unweighted mean of the 16 sub-indicators. It shows how well individual Member States perform in eco-innovation compared to the EU average, which is equated with 100 (index EU=100). The index complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance (https://ec.europa.eu/eurostat/web/products-datasets/product?code=t2020_rt200).

Table 2. *Eco-innovation index, EU, 2010-2018*

Country/Year	2010	2011	2012	2013	2014	2015	2016	2017	2018
European Union	100	100	100	100	100	100	100	100	100
EU (28 countries)	:	:	:	:	:	:	:	:	:
Belgium	109	114	112	98	90	90	82	83	83
Bulgaria	31	43	55	20	31	29	29	38	50
Czechia	74	84	81	66	84	87	80	82	100
Denmark	149	140	135	129	131	131	129	120	115
Germany	134	126	127	138	135	132	135	139	137
Estonia	49	62	63	56	58	59	65	62	81
Ireland	100	116	102	96	98	94	95	99	94
Greece	43	56	69	61	65	66	78	77	83
Spain	105	134	125	120	111	109	99	112	105
France	109	108	100	113	112	113	106	99	112
Croatia	:	:	:	53	91	61	80	75	88
Italy	105	91	98	97	100	104	110	113	112
Cyprus	62	66	65	33	44	43	56	45	45
Latvia	51	72	65	43	65	65	86	73	82
Lithuania	47	50	49	63	66	66	82	82	89
Luxembourg	112	120	110	114	139	125	140	139	138
Hungary	69	76	70	58	74	73	61	63	73
Malta	67	79	76	68	50	59	65	86	59

Netherlands	117	112	109	96	98	100	92	88	92
Austria	127	118	116	107	103	105	109	113	119
Poland	40	38	41	30	53	44	56	59	59
Portugal	71	88	88	81	92	92	96	105	101
Romania	48	58	71	55	68	71	67	65	66
Slovenia	87	99	105	71	93	93	102	117	107
Slovakia	43	49	50	42	61	61	79	74	68
Finland	139	143	136	133	129	131	133	141	121
Sweden	143	130	128	140	121	121	128	144	132
United Kingdom	116	103	106	130	104	113	113	105	110
Iceland	:	:	:	:	:	:	:	:	:
Norway	:	:	:	:	:	:	:	:	:
Switzerland	:	:	:	:	:	:	:	:	:

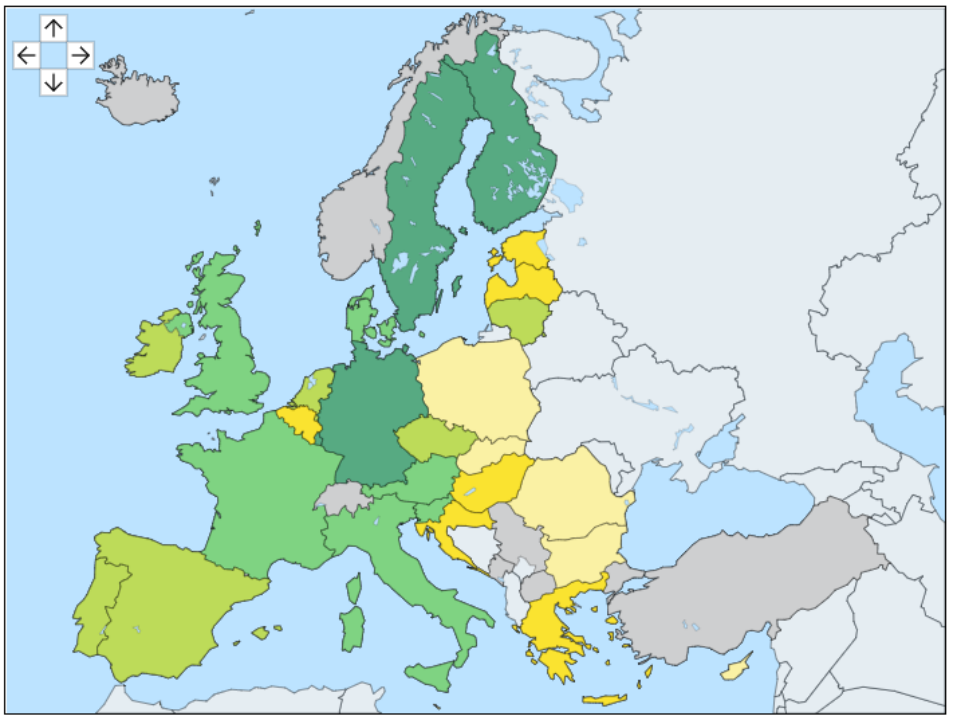
Source:
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=t2020_rt200

The relevant target in the Roadmap to a Resource Efficient Europe is for an increase in the funding for research that contributes to the environmental knowledge base. Such increases will tend to improve a Member State's positioning according to the index. This indicator is published by the Eco-Innovation Observatory.

Table 2 lists all Eco-innovation values for 28 EU countries for period 2010 – 2018. We can notice that Luxembourg, Germany and Scandinavian countries has the highest levels of Eco-innovation Index in EU.

Visual representation of the map of EU showing the measurements for all countries in 2018., we can see in the Image 1.

Image 1. *Map Eco-innovation index, 2018.*

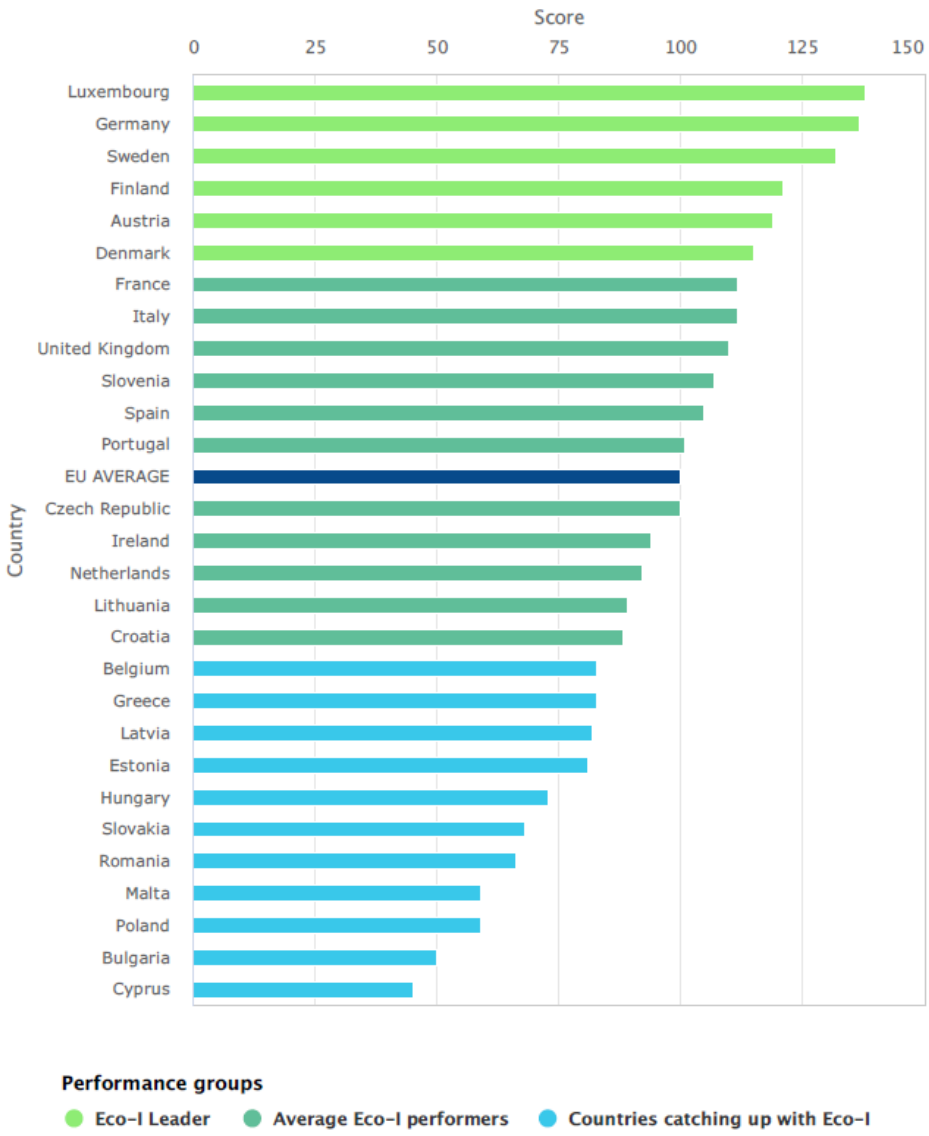


Legend		Cases
	45 to 68	**6**
	68 to 88	6
	88 to 105	6
	105 to 119	6
	119 to 138	4
	Data not available	3

Source:https://ec.europa.eu/eurostat/tgm/mapToolClosed.do?tab=map&init=1&plugin=1&language=en&pcode=t2020_rt200&toolbox=types

Graphical view for EU countries for 2018., is shown in Figure 1.

Figure 1. *Eco-innovation index, 2018.*



Source: https://ec.europa.eu/environment/ecoap/indicators/index_en

As it could be seen, in the Union, Eco-I Leaders were Luxembourg, Germany, Sweden, Finland, Austria and Denmark, while Czech Republic is on the EU averrage, for the year of 2018. The lowest *Eco-innovation index* in EU in 2018. had Cyprus.

3. APPLICATION OF GREEN ECONOMY PRINCIPLES IN POST-TRANSITIONAL COUNTRIES

No progress has been made either in the field of air protection, environmental protection, noise protection, chemicals and genetically modified organisms. Emphasis is placed on the problem of waste management and lack of adopted legislation, as well as waste management plans at national and local level. The situation in the management of water protection was rated unsatisfactory, primarily because of shared responsibilities between ministries and their weak mutual cooperation. Certain progress has been noted in the field of industrial pollution control and risk management (decision rules, registry systems and better cooperation with the European Agency for the Environment). On the other hand, recorded some progress in strengthening administrative capacity for environmental management, particularly at the national level (establishment and strengthening of human resources for the Ministry of Environment and Spatial Planning, better organization and financial strengthening of the inspection), but also at local level (adoption of local environmental plans in a number of municipalities). However, as a major problem noted is insufficient institutional capacity, human and technical resources at the local level and poor Part I - Chapter 5 - 72 - co-ordination of local government with the Republican in the field of environmental protection (Andrejevic & Vucenov, 2011).

The problem is the theoretical "gap between current and desired state." With that in mind, it is necessary to implement appropriate changes and implement appropriate activities to a company or community lead to a sustainable energy business and therefore will solve the problems of this kind. Phases to more responsible energy business are the following (Golušin *et al*., 2012):

- Identification of problems (as a diagnostic activity), a specific phase for each company because each company is characterized by a number of differences and particularities in relation to other companies. If management company set as the desired state of introduction of energy sustainable business to a certain level (or completely), it should be in line with the objective to assess their own strengths and weaknesses defined. This is the stage the set of company goals, which largely determines all other activities;
- Identification of development options, including prediction of activities that can be implemented to achieve the goals that are more energy-efficient business. While predictions of how that can achieve the set goals, each variant should be worked out in detail and realistic estimate. At this stage, a useful (but not critical) may experience companies in a similar situation;
- Choosing the most suitable variant leads to a set goal - energy responsibility. This phase involves making appropriate decisions (choice of several options offered) that determines the future course of action;

- Implementation of the chosen method to achieve the set objectives include a range of activities, requires the engagement of certain human resources, financial resources and time; Control and correction of deficiencies is a necessary activity that must be continuously carried out in order to timely correct the weaknesses and irregularities to which mainly comes from, no matter how many activities were planned in detail;
- Reaching the goal, which the company achieves a higher energy level of responsibility, which is certainly an appropriate way to inform all interested parties, especially consumers, owners and the community;
- Identification of (new) problem, thus returning to the beginning of activities and the company strives to improve its environmental activities on a suitable business to be continuous.

As part of a research report for the project "Economy Review in the Balkans: Changing Public Policy, Not Climate", with organizations from Bulgaria, Macedonia and Serbia, with the support of the European Green Foundation, researchers from the Policy Analysis and Policy-Making Group, Milos Stancic and Jacqueline Zivkovic was hired to write a chapter on Serbia (ttp://gajp.org.rs/project/transformacija-ekonomije-na-balkanu-promena-javne-politike-a-ne-klime/).

This chapter provides an analytical overview of the Serbian economy, its level of development and national public policy. It also addresses some of the factors for greening the economy of the Republic of Serbia. The chapter aims to contribute to a regional study of the European Green Foundation and inspire further exploration of the potential for economic advancement in the field of green economy.

Specifically, the research was conducted by analyzing laws, strategies and action plans, existing studies, through a focus group organized in Belgrade, online questionnaires and individual interviews with various stakeholders. Specific sectors of public policy are covered, such as: energy production and energy efficiency; green construction; innovation and science; green public procurement; sustainable transport; sustainable agriculture; eco-tourism; land and water management; and particular emphasis is given to new green business models. The above areas and thematic guidelines have been selected in accordance with the overall project methodology, as well as with ongoing green economy policy initiatives at EU and worldwide level.

CONCLUSION

Developing models of competitiveness often entails various difficulties. In the efforts to include as many indicators that describe the desired phenomenon, many authors face the problems of data collection and the lack of data for individual countries and regions. In that case, some authors try to insert

qualitative indicators or assessments, which could lead to manipulation with the results by subjective evaluations (Katić *et al*., 2015).

The green economy research conducted in 2017 in Bulgaria, Macedonia and Serbia as part of the project "Reviewing the Balkans Economy: Changing Public Policy, Not the Climate" has shown enormous potential for green economy development, and among the possible solutions for further development, researchers propose bottom-up economic initiatives, a local SME economy and a cooperative aiming to combine labor and services (http://gajp.org.rs/project/transformacija-ekonomije-na-balkanu-promena-javne-politike-a-ne-klime/). Policy Analysis Groups finds that, after funding, public policy research in the context of green economies are crucial, and the main conclusion is that the laws are inconsistent and incomplete.

As we presented in this paper, analyzing concepts of green economy and circular economy, strategies and action plans and existing studies there is an significant progress in identifying indicators for measuring eco-innovation, based on eco-innovation factors, in accordance with the overall project methodology, as well as with ongoing initiatives of the green economy policy in European Union.

Research shows that work on green economy, green management, circular economy and sustainable development is needed. More funding is needed to invest in scientific research and better cross-sectoral cooperation in public policy making.

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