

Revija za ekonomske in poslovne vede
Journal of Economic and Business Sciences

EB

Vol. 12 • No. 1 • 2025



REVIJA ZA EKONOMSKE IN POSLOVNE VEDE
Journal of Economic and Business Sciences

Izdajateljja Publishers

Univerza v Novem mestu Fakulteta za ekonomijo in informatiko
University of Novo mesto Faculty of Economics and Informatics

Univerza v Novem mestu Fakulteta za poslovne in upravne vede
University of Novo mesto Faculty of Business and Management Sciences

Glavni in odgovorni urednik Editor-in-Chief

Jasmina Starc

Uredniški odbor Editorial Board

Ermina Begović (Italija), Vito Bobek (Avstrija), Srečko Devjak (Slovenija), Miroslav Djordjevic (Rusija), Luiela Magdalena Csorba (Romunija), Karl Farmer (Avstrija), Malči Grivec (Slovenija), Kadrija Hodžić (Bosna in Hercegovina), Aleš Jug (ZDA), Milan Jurina (Hrvaška), Vesna Karadžić (Črna Gora), Bjørnar Karlsen Kivedal (Norveška), Sasho Kjošev (Makedonija), Valentina Lukina (Rusija), Vladislav Marjanović (Srbija), Estefanía Mourelle Espasandín (Španija), Edward Pielichaty (Poljska), Igor Sergeev (Rusija), Aleksandar Šobot (Slovenija), Violeta Šugar (Hrvaška)

Tehnična urednica Technical Editor

Maša Bučar Šmajdek

Tajniška dela Secretary

Maša Bučar Šmajdek

Jezikovni pregled Slovene-Language Editor

Izobraževanje in prevajanje Mateja Avbar, s.p.

Jezikovni pregled angleških besedil English-Language Editor

Ensitra, Brigita Vogrinec Škraba s.p.

Naslov uredništva Address of the Editorial Office

EB - Revija za ekonomske in poslovne vede,
Na Loko 2, SI-8000 Novo mesto, Slovenija

Spletna stran revije Website of the Journal

<http://www.eb-nm.si>

Elektronski naslov E-mail

urednistvo@eb-nm.si, editorial.office@eb-nm.si

Izdajanje revije sofinancira Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije.

The publication of the journal is co-financed by the Slovenian Research And Innovation Agency

Naklada Circulation

50

Tisk Printed by

Tiskarna Cicero Begunje, d.o.o.

DOI

<https://doi.org/10.55707/eb.v12i1>

ISSN 2350-384X

VSEBINA CONTENTS

<i>Radojko LUKIĆ, PhD</i> Primerjalna analiza učinkovitosti zavarovalniškega trga Srbije in držav v regiji z metodo MABAC Comparative Analysis Of The Efficiency Of The Insurance Market Of Serbia And Countries In The Region Using The Mabac Method	3
<i>Maksim Nikitashin</i> Ekonomija programskega inženirstva v Sloveniji Economics of Software Engineering in Slovenia	18
<i>Zorana Agić, PhD, Svetlana Dušanić Gačić, PhD, Mirjana Milovanović, PhD</i> Izobraževanje kot strateška prioriteta: evalvacija financiranja izobraževalnega sistema v Republiki Srbski Education As A Strategic Priority: Evaluation Of The Financing Of The Education System In The Republic Of Srpska	39
<i>Anita Blažič</i> Računovodenje kriptovalut v Sloveniji Accounting of Cryptocurrencies in Slovenia	52
<i>Marija Žugič, Uroš Gal, mag. Igor Makovec</i> Generativna umetna inteligenca na Univerzi v Novem mestu Generative Artificial Intelligence at the University of Novo mesto	68

Comparative Analysis Of The Efficiency Of The Insurance Market Of Serbia And Countries In The Region Using The Mabac Method

DOI: <https://doi.org/10.55707/eb.v12i1.141>

Original scientific article

UDC 368:005.336.1(497.11)

KEYWORDS: efficiency, insurance market, international position, MABAC method

ABSTRACT - In recent times, as is known, various methods of multi-criteria analysis have been used more and more to evaluate the efficiency of financial institutions as accurately as possible. One is the MABAC (Multi-Attributive Border Approximation area Comparison) method. Bearing this in mind, this paper analyzes the effectiveness of the insurance in the selected countries (Croatia and Slovenia) and Serbia, based on this method, to assess their international positioning. According to the results of the empirical research on the efficiency of the insurance markets in the selected countries and Serbia based on the MABAC method, the insurance markets of Croatia are ranked best. Serbia's insurance market is ranked second and Slovenia's third. In terms of performance, Serbian insurance market is less good than the Croatian and better than Slovenian. To improve the international position of insurance in Serbia in the future, it is necessary to develop an awareness of the general importance of insurance, especially life insurance, given that it is at a lower development level than in the countries with developed market economies, especially the European Union. In this context, it is necessary to encourage an accelerated growth of life insurance in Serbia by applying appropriate measures. JEL classification: C2, C6, G1, G2, G22.

Izvirni znanstveni članek

UDK 368:005.336.1(497.11)

KLJUČNE BESEDE: učinkovitost, zavarovalniški trg, mednarodni položaj, metoda MABAC

POVZETEK - Kot je znano, se v zadnjem času vse pogostejše uporablja različne metode večkriterijske analize za čim natančnejšo oceno učinkovitosti finančnih institucij. Ena izmed njih je metoda MABAC (Multi-Attributive Border Approximation Area Comparison). Ob upoštevanju tega v prispevku analiziramo učinkovitost zavarovanja v izbranih državah (Hrvaška in Slovenija) in Srbiji na podlagi te metode za oceno njihovega mednarodnega položaja. Po rezultatih empirične raziskave učinkovitosti zavarovalniških trgov izbranih držav in Srbije po metodi MABAC je najbolje uvrščen zavarovalniški trg Hrvaške. Srbski zavarovalniški trg je na drugem, slovenski pa na tretjem mestu. Po uspešnosti je slabši od hrvaškega zavarovalniškega trga in boljši od slovenskega. Za izboljšanje mednarodnega položaja zavarovalništva v Srbiji v prihodnosti je potrebno razviti zavest o splošnem pomenu zavarovalništva, še posebej življenjskega, saj je na nižji stopnji po razvitosti v primerjavi z državami z razvitim tržnim gospodarstvom, zlasti državami Evropske unije. V tem kontekstu je treba z ustreznimi ukrepi spodbuditi pospešeno rast življenjskih zavarovanj v Srbiji. Klasifikacija JEL: C2, C6, G1, G2, G22.

1 Introduction

Recently, to evaluate the efficiency of companies/financial institutions as realistically as possible, various methods of multi-criteria analysis have been developed (Mathew, 2018; Timiryanova, 2020; Okwu, 2020; Singh, 2020; Pachar, 2021; Brezović, 2021; Tsai, 2021). One of them is the MABAC method (Pamučar, 2015; Bo-

Prejeto/Received: 26. 6. 2024
Sprejeto/Accepted: 16. 9. 2024

Besedilo/Text © 2025 Avtor(ji)/The Author(s)
To delo je objavljeno pod licenco CC BY Priznanje avtorstva 4.0 Mednarodna.
/ This work is published under a CC BY Attribution 4.0 International license.
<https://creativecommons.org/licenses/by/4.0/>

žanić, 2016, 2019, 2020; Božanić et al., 2019, Božanić et al., 2020; Işik et al., 2020; Nedeljković et al., 2021). In this paper, the analysis of the insurance efficiency of the selected countries and Serbia is carried out, as a research subject, based on the MABAC method to assess their international position. Its aim and purpose is to determine the most realistic situation possible as a basis and assumption for taking appropriate measures to improve the international position regarding the efficiency of insurance in Serbia in the future.

In the world, there is an increasingly rich literature dedicated to the analysis of the efficiency of companies, that is, financial institutions based on various methods of the multi-criteria analysis (Ersoy, 2017). This is also the case with literature in Serbia (Kočović, 2010; Mandić, 2017; Rakonjac-Antić, 2018; Lukic, 2010, 2011a, b, 2017, 2018a, b, c, 2019, 2020a, b, c, d, e, 2021a, b, c, d, e, f, 2022; Vojteški Kljenak & Lukić, R. 2022a, b, c, 2023a, b, c, d, e, f). However, in the relevant literature, as far as we know, there is not a single comprehensive work devoted to the evaluation of the efficiency of insurance in Serbia using the MABAC method. This work fills that gap to some extent. This, among other things, reflects its scientific and professional contribution.

The starting point of the research in this paper is the fact that the continuous evaluation of the efficiency of a certain insurance market (in this case the insurance market of Serbia) is a prerequisite for improving its international position in the future through better control of critical factors and the application of appropriate measures. The basic research hypothesis is that the efficiency of the Serbian insurance market is low, compared to the insurance markets in the countries with a developed market economy.

The application of the MABAC method plays a significant role in this. It ensures a defining of a more realistic situation regarding the efficiency of insurance in Serbia and its position in the world. Based on this, appropriate measures can be taken to improve the efficiency of insurance in Serbia in the future.

2 MABAC method

Different methods of multi-criteria decision-making can be used in the analysis of the treated problem in this study. In this particular case, the new MABAC method is used due to the simplicity and accuracy of the obtained results.

MABAC (Multi-Attributive Border Approximation area Comparison) is a newer multi-criteria decision-making method developed by Pamučar and Čirović (2015). The basic feature of this method is defining the distance of the criterion function of each observed alternative from the limit approximate value. The mathematical formulation of the MABAC method consists of the following steps (Pamučar, 2015):

Step 1: Formation of the initial decision matrix (X).

Where m alternatives are evaluated according to n criteria. Alternatives are represented by vectors $A_i = (x_{i1}, x_{i2}, \dots, x_{in})$, where x_{ij} is the value of the i -th alternative according to the j -th criterion ($i = 1, 2, \dots, m; j = 1, 2, \dots, n$).

$$X = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \dots \\ A_m \end{matrix} & \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \end{matrix} \quad (1)$$

where m is the total number of alternatives, n is the total number of criteria.

Step 2: Normalization of the elements of the initial matrix (X).

$$N = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \dots \\ A_m \end{matrix} & \begin{bmatrix} n_{11} & n_{12} & \dots & n_{1n} \\ n_{21} & n_{22} & \dots & n_{2n} \\ \dots & \dots & \dots & \dots \\ n_{m1} & n_{m2} & \dots & n_{mn} \end{bmatrix} \end{matrix} \quad (2)$$

The elements of the normalized matrix (N) are obtained using the following equations:

a) For benefit (income) types of criteria (a high value of the criteria is preferred)

$$n_{ij} = \frac{x_{ij} - x_i^-}{x_i^+ - x_i^-} \quad (3)$$

b) For non-finite (cost) types of criteria (a lower value of the criteria is preferable)

$$n_{ij} = \frac{x_i^+ - x_{ij}}{x_i^+ - x_i^-} \quad (4)$$

where x_{ij} , x_i^+ and x_i^- are the elements of the initial decision matrix

(X), and are x_i^+ defined x_i^- as:

$x_i^+ = \max(x_1, x_2, \dots, x_m)$ and represent the maximum values of the observed criterion by alternatives.

$x_i^- = \min(x_1, x_2, \dots, x_m)$ and represents the minimum values of the observed criterion by alternatives.

Step 3: Calculation of elements of the weight matrix (V).

The elements of the weight matrix (V) are calculated as follows:

$$V_{ij} = w_i g(n_{ij} + 1) \quad (5)$$

where n_{ij} the elements of the normalized matrix (N) are w_i the weighting coefficients of the criteria.

Based on the previous equation, the following weight matrix V is obtained

$$V = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{21} & v_{22} & \dots & v_{2n} \\ \dots & \dots & \dots & \dots \\ v_{m1} & v_{m2} & \dots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1 g(n_{11} + 1) & w_2 g(n_{12} + 1) & \dots & w_n g(n_{1n} + 1) \\ w_1 g(n_{21} + 1) & w_2 g(n_{22} + 1) & \dots & w_n g(n_{2n} + 1) \\ \dots & \dots & \dots & \dots \\ w_1 g(n_{m1} + 1) & w_2 g(n_{m2} + 1) & \dots & w_n g(n_{mn} + 1) \end{bmatrix} \quad (6)$$

where n is the total number of criteria, and m is the total number of alternatives.

Step 4: Determining the matrix of boundary approximate regions (G).

The boundary approximate area (BAA) for each criterion is determined according to the following expression:

$$g_i = \left(\prod_{j=1}^m v_{ij} \right)^{1/m} \quad (7)$$

where the elements of the weight matrix (V), and m is the total number of alternatives.

After calculating the value of g and for each criterion, a matrix of borderline approximate areas (G) of the format $n \times 1$ is formed (n represents the total number of criteria by which the choice of offered alternatives is made):

$$G = \begin{bmatrix} C_1 & C_2 & \dots & C_n \\ g_1 & g_2 & \dots & g_n \end{bmatrix} \quad (8)$$

Step 5: Calculation of the elements of the distance matrix of alternatives from the border approximate area (Q).

$$Q = \begin{bmatrix} q_{11} & q_{12} & \dots & q_{1n} \\ q_{21} & q_{22} & \dots & q_{2n} \\ \dots & \dots & \dots & \dots \\ q_{m1} & q_{m2} & \dots & q_{mn} \end{bmatrix} \quad (9)$$

The distance of the alternatives from the border approximate area (q_{ij}) is determined as the difference between the elements of the weight matrix (V) and the values of the border approximate area (G).

$$Q = V - G = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{21} & v_{22} & \dots & v_{2n} \\ \dots & \dots & \dots & \dots \\ v_{m1} & v_{m2} & \dots & v_{mn} \end{bmatrix} - \begin{bmatrix} q_1 & q_2 & \dots & q_n \\ q_1 & q_2 & \dots & q_n \\ \dots & \dots & \dots & \dots \\ q_1 & q_2 & \dots & q_n \end{bmatrix} \quad (10)$$

$$Q = \begin{bmatrix} v_{11} - g_1 & v_{12} - g_2 & \dots & v_{1n} - g_n \\ v_{21} - g_1 & v_{22} - g_2 & \dots & v_{2n} - g_n \\ \dots & \dots & \dots & \dots \\ v_{m1} - g_1 & v_{m2} - g_2 & \dots & v_{mn} - g_n \end{bmatrix} - \begin{bmatrix} q_{11} & q_{12} & \dots & q_{1n} \\ q_{21} & q_{22} & \dots & q_{2n} \\ \dots & \dots & \dots & \dots \\ q_{m1} & q_{m2} & \dots & q_{mn} \end{bmatrix} \quad (11)$$

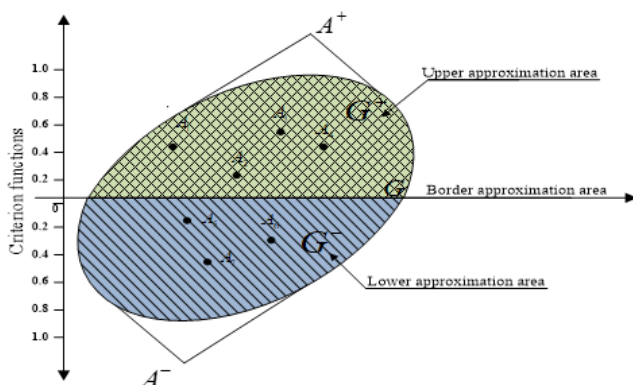
where g_i is the border approximate area for criterion C_i , v_{ij} the elements of the weighting matrix (V), n is the number of criteria, and m is the number of alternatives.

Alternative A_i can belong to the border approximate area (G), the upper approximate area (G^+), or the lower approximate area (G^-),
i.e. $A_i \in \{G \cup G^+ \cup G^-\}$ The upper approximate area (G^+)

is the area where the ideal alternative (A^+) is located, and the lower approximate area is the area where the anti-ideal alternative (A^-) is located (Figure 1).

Figure 1

Displays the upper (G^+), lower (G^-), and approximate regions



Source: Pamučar, 2015

Belonging to the alternative A_i the approximate area (G , G^+ or G^-) is determined based on the following equation:

$$A_i \in \begin{cases} G^+ & \text{if } q_{ij} > 0 \\ G & \text{if } q_{ij} = 0 \\ G^- & \text{if } q_{ij} < 0 \end{cases} \quad (12)$$

Therefore, "for alternative A to be chosen as the best from the set, it is necessary that it belongs to the upper approximate area (G^+) according to as many criteria as possible. If, for example, alternative A_i according to 5 criteria (out of a total of 6 criteria) belongs to the upper approximate area, and according to one criterion it belongs to the lower approximate area (G^-), this means, in other words, that according to 5 criteria, the alternative is close to or equal to the ideal alternative, while according to one criterion close to or equal to the anti-ideal alternative. If the value of $q_{ij} > 0$, i.e. $q_{ij} \in G^+$, then the alternative A_i is close to or equal to the ideal alternative. However, if $q_{ij} < 0$, i.e. $q_{ij} \in G^-$, then alternative A_i is close to or equal to the anti-ideal alternative." (Pamučar, 2015; Božanić, 2016).

Step 6: Ranking of alternatives.

The calculation of the value of the criteria functions according to the alternatives (13) is obtained as the sum of the distances of the alternatives from the boundary approximate areas (q). By summing the elements of the matrix Q by row, the final values of the criterion functions of the alternatives are obtained:

$$S_i = \sum_{j=1}^n q_{ij} \quad j = 1, 2, \dots, n \quad i = 1, 2, \dots, m \quad (13)$$

where n is the number of criteria, and m is the number of alternatives.

3 Analytical Hierarchy Process (AHP) method

Given that the weighting coefficient of the criteria when applying the MABAC method is determined using the AHP method, we will briefly refer to its theoretical and methodological characteristics.

The Analytical Hierarchy Process (AHP) method takes place through the following steps (Saaty, 2008):

Step 1: Formation of the matrix of comparison pairs

$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{bmatrix} \quad (14)$$

Step 2: Normalization of the matrix of comparison pairs

$$a_{ij}^* = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}}, i, j = 1, \dots, n \quad (15)$$

Step 3: Determination of relative importance, i.e. a vector of weights

$$w_i = \frac{\sum_{j=1}^n a_{ij}^*}{n}, i, j = 1, \dots, n \quad (16)$$

Consistency index - CI (consistency index) is a measure of the deviation of n from λ_{max} and can be represented by the following formula:

$$CI = \frac{\lambda_{max} - n}{n} \quad (17)$$

If $CI < 0.1$ of the estimated value of the coefficients a_{ij} are consistent, and the deviation of λ_{max} from n is negligible. This means, in other words, that the AHP method accepts an inconsistency of less than 10%.

The consistency index can be used to calculate the consistency ratio $CR = CI/RI$, where RI is a random index.

4 Measuring the efficiency of the insurance market in the selected countries and Serbia based on the MABAC method: Results and discussion

To measure the insurance efficiency of the selected countries (Croatia and Slovenia) and Serbia, the following criteria were chosen: C1 – Population, C2 – Gross domestic product, C3 – Inflation rate, C4 - Exchange rate local currency per USD, C5 - Insurance premium in % of the total insurance premium in the world, C6 - Insurance premium in % of GDP, C7 - Insurance premium per inhabitant in USA and C8 - Life insurance premium in % of the total premium. The selection of the countries was made according to the criteria of countries with a developed insurance market and countries in the region of Serbia. The alternatives are: A1 - Slovenia, A2 - Croatia and A3 - Serbia. Table 1 shows the initial data for the analysis of insurance efficiency of

the selected countries and Serbia based on the MABAC method for 2022. Figure 2 shows the position of Serbia in international insurance.

Table 1

Initial data for the analysis of the insurance efficiency of selected countries and Serbia

	Population (millions)	G r o s s domestic product, USD bn	Inflati-on rate (in %)	Exchange rate local currency per USD	Insurance premium in % of the total insurance premium in the world	Insurance premium in % of GDP	I n s u r a n c e premium per inhabitant in the USA	Life insurance premium in % of the total premium
	C1	C2	C3	C4	C5	C6	C7	C8
Slovenia	2	62	8.8	0.9	0.0	4.7	1396	27.5
Croatia	7	69	10.8	7.2	0.0	2.6	456	22.4
Serbia	4	64	12.0	111.7	0.0	1.9	177	19.7

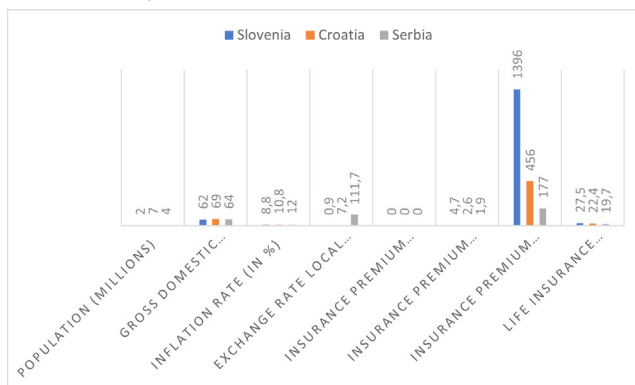
Note: GDP - gross domestic product USD - US dollar

Source: World insurance: the recovery gains pace. Swiss Re sigma No 3 / 2023, 1-49.

Figure 2 shows the performance indicators of Serbia of the selected countries.

Figure 2

Performance indicators of Serbia and selected countries



Source: Author's report

Table 2 shows the descriptive statistics of the initial data.

Table 2

Descriptive statistics

		Statistics							
		C1	C2	C3	C4	C5	C6	C7	C8
N	Valid	3	3	3	3	3	3	3	3
	Missing	0	0	0	0	0	0	0	0
Mean	4.3333	65.0000	10.5333	39.9333	.0000	3.0667	676.3333	23.2000	
Std. Error of Mean	1.45297	2.08167	.93333	35.92939	.00000	.84130	368.73673	2.28692	
Median	4.0000	64.0000	10.8000	7.2000	.0000	2.6000	456.0000	22.4000	

Std. Deviation	2.51661	3.60555	1.61658	62.23153	.00000	1.45717	638.67076	3.96106	
Skewness	.586	1.152	-.722	1.712		1.293	1.368	.872	
Std. Error of Skewness	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225	
Minimum	2.00	62.00	8.80	.90	.00	1.90	177.00	19.70	
Maximum	7.00	69.00	12.00	111.70	.00	4.70	1396.00	27.50	

Note: Author's calculation using SPSS software

The percentage share of the insurance premium of Slovenia, Croatia and Serbia in the total world insurance premium is equal to zero. In the specific case, therefore, the insurance premium as a percentage of gross domestic product is above average in Slovenia and below average in Croatia and Serbia. The highest insurance premium per inhabitant is in Slovenia and is above the average. The percentage share of the life insurance premium in the total insurance premium is the highest in Slovenia and is above the average. Such insurance flows in Slovenia, Croatia and Serbia were influenced, among other things, by the analyzed macroeconomic indicators (population, gross domestic product, inflation and exchange rate). The target performances of the insurance of Slovenia, Croatia and Serbia can be achieved by adequate control of the analyzed statistical variables. They are nothing but insurance performance factors.

Table 3 shows the weighting coefficients of the criteria. They were calculated using the AHP (Analytical Hierarchical Process) method (Saaty, 2008). (The calculation was performed using Excel AHPSoftware).

Table 3

Weight coefficients of the criteria

		1	2	3	4	5	6	7	8	WEIGHTS	
		C1	C2	C3	C4	C5	C6	C7	C8		
1	C1	1.00	1.00	1.50	2.00	1.00	1.00	1.00	1.00	0.1405	
2	C2	1.00	1.00	2.00	2.50	2.00	2.00	2.00	2.00	0.2030	
3	C3	0.67	0.50	1.00	2.00	1.00	1.00	1.00	1.00	0.1162	
4	C4	0.50	0.40	0.50	1.00	2.00	2.00	2.00	2.00	0.1359	
5	C5	1.00	0.50	1.00	0.50	1.00	2.00	2.00	2.00	0.1301	
6	C6	1.00	0.50	1.00	0.50	0.50	1.00	2.00	1.00	0.1000	
7	C7	1.00	0.50	1.00	0.50	0.50	0.50	1.00	1.00	0.0842	
8	C8	1.00	0.50	1.00	0.50	0.50	1.00	1.00	1.00	0.0901	
										1.0000	
										Consistency Ratio	0.0503

Note: Author's calculation using the software program AHPSoftware-Excel

In this particular case, since the consistency ratio is $0.0503 < 0.1$, the estimated values of the coefficients a_{ij} are consistent, and the deviation λ_{max} from n is negligible. This means, in other words, that the AHP method accepts an inconsistency of less than 10%.

In this case, the most important criterion is C2. Adequate control of the annual growth rate of the gross domestic product can influence the achievement of the target performance of insurance in Slovenia, Croatia and Serbia. Of course, this is also based

on adequate management with other analyzed criteria treated as insurance performance factors.

The obtained results of the analysis of the insurance efficiency of the selected countries and Serbia using the MABAC method are shown in the tables below (Table 4, 5, 6, 7, 8), as well as graphically (Figure 3). (Calculations were performed using Excel MABACSoftware.) Table 4 shows the calculated weight coefficients of the criteria, the original empirical data of the criteria, and the maximum and minimum. In the specific case, for example, the highest insurance premium as a percentage of the gross domestic product is in the Slovenia and the lowest in Serbia. The data analysis in this table is similar for other countries about the presented criteria. The original empirical data for each country and each criterion are normalized in Table 5. In Table 6, they are weighted. Table 7 shows the distance of the alternatives from the BAA matrix (Q). The ranking of alternatives is shown in Table 8.

Table 4

Initial

weights of criteria	0.1405	0.203	0.1162	0.1359	0.1301	0.1	0.0842	0.0901
kind of criteria	1	1	1	1	1	1	1	1
	C1	C2	C3	C4	C5	C6	C7	C8
A1	2	62	8.8	0.9	0	4.7	1396	27.5
A2	7	69	10.8	7.2	0	2.6	456	22.4
A3	4	64	12	111.7	0	1.9	177	19.7
MAX	7	69	12	111.7	0	4.7	1396	27.5
MIN	2	62	8.8	0.9	0	1.9	177	19.7

Note: Author's calculation using MABACSoftware-Excel software

Table 5

Normalized Matrix

weights of criteria	0.1405	0.203	0.1162	0.1359	0.1301	0.1	0.0842	0.0901
kind of criteria	1	1	1	1	1	1	1	1
	C1	C2	C3	C4	C5	C6	C7	C8
A1	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000
A2	1.0000	1.0000	0.6250	0.0569	0.0000	0.2500	0.2289	0.3462
A3	0.4000	0.2857	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000

Note: Author's calculation using MABACSoftware-Excel software

Table 6

Normalized Weighted Matrix (V)

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0.1405	0.2030	0.1162	0.1359	0.1301	0.2000	0.1684	0.1802
A2	0.2810	0.4060	0.1888	0.1436	0.1301	0.1250	0.1035	0.1213
A3	0.1967	0.2610	0.2324	0.2718	0.1301	0.1000	0.0842	0.0901

Border Approximation Area Matrix (G)	0.1980	0.2781	0.1721	0.1744	0.1301	0.1357	0.1136	0.1253
--------------------------------------	--------	--------	--------	--------	--------	--------	--------	--------

Note: Author's calculation using MABACSoftware-Excel software

Table 7*Distance of Alternatives from BAA matrix (Q)*

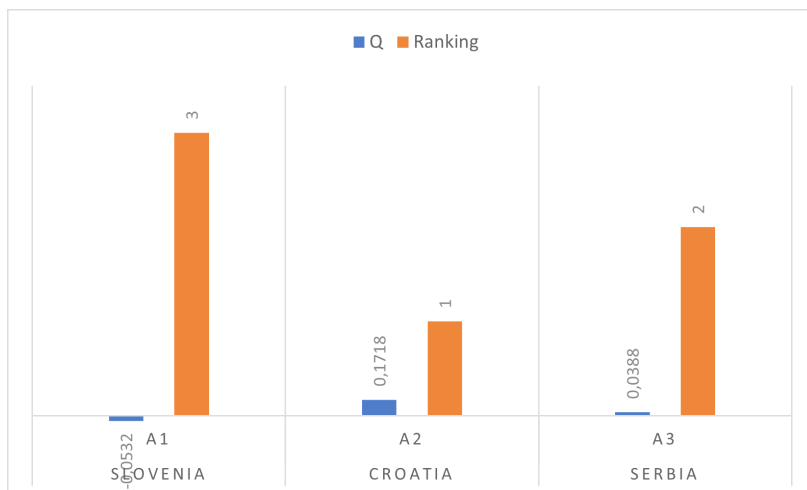
	C1	C2	C3	C4	C5	C6	C7	C8
A1	-0.0575	-0.0751	-0.0559	-0.0385	0.0000	0.0643	0.0548	0.0549
A2	0.0830	0.1279	0.0167	-0.0308	0.0000	-0.0107	-0.0102	-0.0041
A3	-0.0013	-0.0171	0.0603	0.0974	0.0000	-0.0357	-0.0294	-0.0352

Note: Author's calculation using MABACSoftware-Excel software

Table 8*Ranking of alternatives*

	Alternatives	Q	Q	Ranking
Slovenia	A1	-0.0532	-0.0532	3
Croatia	A2	0.1718	0.1718	1
Serbia	A3	0.0388	0.0388	2

Note: Author's calculation using MABACSoftware-Excel software

Figure 3*Ranking of alternatives*

Source: Author's report

In the specific case, therefore, in terms of insurance performance, Croatia is in first place. Insurance of Serbia is in second place. The third place was taken by insurance in Slovenia. Serbia's insurance performance is less compared to Croatia, but better compared to Slovenia.

This international positioning of the insurance market in Serbia has been influenced by numerous factors, such as population growth, gross domestic product growth rate, inflation, exchange rate, interest rates, understanding of the importance of insurance, political situation, behaviour of insurance companies when an insured event occurs (risk) in terms of realistic assessment and payment of damages, and digitization of the entire business. Their adequate control can influence the achievement of the

target level of insurance development in Serbia in the context of international positioning.

5 Conclusion

The paper evaluates the efficiency of the insurance market in Serbia and other selected countries using the MABAC method as one of the modern methods of multi-criteria analysis. Basic indicators of the development of the insurance market were used as criteria: C1 – Population, C2 – Gros domestic product, C3 – Inflation rate, C4 - Exchange rate local currency per USD, C5 - Insurance premium in % of the total insurance premium in the world, C6 - Insurance premium in % of GDP, C7 - Insurance premium per inhabitant in USA and C8 - Life insurance premium in % of the total premium. The analysis includes three national insurance markets. These are Slovenia, Croatia and Serbia. Based on the obtained empirical results, it can be concluded that in terms of performance, Croatia is in first place, Serbia is in second place and Slovenia is in third place. Serbia's insurance performance is less compared to Croatia, but better compared to Slovenia.

To improve the international position of the insurance market in Serbia in the future, it is necessary to develop an awareness of the general importance of insurance as much as possible. Life insurance in particular is at an unsatisfactory level, compared to the observed countries of the developed market economy, i.e. the European Union. In this context, it is necessary to apply appropriate measures to encourage an accelerated development of life insurance in Serbia.

Dr. Radojko Lukić

Primerjalna analiza učinkovitosti zavarovalniškega trga Srbije in držav v regiji z metodo MABAC

V zadnjem času so bile za čim bolj realno oceno učinkovitosti podjetij/finančnih institucij razvite različne metode večkriterijske analize (Mathew, 2018; Timiryanova, 2020; Okwu, 2020; Singh, 2020; Pachar, 2021; Brezović, 2021; Tsai, 2021). Ena izmed njih je metoda MABAC (Pamučar, 2015; Božanić, 2016, 2019, 2020; Božanić idr., 2019; Božanić idr., 2020; Işik idr., 2020; Nedeljković idr., 2021). V prispevku je kot predmet raziskave izvedena analiza zavarovalniške učinkovitosti v izbranih državah in Srbiji na podlagi metode MABAC za oceno njihovega mednarodnega položaja. Cilj in namen tega je ugotoviti čim bolj realno stanje kot osnovo in predpostavko za sprejetje ustreznih ukrepov za izboljšanje mednarodnega položaja glede učinkovitosti zavarovalništva v Srbiji v prihodnosti.

V svetu je vedno bolj bogata literatura, ki se posveča analizi učinkovitosti podjetij in finančnih institucij na podlagi različnih metod večkriterijske analize (Ersoy, 2017). Tako je tudi z literaturo v Srbiji (Kočović, 2010; Mandić, 2017; Rakonjac-Antić, 2018; Lukic, 2010, 2011a, b, 2017, 2018a, b, c, 2019, 2020a, b, c, d, e, 2021a, b, c, d, e, f, 2022; Vojteški Kljenak in Lukić, 2022a, b, c, 2023a, b, c, d, e, f). Vendar pa v relevantni literaturi, kolikor nam je znano, ni niti enega obsežnega dela, ki bi bilo posvečeno oceni učinkovitosti zavarovalništva v Srbiji po metodi MABAC. To delo do neke mere zapolnjuje to vrzel. V tem se med drugim odraža njegov znanstveni in strokovni prispevek.

Izhodišče raziskave v tem prispevku je dejstvo, da je nenehno ocenjevanje učinkovitosti določenega zavarovalniškega trga (v tem primeru zavarovalniškega trga Srbije) predpogoj za izboljšanje njegovega mednarodnega položaja v prihodnosti z boljšim nadzorom nad kritičnimi dejavniki in uporabo ustreznih ukrepov. Osnovna hipoteza raziskave je, da je učinkovitost srbskega zavarovalniškega trga nizka v primerjavi z zavarovalniškimi trgi držav z razvitim tržnim gospodarstvom.

Pri tem igra pomembno vlogo uporaba metode MABAC. Zagotavlja ugotavljanje realnejše slike glede učinkovitosti zavarovalništva v Srbiji in njenega položaja v svetu. Na podlagi tega se lahko sprejmejo ustrezni ukrepi za izboljšanje učinkovitosti zavarovalništva v Srbiji v prihodnosti.

Za merjenje zavarovalne učinkovitosti v izbranih državah (Hrvaški in Sloveniji) in Srbiji so bili izbrani naslednji kriteriji: C1 – prebivalstvo, C2 – bruto domači proizvod, C3 – stopnja inflacije, C4 – tečaj lokalne valute na USD, C5 – zavarovalna premija v % celotne zavarovalne premije v svetu, C6 – zavarovalna premija v % BDP, C7 – zavarovalna premija na prebivalca v ZDA in C8 – premija življenjskega zavarovanja v % celotne premije. Izbor držav je bil narejen po sledečih kriterijih: države z razvitim zavarovalniškim trgom in države v regiji, katere del je Srbija. Alternative so: A1 – Slovenija, A2 – Hrvaška in A3 – Srbija. Tabela 1 prikazuje izhodiščne podatke za analizo učinkovitosti zavarovanja v izbranih državah in Srbiji po metodi MABAC za leto 2022.

Odstotni delež zavarovalne premije v Sloveniji, Hrvaški in Srbiji v celotni svetovni zavarovalni premiji je enak nič. V konkretnem primeru je torej zavarovalna premija v odstotku bruto domačega proizvoda nadpovprečna v Sloveniji ter podpovprečna na Hrvaškem in v Srbiji. Najvišjo zavarovalno premijo na prebivalca ima Slovenija in je nadpovprečna. Odstotni delež premije življenjskih zavarovanj v skupni zavarovalni premiji je najvišji v Sloveniji in je nadpovprečen. Na takšne zavarovalne tokove v Sloveniji, na Hrvaškem in v Srbiji so med drugim vplivali analizirani makroekonomski kazalniki (prebivalstvo, bruto domači proizvod, inflacija in tečaj). Ciljno uspešnost zavarovanj v Sloveniji, na Hrvaškem in v Srbiji je mogoče doseči z ustreznim nadzorom analiziranih statističnih spremenljivk. Niso nič drugega kot dejavniki uspešnosti zavarovanja.

V tem primeru je najpomembnejši kriterij C2. Ustrezno obvladovanje letne stopnje rasti bruto domačega proizvoda lahko vpliva na doseganje ciljne uspešnosti zavarovalništva v Sloveniji, na Hrvaškem in v Srbiji. Seveda tudi to temelji na ustreznem

upravljanju z drugimi analiziranimi kriteriji, ki so obravnavani kot dejavniki uspešnosti zavarovanja.

V konkretnem primeru je torej po uspešnosti zavarovalništvo na Hrvaškem na prvem mestu. Na drugem mestu je zavarovalništvo v Srbiji. Tretje mesto je zasedlo zavarovalništvo v Sloveniji. Srbsko zavarovalništvo je v primerjavi s Hrvaško slabše, v primerjavi s Slovenijo pa boljše.

Na to mednarodno pozicioniranost zavarovalniškega trga v Srbiji so vplivali številni dejavniki, kot so rast prebivalstva, stopnja rasti bruto domačega proizvoda, inflacija, menjalni tečaj, obrestne mere, razumevanje pomena zavarovanja, politična situacija, obnašanje zavarovalnic, ko nastopi zavarovalni dogodek (riziko), v smislu realne ocene in izplačila škode ter digitalizacija celotnega poslovanja. Ustrezen nadzor nad njimi lahko vpliva na doseganje ciljne ravni razvoja zavarovalništva v Srbiji v okviru mednarodnega pozicioniranja.

LITERATURE

1. Božanić, D. I., Pamučar, D. S. and Karović, S. M. (2016). Primene metode MABAC u podršci odlučivanju upotrebe snaga u odbrambenoj operaciji. *Tehnika*, 71(1), 129–136.
2. Božanić, D., Tešić, D. and Kočić, J. (2019). Multi-criteria FUCOM–Fuzzy MABAC model for the selection of location for construction of single-span bailey bridge. *Decision Making: Applications in Management and Engineering*, 2(1), 132–146. <https://doi.org/10.31181/dmame1901132b>
3. Božanić, D., Tešić, D. and Milić, A. (2020). Multicriteria decision-making model with Z-numbers based on FUCOM and MABAC model. *Decision Making: Applications in Management and Engineering*, 3(2), 19–36. <https://doi.org/10.31181/dmame2003019d>
4. Brezović, K., Stanković, R., Šafran, M. and Kolarić, G. (2021). Applying multi-criteria analysis in evaluation of distribution channels. In M. Petrović and L. Novačko (Eds.), *Transformation of transportation* (pp. 125–141). Springer. https://doi.org/10.1007/978-3-030-66464-0_8
5. Ersoy, N. (2017). Performance measurement in the retail industry by using multi-criteria decision-making methods. *Ege Academic Review*, 17(4), 539–551. <https://doi.org/10.21121/eab.2017431302>
6. Işık, Ö., Aydın, Y. and Koşaroğlu, Ş. (2020). The assessment of the logistics performance index of CEE countries with the new combination of SV and MABAC methods. *LogForum*, 16(4), 549–559. <https://doi.org/10.17270/J.LOG.2020.504>
7. Kočović, J., Šulejić, P. and Rakonjac-Antić, T. (2010). Osiguranje. *Ekonomski fakultet*.
8. Lukić, R. (2010). Revizija u bankama. *Ekonomski fakultet*.
9. Lukić, R. (2011a). Evaluacija poslovnih performansi u maloprodaji. *Ekonomski fakultet*.
10. Lukić, R. (2011b). Estimates of economic performance of organic food retail trade. *Economic Research – Ekonomska Istraživanja*, 24(3), 157–169. <https://doi.org/10.1080/1331677X.2011.11517474>
11. Lukić, R., Sokić, M. and Kljenak, D. V. (2017). Efficiency analysis of the banking sector in the Republic of Serbia. *Business Excellence and Management*, 7, 5–17.
12. Lukić, R. (2018a). Bankarsko računovodstvo. *Ekonomski fakultet*.
13. Lukić, R. (2018b). Analysis of the efficiency of insurance companies. In *Insurance in the post-crisis era* (pp. 122–136). Faculty of Economics, University of Belgrade.
14. Lukić, R., Lalić, S., Suceška, A., Hanić, A. and Bugarčić, M. (2018c). Carbon dioxide emissions in retail food. *Economics of Agriculture*, 65(2), 859–874. <https://doi.org/10.5937/ekoPolj1802859L>

15. Lukić, R. and Hadrović Zekić, B. (2019). Evaluation of the efficiency of trade companies in Serbia using the DEA approach. In Proceedings of the 19th International Scientific Conference Business Logistics in Modern Management (pp. 145–165). Josip Juraj Strossmayer University of Osijek, Faculty of Economics in Osijek.
16. Lukić, R., Hadrović Zekić, B. and Crnjac Milić, D. (2020a). Financial performance evaluation of trading companies in Serbia using the integrated fuzzy AHP–TOPSIS approach. In 9th International Scientific Symposium: Region, Entrepreneurship, Development (pp. 690–703).
17. Lukić, R. (2020b). Analysis of the efficiency of trade in oil derivatives in Serbia by applying the fuzzy AHP–TOPSIS method. *Business Excellence and Management*, 10(3), 80–98. <https://doi.org/10.24818/beman/2020.10.3-06>
18. Lukić, R., Vojteski Kljenak, D. and Anđelić, S. (2020c). Analyzing financial performances and efficiency of the retail food in Serbia by using the AHP–TOPSIS method. *Economics of Agriculture*, 67(1), 55–68. <https://doi.org/10.5937/ekoPolj2001055L>
19. Lukić, R. (2020d). Računovodstvo trgovinskih preduzeća. *Ekonomski fakultet*.
20. Lukić, R., Hanić, H. and Bugarčić, M. (2020e). Analysis of profitability and efficiency of trade in Serbia. *Economic Analysis*, 53(2), 39–50.
21. Lukić, R., Vojteski Kljenak, D., Anđelić, S. and Gavrilović, M. (2021a). Application of WASPAS method in the evaluation of efficiency of agricultural enterprises in Serbia. *Economics of Agriculture*, 68(2), 375–388.
22. Lukić, R. (2021b). Analysis of the efficiency of insurance companies by lines of insurance in Serbia using the COCOSO method. *Insurance Trends*, 2, 24–38. <https://doi.org/10.5937/TokOsig2102009L>
23. Lukić, R. (2021c). Application of MABAC method in evaluation of sector efficiency in Serbia. *Review of International Comparative Management*, 22(3), 400–417. <https://doi.org/10.24818/RMCI.2021.3.400>
24. Lukić, R. (2021d). Analysis of trade efficiency in Serbia based on the MABAC method. *Ekonomski pogledi – Economic Outlook*, 23(2), 1–18.
25. Lukić, R. (2021e). Analiza efikasnosti finansijskih institucija na bazi OCRA metode. *Tehnika*, 76(1), 103–111. <https://doi.org/10.5937/tehnika2101103LLukic>
26. Lukić, R. (2021f). Application of ARAS method in assessing the efficiency of insurance companies in Serbia. *Insurance Trends*, 3, 23–36. <https://doi.org/10.5937/tokosig2103009F>
27. Lukić, R. (2022a). Evaluation of the efficiency of banks in Serbia using the MABAC method. *Bankarstvo - Banking*, 2, 35–60. <https://doi.org/10.5937/bankarstvo2202010L>
28. Lukić, R. (2022b). Analysis of financial performance and efficiency of banks in Serbia using fuzzy LMAW and MARCOS methods. *Bankarstvo – Banking*, 4, 130–169. <https://doi.org/10.5937/bankarstvo2204130L>
29. Lukić, R. (2022c). Application of the MARCOS method in analysis of the positioning of electronic trade of the European Union and Serbia. *Informatica Economică*, 26(3), 50–63. <https://doi.org/10.24818/issn14531305/26.3.2022.05>
30. Lukić, R. (2023a). Analysis of the performance of companies in Serbia listed on the Belgrade stock exchange. In *Zbornik radova – Računovodstvo i revizija u teoriji i praksi* (Vol. 5, No. 5, pp. 69–80). Banja Luka College / Besjeda Banja Luka. <https://doi.org/10.7251/ZRRRTP2301069L>
31. Lukić, R. (2023b). Measurement and analysis of the information performance of companies in the European Union and Serbia based on the fuzzy LMAW and MARCOS methods. *Informatica Economică*, 27(1), 17–31. <https://doi.org/10.24818/issn14531305/27.1.2023.02>
32. Lukić, R. (2023c). Influence of net working capital on trade profitability in Serbia. *European Journal of Interdisciplinary Studies*, 15(1), 48–67. <https://doi.org/10.24818/ejis.2023.04>
33. Lukić, R. (2023d). Application of PROMETHEE method in evaluation of insurance efficiency in Serbia. *Revija za ekonomske in poslovne vede – Journal of Economic and Business Sciences*, 10(1), 3–19. <https://doi.org/10.55707/eb.v10i1.121>
34. Lukić, R. (2023e). Analysis of the efficiency of insurance companies in Serbia. *Revija za ekonomske in poslovne vede*, 10(2), 47–64. <https://doi.org/10.55707/eb.v10i2.128>

34. Lukić, R. (2023f). Analysis of the performance of insurance companies in Serbia based on the AHP-TOPSIS method. *Marsonia: Časopis za društvena i humanistička istraživanja*, 2(2), 21–35.
35. Mandić, K., Delibašić, B., Knežević, S. and Benković, S. (2017). Analysis of the efficiency of insurance companies in Serbia using the fuzzy AHP and TOPSIS methods. *Economic Research – Ekonomska Istraživanja*, 30(1), 550–565. <https://doi.org/10.1080/1331677X.2017.1305780>
36. Mathew, M. and Sahu, S. (2018). Comparison of new multi-criteria decision-making methods for material handling equipment selection. *Management Science Letters*, 8(3), 139–150. <https://doi.org/10.5267/j.msl.2018.1.004>
37. Nedeljković, M., Puška, A., Doljanica, S., Virijeć Jovanović, S., Brzaković, P. and Stević, Ž. (2021). Evaluation of rapeseed varieties using novel integrated fuzzy PIPRECIA–Fuzzy MABAC model. *PLOS ONE*, 16(2), e0246857. <https://doi.org/10.1371/journal.pone.0246857>
38. Okwu, M. O. and Tartibu, L. K. (2020). Sustainable supplier selection in the retail industry: A TOPSIS- and ANFIS-based evaluating methodology. *International Journal of Engineering Business Management*, 12, 1–14. <https://doi.org/10.1177/1847979019899542>
39. Pachar, N., Darbari, J. D. and Govindan, K. (2021). Sustainable performance measurement of Indian retail chain using two-stage network DEA. *Annals of Operations Research*. <https://doi.org/10.1007/s10479-021-04088-y>
40. Pamučar, D. and Čirović, G. (2015). The selection of transport and handling resources in logistics centers using Multi-Attributive Border Approximation Area Comparison (MABAC). *Expert Systems with Applications*, 42(6), 3016–3028. <https://doi.org/10.1016/j.eswa.2014.11.057>
41. Rakonjac-Antić, T. (2018). *Penzijsko i zdravstveno osiguranje*. Beograd: Ekonomski fakultet.
42. Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences*, 1(1), 83–98. <https://doi.org/10.1504/IJSSCI.2008.017590>
43. Singh, J., Tyagi, P., Kumar, G. and Agrawal, S. (2020). Convenience store locations prioritization: A fuzzy TOPSIS-GRA hybrid approach. *Modern Supply Chain Research and Applications*, 2(4), 281–302. <https://doi.org/10.1108/MS CRA-01-2020-0001>
44. Tsai, C.-M., Lee, H.-S. and Gan, G.-Y. (2021). A new fuzzy DEA model for solving the MCDM problems in supplier selection. *Journal of Marine Science and Technology*, 29(1), Article 7. <https://doi.org/10.51400/2709-6998.1006>
45. Timiryanova, V. (2020). Analyzing the production-distribution-consumption cycle using hierarchical modeling methods. *Accounting*, 6(7), 1313–1322.
46. Vojteški Kljenak, D. and Lukić, R. (2022). Evaluacija efikasnosti davalaca finansijskog lizinga u Srbiji. *Glasnik društvenih nauka – Journal of Social Sciences*, 14(XIV), 113–144.

Economics of Software Engineering in Slovenia

DOI <https://doi.org/10.55707/eb.v12i1.148>

Original scientific article

UDC 004.41:33(497.4)

KEYWORDS: digitalization, digital piracy, economics, software engineering, open-source software, public administration, Slovenia, sustainability

ABSTRACT – Information technologies and their software engineering branch are an important part of the modern economy and its digitalization. At the same time, they are influenced also by the economy, and have formed their own economic fields. However, this field remains poorly studied in some aspects. Understanding them can improve the field's operation. The research presented is of a sequential qualitative nature. The first part is a scoping literature review of the global software engineering economics. This is followed by a narrative literature review of the identified topics in the Slovenian environment. The results have shown similarities and deviations in the national economy. Some of the latter, like public sector-related specifics, need additional consideration, and some of them, like digital piracy- and sustainability-related, identify challenges for the country's software engineering sector. Research results can be used by professionals to improve their knowledge about the economics of the business field both globally and locally. Also, they can be used for the promotion and improvement of the studied concepts in Slovenia and as a good starting point for continuing research works on the topics analyzed.

Izvirni znanstveni članek

UDK 004.41:33(497.4)

KLJUČNE BESEDE: digitalizacija, digitalno piratstvo, ekonomija, javna uprava, programska oprema, Slovenija, trajnost

POVZETEK – Informacijske tehnologije in njihova veja programski inženiring so pomemben del sodobnega gospodarstva in njegove digitalizacije. Hkrati pa so pod vplivom ekonomike in so oblikovali svoja gospodarska področja. Vendar so ta področja na nekaterih podpodročjih še vedno slabo raziskana. Njihovo razumevanje lahko izboljša delovanje področja. Predstavljena raziskava je zaporedne kvalitativne narave. Prvi del je pregled literature o globalni ekonomiji programskega inženiringa. Nato sledi pripovedni literarni pregled identificiranih tem v slovenskem okolju. Rezultati so pokazali podobnosti in odstopanja v nacionalnem gospodarstvu. Nekatere od slednjih, kot so posebnosti, povezane z javnim sektorjem, je treba dodatno upoštevati, nekatere od njih, kot sta digitalno piratstvo in trajnost, pa predstavljajo izzive za sektor programskega inženiringa v državi. Rezultate raziskave lahko strokovnjaki uporabijo za izboljšanje svojega znanja o ekonomiji poslovnega področja na svetovni in lokalni ravni. Prav tako se lahko uporabijo za promocijo in izboljšanje proučevanih konceptov v Sloveniji in kot dobro izhodišče za nadaljevanje raziskovalnega dela o analiziranih temah.

1 Introduction

Information technologies (IT) have become omnipresent in all spheres of human life and activities in the recent past. This applies to economics as well. The influence of IT and digitalization there is hard to overestimate. At the same time, information technologies have become a huge economic sector as well. It has its own basic principles, model, techniques utilized, and other specifics (Boehm, 1984; Madauss, 2024; Sneed, 1991).

Software engineering is a branch of IT that deals with the development of computer software. It is extremely important because without software computers cannot operate by themselves and, in the end, become useless. The mentioned branch focuses on the process of development at all stages, from planning and design to deployment and maintenance. It has been developing rapidly in the past few decades and is now extremely huge with its own economic and management principles (Felderer et.al. 2020).

Despite its importance, active study and development of software engineering still remain risky and are, in some cases, a poorly studied economic and business field. Recent research works have shown that 20-30 percent of all software projects are nowadays still failing, and 80-90 percent of employees from the field believe that the projects they are working on will not be successful or, even worse, that they are “doomed” (Money et.al., 2021). For this reason, it is very important to continue the research in the field that will enhance the understanding of the field’s economics and improve its business.

In Slovenia, this field is poorly studied. However, official statistics show that it is quite popular and the number of companies and people employed in the IT and software engineering sectors has grown, while the number of closed companies has decreased by 7, 9, and 21 percent accordingly in the years 2020-2022 (Enterprise Births and Enterprise Deaths by ACTIVITY, YEAR, MEASURES and SIZE OF ENTERPRISE-PxWeb, n.d.; High-growth Enterprises by ACTIVITY, YEAR and INDICATOR-PxWeb, n.d.). This is more or less expected because of the ongoing immutable digitalization of all economic and business areas (Oršič, 2023; Zabukovšek, 2016; Zabukovšek, 2024).

Despite IT, in general, and software engineering, in particular, being treated as a very internationalized and globalized area, national specifics play an important role. Especially when it comes to the economic aspects, because the area is influenced by the national environment and specifics as well as all others. Also, the production of the companies dealing with software development is still distributed in the nationalized business markets. For this reason, it is important to study the economics of software engineering in the scope of national environments, like the Slovenian one.

The economics of software engineering in Slovenia and its study are very important since digitalization has been immutably ongoing in all sectors of national economics for a relatively long period of time. For example, the number of organizations utilizing digital technologies in any form has grown by 4 percent in the period of 2010-2019 (The Usage of ICT Hardware and Computer Networks in Enterprises With 10 or More Persons Employed (NACE Rev. 2) by YEAR, ICT USAGE IN ENTERPRISES and ACTIVITY-PxWeb, n.d.), those of them using cloud services by 11 percent in the years 2021-2023 (Number of Enterprises by YEAR, PURCHASE OF CLOUD COMPUTING SERVICE and ENTERPRISE SIZE CLASS-PxWeb, n.d.) and finally, those of them implementing e-business and related software by 15 percents in the period of 2021-2024 (Number of Enterprises by YEAR, ELECTRONIC EXCHANGE OF INFORMATION IN THE ENTERPRISE and ENTERPRISE SIZE CLASS-PxWeb,

n.d.). There are several reasons for such a trend, mainly related to the efficiency of the business operation and improved decision-making. As was mentioned, software plays a critical role in the process of digitalization of the economy, driving innovations and enhancing products and services (Felderer et.al. 2020). However, the related business area still stays poorly studied and risky, particularly on the national level. This makes its study and understanding critical for the development and the future of the national economy.

The work presented in continuation is intended for the systematization of the existing knowledge, concepts, and models in the area of economics of software engineering and their extension for Slovenia as well as for the countries with similar local environments and specifics, like for instance huge public sector of the economy.

2 Methodology

The entire research was designed as two sequential literature researches. First, the scoping literature review was planned to be conducted because the topic of the study is still relatively new and poorly studied. The goal was to analyze the field and the existing trends in the global environment. Then, the second part should have followed: the narrative literature research. This part should have been based on the results of the scoping literature review and study of the topics, identified in the Slovenian environment.

2.1 Scoping literature review

As a methodology for the research of the theory, the scoping literature review was selected, as was mentioned since the topic of the study is still relatively new and poorly studied.

This methodology is known, because it helps ensure a complete and comprehensive overview of some relatively new or poorly studied themes. Its goal is to find, map, analyze, and summarize as many sources on the topic of study as possible with the purpose of making sure no existing knowledge is missed, as well as to identify the most important concepts and gaps. The key steps here are as follows:

1. Definition of the research question
2. Definition of the query for search
3. Search for sources
4. Selection of the relevant sources
5. Data extraction and organization
6. Analysis and summarization of data
7. Synthesis and presentation of the results (Hart, 1998; Ma, 2022)

The research questions (RQs) defined by the author were as follows:

- RQ1. What is software engineering economics?
- RQ2. What are the world specifics of the software engineering sector economics?

- RQ3. What are the specifics of the software engineering economic sector in Slovenia?
- RQ4. What are the key similarities and differences between Slovenian and world specifics?
- RQ5. What are world trends in the software engineering economic sector?
- RQ6. What are the trends of the software engineering economic sector in Slovenia?
- RQ7. What are the key similarities and differences between Slovenian and world trends?

Considering these questions and the popularity of agile methodologies in the software engineering sphere (Nikitashin et. al., 2024), the keywords selected for the query were as follows:

- Agile methodologies
- Economics
- Management
- Software development
- Software engineering

The filtering criteria were defined as shown in Table 1

Table 1

Criteria for the scoping literature review

Criteria	Description	Objectives
Actuality	The work is not older than 20 years.	Ensure that only valid knowledge was included in the analysis.
Reliability	The work was peer-reviewed, according to the data for the website of the resource.	Ensure the results of the analyzed work are reliable and officially confirmed.
Uniqueness	The work does not repeat and reference one of the works already analysed.	Ensure the results of the analysis do not contain unnecessary repetitions and are balanced.
Validity	The work studies one of the topics specified by one of the research questions or its relationship with agile methodologies.	Ensure the work is relevant to the analysis.

For the search, the Scopus database was selected as one of the biggest and most recognized interdisciplinary databases. Also, some sub-sources of the research items found, which the latter were referring to, were included in the analysis.

2.2 Narrative literature review

The narrative literature review methodology is intended to summarize the existing knowledge on the selected topic and critically analyze the findings. Its aim is to give a comprehensive overview of the current state of knowledge on the topic of interest. The steps to successfully conduct the review are the following:

1. Definition of the scope (identification of the key themes, questions, and boundaries of the topic of study)
2. Search for literature (definition of the keywords, search for the sources in databa-

ses and reference lists to find relevant studies)

3. Evaluation of the sources (evaluation with a focus on quality, relevance, and credibility)
4. Synthesis of the information (identification of common themes, patterns, and contradictions in the literature)
5. Organization and writing of the review (organization of the results on a thematic, chronological, or methodological basis) (Hart, 1998)

Based on the results of the scoping literature review, the topics and keywords were defined as follows:

- Digital piracy
- Digitalization
- Economics
- Open-source software
- Public administration
- Software engineering
- Sustainability

The search was conducted in the COBISS database as the most comprehensive source of the scientific works on the selected topic in the Slovenian national environment.

3 Results

After conducting both parts of the research, the following results were obtained and organized into two meaningful parts.

3.1 The world

Both software engineering and economics influence each other.

Digital transformation and information technologies (IT) in general play an important role in the field of economy. They can help to improve such aspects as:

- General efficiency by streamlining economic processes and enhancing data analysis and management with higher efficiency and accuracy;
- Decision-making with the help of comprehensive data analysis;
- Resource management with optimization of the allocation and reducing costs. (Rusakova & Bystrov, 2024)

Software engineering as a branch of information technologies has a key role in digital transformation in all economic sectors. It is a key innovation driver enhancing all aspects, including products, systems, and services. Software is already integrated and will continue its integration in the listed aspects as well as in everyday lives of people. For this reason, it will require the involvement of economic and business specialists in development (Felderer et.al. 2020).

Project management software can serve as a more particular example. While the process itself is possible even without the IT support, in this case, it is much less effective. At the same time, project management software is just a tool, and it cannot do everything by itself. Here, similarly to any IT-supported economic and managerial sphere, it is important to consider an adequate level of integration, as well as good organizational culture and management, and also technological and educational preparedness for the implementation of the technology (Madauss, 2024).

As was mentioned, software solutions can enhance almost all economic spheres in different aspects. As an example, we can use farming. Implementation of specially developed software, enhanced with the most actual features, like artificial intelligence (AI), can help in the optimization of crop yields and consequently increment of profitability of small-size farms (Kulibaba & Barinov, 2024). Another example is shipbuilding. Possible benefits here are improved planning, design, construction, and management of ships; in particular, reduced risks related to errors in planning and design, more efficient collaboration among the project participants, and enhanced maintenance and management of ships (Yanchenko, 2024).

At the same time, as was mentioned, economics and management play an important role in software engineering.

While planning and designing a software project, it is critical to consider such economic aspects as long-term viability and sustainability, well-analyzed cost-effectiveness, and value creation with improvements in performance, maintainability, and scalability (Grundy, 2014).

Historically, at the very beginning of the software engineering era, it was a standard that the entire process of development was conducted by the engineers themselves. This approach very often causes cost overruns and user-unfriendly systems because of a weak understanding of the relationship between requirements and costs. Here, it is important to integrate requirements, architecture, and development process, as well as utilize cost and schedule estimates for effective management of the projects, to avoid the creation of mission-disruptive systems. Also, it is important to consider fast changes in the area and adequately adopt techniques, models, and tools for them (Boehm & Sullivan, 2000).

The earliest and the most comprehensive sources about the topic of software engineering economics were authored by Boehm (1984) and Sneed (1991). Despite their age, they are still very popular in the sphere and are addressed in a large number of very recent sources. For this reason, they were included in the analysis, even though they do not meet all the filtering criteria.

The economic analysis techniques and models play an important role in software engineering and management. Examples are the following:

- Cost-benefit analysis (determination of the overall value and feasibility of the project)
- Return on Investment (ROI) analysis (allocation of resources to maximize financial return)

- Risks analysis (consideration of potential financial impacts in planning of the project)
- Cost estimation analysis (utilization of COCOMO (Constructive Cost Model) for estimation of the costs of the project)
- Trade-off analysis (comparison of different design and implementation options considering their economic implications, to balance performance, costs, and other important factors) (Boehm, 1984; Sneed, 1991)

Considering the recommendations for the utilization of cost-effectiveness principles can be pointed to the possibility of the use of Markov models (Hamori & Bhar, 2004).

The described techniques are important, because the most critical roles in the projects are given to accurate cost estimation as well as effective resource allocation, due to their limitedness. Decision-making in such projects must always consider both technical and economic points of view, keeping an adequate balance between them. The stated applies both for software development and re-engineering projects (Boehm, 1984; Sneed, 1991).

In the recent past, economic models' utilization in software engineering has been studied in different contexts, for example, in terms of implementation of software product line engineering (SPLE). The core idea of SPLE is the development of a family of systems with reusable core assets. Realization of this concept requires a huge initial investment. For this reason, the analysis of the cost-benefit aspects plays an important role. Besides the already described techniques and models, the following are proposed:

- Total Cost of Ownership (TCO) (understanding of the long-term financial effect and sustainability of SPLE)
- Net Present Value (NPV) (comparison of SPLE with other opportunities for investment in terms of economic viability)
- Economic Value Added (EVA) (determination of whether SPLE will generate sufficient returns of value to justify the investments) (Thurimella & Padmaja, 2014)

Some additional important software development aspects have been studied from an economic perspective and should be considered while managing projects:

- Software quality (usability, ease of learning, usage frequency)
- Economic incentives (the biggest and the most successful software companies are incentivized to create high-quality, well-balanced, and user-friendly software) (Zhu & He, 2016)

Software quality is closely related to software testing. In this area, a high level of co-operation between technical and business specialists is recommended. This may help to achieve better results by balancing testing effectiveness (number of errors uncovered) with economic aspects like cost and time consumption (amount of resources and time spent) (Shi, 2010).

Additionally, an important aspect influencing software quality is technical debt arising during the development process. They can be described as events of change

of trade-off and requirement or conflicts of interest occasionally happening during the development process, for instance rushing a system to the market at the expense of its quality. Here, a proper analysis with such techniques as real options, cost-benefit, and value-based analysis is recommended. Also, it is critical to establish a common vocabulary for the business and technical specialists (Ampatzoglou et al., 2015).

While developing and planning software solutions, it is important to consider some additional important business aspects:

- User involvement (active participation of users in the development and adoption processes including their training engagement and organized feedback provision)
- Self-efficacy (confidence of the users in their ability to use the new software effectively)
- Perception of need (positive perception of the necessity for software solution)
- Public recognition (recognition and support from the stakeholders and broader community) (Begicheva et al., 2024)

In the recent past, some authors have proposed a deeper development of the theory of the software engineering economics; for example, with the creation of taxonomy and classification. It may help to improve such aspects as cost-benefit analysis, helping to make more informed decisions and resource allocation and management, leading to a much more economically efficient process of software development (Usman et al., 2017).

Besides the factors mentioned, economy and its conditions are important in software engineering as in any sector as well. Nevertheless, the IT sector in general is obviously treated as global and less dependent on some local disturbances; bad conditions, like uncertainties and layoffs, can significantly influence the software development market. Like anywhere else, companies there must always monitor the situation and be ready to adapt themselves, their strategies, behaviour, models, and management (Žatuchin, 2024). The last one is especially important, because the right selection of the development model and methodology can significantly influence different factors, from productivity to satisfaction of the employees in the sector (Nikitashin et al., 2024).

In recent years, besides the previously described, there have been two of the most popular topics in the relationship between software engineering and economics.

The first is software piracy and its economic impact. As may be expected, it was determined that piracy hurts economic growth by reducing incentives for development companies to create new products, which slows down technological progress and the growth of productivity. At the same time, it was pointed out that this relationship is very complex and controversial. Also, high levels of piracy can serve as an indicator of poor economic and legal institutional quality in the country (Fernandez et al., 2018).

The second topic is open-source software (OSS), which can be treated as a solution to the piracy problem.

OSS is a unique economic phenomenon. It is software developed by volunteer programmers collaborating through informal communities. These systems are distri-

buted freely and despite being developed by volunteers, they often achieve a high level of complexity and quality. Thus, OSS can be a competitor to the traditional paid software and the companies developing it. Such organizations must adapt their strategies to this competition.

At the same time, OSS engineering changes exist and create a new economic and business model. It has a minimal cost of development due to volunteer contribution. Developers of such systems invent absolutely new monetization strategies, like paid support services, development of custom versions, licensing, and hosting services. Last but not least, OSS accelerates innovations in the field thanks to its openness, and consequently, rapid improvements and implementation of new, sometimes unique features. Due to its high competitiveness, some traditional companies are now switching their models to OSS-based ones (Bitzer & Schröder, 2006).

Such software may help in the economic development of the field by reducing costs and increasing innovation, because it allows more developers to contribute and improve the systems and because it provides access to advanced technologies for a broader audience (Kamau & Namuye, 2012; Kshetri, 2025). At the same time, there are some considerations about the sustainability of OSS present (Kshetri, 2025). Additionally, such reasons as loyalty to more popular and widely recognized solutions, as well as lack of awareness, training, and public support, are mentioned as stoppers of development and utilization of OSS (Kamau & Namuye, 2012).

Public and governmental institutions' support may be a solution for the described issues. On the one hand, OSS can contribute to the growth of the economy of a country by accelerating digitalization, increasing market competitiveness, creating innovation and jobs, and the development of new business models. On the other hand, public support and funding can reduce the financial burden related to the development and provide long-term stability for OSS projects. At the same time as with any software project, it is important to consider all economic aspects and conduct all the standards previously described before actual investments. This may be very complex and problematic, and here, specially developed toolkits should be utilized, considering potential economic, social, and technical impacts (Osborne et al., 2024).

An additional factor that must be considered in modern software engineering economics is sustainability. It is important because of the long-term economic and financial benefits for companies, like reduced operational costs, and because nowadays it may significantly influence public reputation which is especially important in the case of OSS projects. The term sustainability can be used in different meanings such as:

- Environmental sustainability (energy efficiency, utilization of green data centers, prioritization of renewable energy sources)
- Social sustainability (inclusive and diverse working environment, fair labour practices, accessibility of products to all users)
- Economic sustainability (cost-effective resource management, sustainable business models, economic benefits of adopting sustainable practices)

Integration of all listed aspects is critically important for establishing sustainable development process and products (Schott & Ovtcharova, 2024).

Two very important steps helping on the way to achieve sustainable software engineering in a company are the implementation of Life Cycle Analysis (LCA) and ISO quality models.

The first one means a complex analysis of the entire development process in all key steps. It can be used to evaluate the impact of software on the environment, including both its development and operation, for instance, through monitoring energy consumption, usage of resources, and emissions. This may help to identify specific areas where impacts on the environment can be reduced; for example, by optimizing code for better energy efficiency, sustainable materials selection, or process improvements to minimize waste.

ISO quality models in turn can help through the following:

- Providing standardized guidelines helps to integrate sustainable practices into software development processes and ensure that sustainability practices are consistently applied across different projects and organizations.
- Achieving and balancing high-quality and sustainable outcomes by emphasizing the importance of paying equal attention to performance, reliability, and environmental responsibility.
- Promoting a culture of continuous improvement and motivating organizations to regularly evaluate and enhance their sustainability practices, helping them to identify new opportunities to reduce the impact on the environment and improve the efficiency of utilization of resources.
- Ensuring that sustainable practices are recognized worldwide and can be implemented in different regions and industries. Such universal applicability makes it easier for organizations to adopt and implement sustainability practices (Qiang et al., 2024).

The social sustainability aspect plays an extremely important role in modern software development as well. It involves creating technology that helps to improve people's lives and at the same time mitigates social risks and tends to minimize negative impacts on society and human beings, as well as on economy and the environment. It helps to reduce negative social impacts, like social isolation, cybercrime, and surveillance capitalism. One of the key recommendations for developers and organizations is to deprioritize antisocial features and promote positive social interactions and inclusivity in their products (Ayoola et al., 2024).

3.2 Slovenia

Digital transformation of the different economic sectors is ongoing both in Slovenia and the world now. For example, in the automobile industry, the integration of enterprise resource planning (ERP) and manufacturing execution (MES) systems for the automation of processes is recommended by some authors. The reasons are that it brings such benefits as improved efficiency of production, decision-making as well as error reduction, and a more productive working environment (Zabukovšek, 2016). Another example is logistics, where digitalization helps to achieve better sustainability and consequently economic results (Oršič, 2023).

Some other research works conducted in Slovenian companies have shown the importance of digitalization and a strategic approach to conducting it. This strategy must be well-developed and aligned with the business one. Otherwise, even the most successful organizations may fail to adopt the best and the most successful business strategies if there are misalignments with the IT strategy (Zabukovšek, 2024). Digitalization brings several benefits, like improved productivity, less workload for employees, time savings, and reduced costs. At the same time, it requires good adoption of employees and management of the organization.

Considering the specifics of the market with a large number of small- and medium-sized enterprises, certain frameworks for informatics management in such organizations have been studied and developed (Levstek, 2022). Furthermore, studies include some specific digitalization topics, like optimization of business processes with artificial intelligence (AI) in Slovenian banks, which led to operating improvements (Smirnov, 2024). Additionally, the utilization of AI can have a positive impact on the management of projects in the software development area as well; for instance, by reducing time consumption and consequently decreasing costs of development and improving satisfaction of customers (Nikitashin, 2025).

Digitalization in Slovenia is taking place on different management levels. One of them, important in terms of this analysis and software engineering in general, is human resource management. Its digitalization in the country brings both opportunities and threats, and sometimes faces local problems as well. However, it remains an important factor in the success of any organization with improved information flow, innovation, creativity, and motivation of employees (Kiselak, 2022).

At the same time, some classical, hierarchical management approaches are identified as inefficient in the modern Slovenian organizations in general. For this reason, the utilization of some principally new, agile-like approaches, like self-organized working groups, has been proposed. Utilization of this approach helps to significantly increase developmental power, innovation, and to a lesser degree, efficiency inside an organization (Kopina, 2018).

Digital piracy is a significant issue present both in Slovenia and all developing countries. The reasons for the high rate of piracy are the high costs of legal content, unavailability of some services, and easy access to pirated content without strict control over its distribution. This led to economic losses for the creators and legal distributors of services and content. The situation has been changing for the better with the decrease in piracy rate in the recent past. However, there is still a need for changes to combat the problem; for example, increase in availability of the legal distribution sources or much stricter copyright law and control over its compliance (Žvar, 2023).

As anywhere else, availability of legal sources can be achieved with OSS promotion. It has already found utilization in some professional spheres in Slovenia, such as civil engineering. Research has identified that there are some solutions that already exist, and they have a good potential for future development. Implementation of such solutions may bring some economic benefits, like cost savings, especially for small businesses, which are present in big numbers on the national market (Prša, 2015).

Besides industry-specific applications, OSS can be utilized for purposes much more common across different organizations; for instance, for process engineering. OSS tools may bring such benefits as:

- Cost-effectiveness (it eliminates costs of licensing, making it accessible for low-budget organizations like small businesses and educational institutions)
- Flexibility (it allows extensive customizations and adaptations to specific problems of the organization, providing a universal tool for different applications)
- Support (it has a community of developers and users, contributing to its regular, non-stop improvement and providing support)
- Integration (it can be integrated with other software tools and libraries, which enhances its functionalities and allows comprehensive simulations of the processes)

At the same time, some disadvantages were identified, including:

- Complexity (it can be hard to understand and challenging for new users, requiring significant investments of time and effort to learn it)
- Poor documentation (its documentation may not always be up-to-date or comprehensive enough, which causes difficulties for users who need specific guidance or support)
- Performance (it can have limitations of performance in case of very complex simulations, particularly while being used with less powerful hardware) (Arih, 2024)

Digitalization is also happening in Slovenian public services and administration, where areas for potential enhancements with IT have been identified. For instance, in the public healthcare system, with systems for the provision of feedback of customers, which can help improve the quality of the services (Mohorič Kenda, 2018), or in tax collection, with improved data management systems, which can help simplify and streamline the process and collection, as well as distribution utilization of the taxes collected, for example, for the development of the infrastructure and services (Kozlovič, 2016).

In some cases, the implementation of IT enhancements has already started and was reported, for instance, a project for the renovation of information infrastructure in the Ministry of Public Administration. The results analysis has shown improved delivery of services, better management of data, increased transparency of operating, and general satisfaction of citizens as key benefits. At the same time, such projects require continuous monitoring, engagement of stakeholders, and regular adoption of technological advancements (Lojk, 2016). The results analysis of another project for the centralization of ICT at the same ministry has also identified some benefits, such as improved efficiency, reduction of costs, enhanced security of data, and better management of resources. At the same time, some challenges were also identified, primarily related to human resources, e.g. necessity for training, resistance to change, and technical issues. However, the benefits prevail, and it is recommended to continue such projects across the entire public sector (Primec, 2023).

Of course, there are or could be some issues present during the process of digitalization in the public sector. For example, data security risks, because the governmental institution can be the target of different kinds of cyberattacks. The success of such

attacks may have a significant negative effect on the citizens' trust. However, those problems can be prevented with the utilization of advanced encryption techniques and methods for secure authentication, as well as with the conduction of regular security audits. Additionally, digitalization may help to reduce risks of corruption by enhancing accountability, transparency, and traceability of distribution and utilization the public funds (Arnšek, 2024; Černe, 2022).

As elsewhere, the digitalization of the public administration in Slovenia can be enhanced by OSS. Organizations from the governmental sector often face such challenges as budget limitations and high expectations and demands from the citizens. Utilization of modern IT and software can help make their operation faster and much more efficient. Some European countries have already implemented a certain kind of OSS in the public sector organizations. Analysis has shown that this helped improve such aspects as efficiency and cost-effectiveness by reducing licensing costs associated with proprietary software. OSS also has such benefits as adaptability and flexibility, because it can be tailored to meet the specific customers' needs. Additionally, OSS may provide governmental institutions independence from the specific traditional private providers. Of course, there are some smaller short-term shortcomings, similar to other economic sectors, but still, long-term opportunities and benefits outweigh (Dujčić, 2007; Upelj, 2010).

In terms of sustainability of IT in Slovenia, for instance, the so-called green computing has been studied. It is a kind of strategy intended to reduce the carbon emissions of computing and consequently contribute to a healthier and safer environment. There were both positive and negative findings in this field. On the one side, Slovenia stays outside of the rest of the world in terms of awareness and adoption, with approximately 80 percent of the population never having heard about the concept itself. At the same time, there is a growing recognition of the importance of green computing and its potential benefits, with half of the respondents of the thematical survey recognizing it as a significant element of the organizational strategy in the near future (Milošič, 2023).

4 Discussion

With respect to RQ1, it can be identified that software engineering economics is a branch of economics studying the business area related to the development of software at all stages. It plays an important role in the ongoing digitalization of the entire economy, which was one of its most significant trends in the recent past, and the results of both parts of the research have shown its importance in global and Slovenian environments. In both of them, digitalization faces issues but still brings much more benefits than problems. Answering RQ2-RQ4, it can be stated that the economic branch of software engineering and its specifics have similarities in both environments as well. Despite the fact that the models and techniques utilized on the national market have not been studied locally in the recent past, they can be assumed to be similar because

of the large number of the same trends and issues. For example, both the national and the global business fields have a trend of implementing and utilizing agile principles in management. Also, both of them are facing the negative impact of digital piracy, even though in Slovenia, the problem is a little bit more acute, similarly to all developing countries. Also, in the local and the global environments, the potential of cooperation between the developers and distributors of OSS and the public institutions, as well as its overwhelming benefits, have been identified (RQ2-RQ7).

At the same time, some local deviations and specifics were found, for example, addressing RQ2-RQ4, in the structure of the markets in general. The Slovenian market has a much bigger share of the small and medium-sized organizations. For this reason, some specific models for IT management have been developed and recommended for utilization there.

Additionally, similarly to most post-socialistic countries, Slovenia has a relatively big public sector in terms of economy. According to the data published by the OECD, Slovenia has a small under-average percentage of working power employed in the public sector and above average size of the sector (“Government at a Glance 2023: Slovenia,” n.d.). It is probably due to this reason that more research on the IT and software in governmental organizations was conducted than on average. Also for this reason, it is much more important to consider the research results and finding about OSS, as well as the cooperation of its developers with public institutions, since it may be more critical for the country and its economic environment and can bring import benefits for both parts, as well as help in the development of the Slovenian national economy (RQ3, RQ4).

Another important moment is sustainability and its promotion due to its important role in the modern economy; it can bring a lot of long-term benefits outweighing short-term issues. However, at the same time, it is still poorly known in Slovenia and a large percent of the population has never heard of some of the important concepts; on the other hand, people have shown the understanding of the importance of sustainability and its application in the economy in general (RQ3, RQ4, RQ6, RQ7).

5 Conclusion

In conclusion, it should be mentioned that the research has limitations, including its theoretical nature in general and the limited number of sources studied. It has not included any kind of analysis of the real economic and business area, neither globally nor locally. However, it was, for the most part, structurally and comprehensively conducted, in strict accordance with the well-established and widely recognized literature research methodologies and the plan defined at the beginning. For this reason, it can be described as successful and its results as useful.

The findings of this work can be utilized for different purposes. For instance, for professionals working in the field in leading or technical roles, both locally and around the globe, as a comprehensive overview and guidelines for understanding the econo-

mics of the area and work organization of companies. Also, this work can be utilized for the promotion and improvement of the studied concepts in Slovenia. In the end, it can be a good starting point for continuing the research on the topic both in Slovenian or similar national economic environments and globally.

Maksim Nikitashin

Ekonomija programskega inženirstva v Sloveniji

Informacijske tehnologije (IT) so v nedavni preteklosti postale pomemben del sodobnega gospodarstva in njegove nenehne digitalizacije. Hkrati so oblikovale lastno gospodarsko in poslovno polje z veliko posebnostmi. Tako informacijska tehnologija kot gospodarstvo vplivata drug na drugega. Prva s stalno neustavljivo digitalizacijo vseh poslovnih področij. Slednje z vplivom gospodarskih in nacionalnih posebnosti na ljudi in organizacije, ki se ukvarjajo z informacijskimi tehnologijami kjer koli po svetu.

Programsko inženirstvo je veja informacijskih tehnologij, ki se ukvarja s programsko opremo za računalnike. Ta je zelo pomembna za napredek informacijskih tehnologij in digitalizacijo gospodarstva, saj računalniki brez programske opreme lahko postanejo neuporabni. Tudi ta veja je v zadnjih desetletjih oblikovala svoje poslovno podpodročje z večjim številom posebnosti. Vendar sta tako informacijska tehnologija kot programski inženiring še vedno naložbeno tvegana in na nekaterih področjih slabo raziskana. To velja tudi za tematike ekonomskih principov, modelov, tehnik in njihovih specifik na področju IT. Navedeno je prisotno tako v svetovnem merilu kot predvsem v nekaterih lokalnih nacionalnih okoljih, kot je slovensko. Razumevanje teh tem lahko bistveno izboljša delovanje področja in delo na njem ter zmanjša število nastajajočih težav. Zaradi tega je pomembno izvajati strukturirane študije te tematike na globalni in tudi nacionalni ravni.

Predstavljena raziskava je zaporedne kvalitativne narave. Prvi del obsega pregled literature o globalni ekonomiji programskega inženiringa, njenih trendih in posebnostih. Navedena metodologija je izbrana predvsem zaradi slabe priučenosti tematike. Sledi drugi del: narativni literarni pregled izbranih tem v slovenskem okolju, ki temelji na ugotovitvah prvega dela. Pri obeh metodologijah je potrebno določiti tematike, vprašanja in ključne besede, nato pa opraviti iskanje, analizirati in sintetizirati rezultate ter zapisati ugotovitve. Razlika je v tem, da prva običajno v začetnem delu zahteva še določene kriterije ter je bolj splošna in manj selektivna kot druga. Za iskanje v prvem delu je bila izbrana znanstvena baza Scopus kot ena največjih in najbolj prepoznavnih. V primeru narativnega pregleda je iskanje potekalo v bazi podatkov COBISS kot največji nacionalni bazi podatkov, ki vsebuje največje število raziskovalnih del o Sloveniji in njenem okolju.

V prvem delu so določene posebnosti in trendi, kot so pomembnost in največje prednosti digitalizacije sodobnega gospodarstva in poslovanja na skoraj vseh obstoječih področjih z veliko primeri, pomemben vpliv programskega inženirstva na proces digitalizacije, uporaba predvsem modelov in tehnik, povezanih s stroškovno učinkovitostjo v sektorju razvoja programske opreme, kot so analiza stroškov in koristi, analiza donosnosti naložbe, analiza konstruktivnega stroškovnega modela (COCOMO), analiza kompromisov, analiza skupnih stroškov lastništva, analiza neto sedanje vrednosti in analiza ekonomske dodane vrednosti, tudi pomembna vloga upravljanja kakovosti, ekonomskih spodbud, vključevanja uporabnikov, posebej poslovnih strokovnjakov, učinkovitosti in razumevanja potreb pri razvoju ter javne prepoznavnosti produkcije.

Določene so tudi posebnosti področja, kot je na primer trend uvajanja agilnih metodologij in principov, ki prispevajo k povečanju učinkovitosti in inovativnosti.

Drugačna izmed omenjenih posebnosti je odprtokodna programska oprema. To je vrsta opreme, ki so jo razvili prostovoljni programerji, ki sodelujejo prek neformalnih skupnosti. Ti sistemi se distribuirajo prosto in so lahko konkurenca klasični plačljivi programski opremi. Odprtokodna oprema močno pospešuje inovacije in razvoj ter ima svoji unikatni ekonomski načeli. Stroški razvoja so minimalni zaradi prostovoljnega prispevka. Razvijalci takšnih sistemov izumljajo povsem nove strategije monetizacije, kot so plačljive podporne storitve, razvoj prilagojenih različic, licenciranje in storitve gostovanja. Zaradi njene visoke konkurenčnosti nekatera tradicionalna podjetja zdaj svoje modele preusmerjajo na modele, ki temeljijo na odprtokodni opremi. Hkrati je prisotnih nekaj pomislekov o trajnosti takšne opreme. Poleg tega so razlogi, kot so zvestoba bolj priljubljenim in splošno priznanim rešitvam ter pomanjkanje ozaveščenosti, usposabljanja in podpore javnosti, omenjeni kot ovire pri razvoju in uporabi odprtokodne opreme.

Hkrati pa ima odprtokodna programska oprema potencial za vzajemno koristno uporabo v javnih institucijah. Podpora javnim in vladnim organizacijam je lahko rešitev za prej naštete omejitve. Po eni strani odprtokodna oprema lahko prispeva k rasti gospodarstva države s pospeševanjem digitalizacije, povečanjem konkurenčnosti trga, ustvarjanjem inovacij in delovnih mest ter razvojem novih poslovnih modelov. Po drugi strani pa lahko javna podpora in financiranje zmanjšata finančno breme, povezano z razvojem, in zagotovita dolgoročno stabilnost projektov odprtokodne programske opreme. Vendar kot pri vsakem programskem projektu je pomembno upoštevati vse ekonomske vidike in pred dejanskimi investicijami opraviti vse prej opisane analize standardov. To je lahko zelo zapleteno in problematično, zato je treba uporabiti posebej razvite complete orodij, ki upoštevajo možne gospodarske, socialne in tehnične vplive.

Še ena posebnost je digitalno piratstvo in njegov negativni vpliv na poslovno področje. Ugotovljeno je bilo, da piratstvo škodi gospodarski rasti področja, saj zmanjšuje ekonomske spodbude razvojnim podjetjem za ustvarjanje novih izdelkov, kar upočasnjuje tehnološki napredek in rast produktivnosti. Ob tem je bilo poudarjeno, da je to razmerje zelo kompleksno in kontroverzno.

Zadnja posebnost, ki pa ni po značaju prav določena posebnost, je trend trajnosti ter njene pretežne dolgoročne koristi ne zgolj za gospodarstvo, ampak tudi za družbo in okolje. Poseben značaj ima tako imenovana družbena trajnost. Njen vidik igra izjemno pomembno vlogo pri sodobnem razvoju programske opreme. Vključuje ustvarjanje tehnologije, ki pomaga izboljšati življenje ljudi in hkrati blaži socialna tveganja ter teži k minimaliziranju negativnih vplivov na družbo in ljudi ter gospodarstvo in okolje. Pomaga zmanjšati negativne družbene vplive, kot so socialna izolacija, kibernetiski kriminal in kapitalizem nadzora. Tukaj je eno od ključnih priporočil za razvijalce in organizacije, ki naj dajo prednost antisocialnim funkcijam in spodbujajo v svojih izdelkih pozitivne socialne interakcije in vključenost.

Rezultati drugega dela raziskave so pokazali podobnosti in odstopanja med nacionalnim in globalnim gospodarstvom. Podobnosti, ki so bile najdene v trendih upravljanja, so implementacija in uporaba agilnih metodologij in principov ter rast trga odprtokodne programske opreme in njen dober potencial za sodelovanje z vladnimi in javnimi institucijami. Poleg tega so nekatere težave, s katerimi se soočajo, podobne tako globalno kot lokalno.

Hkrati pa obstajajo razlike, ki so posledica predvsem nacionalnih gospodarskih struktur. Na primer deleži organizacij na trgu glede na velikost, lahko z večjim odstotkom malih in srednje velikih podjetij, kar je vodilo v razvoj lokalno specifičnih modelov za upravljanje informacijskih tehnologij.

Drugi primer je nadpovprečna velikost javnega sektorja, značilna za postsocialistične države. Analiza rezultatov projekta informatizacije in digitalizacije na ministrstvu za javno upravo je kot ključne koristi pokazala izboljšano učinkovitost poslovanja, zmanjšanje stroškov, večjo varnost podatkov, boljše upravljanje virov, izboljšano izvajanje storitev, boljše upravljanje s podatki, večjo transparentnost poslovanja in splošno zadovoljstvo občanov. Hkrati pa tovrstni projekti zahtevajo stalno spremljanje, vključevanje deležnikov in redno sprejemanje tehnoloških dosežkov.

Zaradi velikosti in značilnosti javnega sektorja so ugotovitve v zvezi z njo, zlasti tiste, povezane z odprtokodno programsko opremo, veliko bolj kritične, saj lahko pripomore tako k večji učinkovitosti in transparentnosti delovanja kot tudi zadovoljstvu prebivalstva. Ta odstopanja morajo upoštevati vsi akterji na nacionalnem trgu.

Prav tako so nekateri ugotovljeni izzivi bolj pereči ali specifični za Slovenijo. Na primer, višja od povprečja je stopnja digitalnega piratstva, značilna za države v razvoju. Ugotovljeni razlogi za visoko stopnjo piratstva so visoki stroški legalnih vsebin, nedostopnost nekaterih storitev in enostaven dostop do piratskih vsebin brez strogega nadzora nad njihovo distribucijo. To povzroča gospodarske izgube ustvarjalcem in zakonitim distributerjem storitev in vsebin. Razmere so se spremenile na bolje z zmanjšanjem stopnje piratstva v bližnji preteklosti. Vendar pa so še vedno potrebne spremembe za boj proti navedenemu problemu, na primer povečanje dostopnosti do zakonitih virov distribucije ali veliko strožja zakonodaja o avtorskih pravicah in nadzor nad njeno skladnostjo.

Drugačno glede na omenjene izzive je slabo prepoznavanje načel trajnosti informacijskih tehnologij in zelenega računalništva med prebivalstvom. Na eni strani Slovenija ostaja pod svetovnim povprečjem v smislu ozaveščenosti in sprejemanja, saj približno 80 odstotkov prebivalstva še nikoli ni slišalo za sam koncept. Hkrati narašča prepoznavnost pomena zelenega računalništva in njegovih potencialnih koristi, saj ga polovica anketirancev tematske ankete prepozna kot pomemben element strategije organizacij v bližnji prihodnosti. Opisani vidik trajnosti je ključen za prihodnost države in njenega gospodarstva nasploh zaradi dolgoročnih koristi za naravno okolje, družbo in gospodarstvo samo ter pretehta vse kratkoročne pomanjkljivosti.

Ugotovljene razlike zahtevajo dodatno posebno obravnavo na lokalni ravni in nekatere od njih, kot sta digitalno piratstvo in trajnost, opredeljujejo izzive za prihodnost sektorja programskega inženiringa v Sloveniji. Izsledke raziskave lahko poslovni in tehniški strokovnjaki, zaposleni na tem področju, uporabijo za izboljšanje razumevanja in znanja o ekonomiji poslovnega področja tako globalno kot lokalno. Prav tako jih je mogoče uporabiti za promocijo in izboljšanje proučevanih konceptov v Sloveniji ter kot dobro izhodišče za nadaljevanje raziskovalnega dela o analiziranih temah.

LITERATURE

1. Ampatzoglou, A., Ampatzoglou, A., Chatzigeorgiou, A. and Avgeriou, P. (2015). The financial aspect of managing technical debt: A systematic literature review. *Information and Software Technology*, 64, 52–73. <https://doi.org/10.1016/j.infsof.2015.04.001>
2. Arih, Z. (2024). Ocena odprtokodnega programskega okolja idaes za potrebe procesnega inženirstva : diplomsko delo visokošolskega strokovnega študijskega programa I. stopnje [Bachelor's thesis, Z. Arih]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=89305>
3. Arnšek, T. (2024). Digitalizacija javnih naročil in korupcijska tveganja [Master's thesis]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=86911>
4. Ayoola, B., Kuuttila, M., Wehbe, R. R. and Ralph, P. (2024). User personas improve social sustainability by encouraging software developers to deprioritize antisocial features. *arXiv* (Cornell University). <https://doi.org/10.48550/arxiv.2412.10672>
5. Begicheva, S., Begicheva, A. and Nazarov, D. (2024). Constructing a model to identify the determinants of successful software import substitution. *Business Informatics*, 18(3), 7–23. <https://doi.org/10.17323/2587-814x.2024.3.7.23>
6. Bitzer, J. and Schröder, P. J. (2006). The Economics of Open source Software Development. In Elsevier eBooks (pp. 1–13). <https://doi.org/10.1016/b978-044452769-1/50001-9>
7. Boehm, B. W. (1984). Software Engineering Economics. *IEEE Transactions on Software Engineering*, SE-10(1), 4–21. <https://doi.org/10.1109/tse.1984.5010193>
8. Boehm, B. W. and Sullivan, K. J. (2000). Software economics. In *ICSE '00: Proceedings of the Conference on The Future of Software Engineering* (pp. 319–343). <https://doi.org/10.1145/336512.336584>
9. Černe, Ž. (2022). Varnostni vidiki e-uprave – analiza nevarnosti napadov z lažnim predstavljanjem [Bachelor's thesis]. Repository of the University of Ljubljana. <https://repozitorij.uni-lj.si/IzpisGradiva.php?lang=eng&id=141735>
10. Dujić, S. (2007). Odprtokodne in proste programske rešitve kot dejavnik učinkovite in gospodarne javne uprave : diplomsko delo [Bachelor's thesis, S. Dujić]. Repository of the University of Ljubljana. <http://dk.fdv.uni-lj.si/diplomska/pdfs/Dujic-Sladjan.PDF>

11. Enterprise births and enterprise deaths by ACTIVITY, YEAR, MEASURES and SIZE OF ENTERPRISE-PxWeb. (n.d.). PxWeb. <https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/1418405S.px/>
12. Felderer, M., Reussner, R. and Rumpe, B. (2020). Software Engineering und Software-Engineering-Forschung im Zeitalter der Digitalisierung. *Informatik-Spektrum*, 44(2), 82–94. <https://doi.org/10.1007/s00287-020-01322-y>
13. Fernandez, R. N., Ribeiro, F. G., & Del Ponte Duarte, J. M. (2018). Effects of software piracy on economic growth. *International Journal of Economics and Finance*, 10(6), 1. <https://doi.org/10.5539/ijef.v10n6p1>
14. Government at a Glance 2023: Slovenia. (n.d.). In OECD. OECD. Retrieved January 26, 2025, from https://www.oecd.org/en/publications/government-at-a-glance-2023_c4200b14-en/slovenia_e93fb938-en.html
15. Grundy, J. (2014). Foreword by John Grundy Economics-Driven Software Architecting. In Elsevier eBooks (pp. xxi–xxvi). <https://doi.org/10.1016/b978-0-12-410464-8.00018-0>
16. Hamori, S. and Bhar, R. (2004). Hidden Markov Models: Applications to Financial Economics. https://openlibrary.org/books/OL3303963M/Hidden_Markov_models
17. High-growth enterprises by ACTIVITY, YEAR and INDICATOR-PxWeb. (n.d.). PxWeb. <https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/1430910S.px/>
18. Kamau, J. and Namuye, S. (2012). A review of users adoption of open source software in Africa. *Computer and Information Science*, 5(5). <https://doi.org/10.5539/cis.v5n5p45>
19. Kiselak, M. (2022). Vpliv globalizacije in digitalizacije na management človeških virov [Magistrsko delo, M. Kiselak]. Digitalna knjižnica Univerze v Mariboru. <https://dk.um.si/IzpisGradiva.php?lang=slv&id=81345>
20. Kopina, M. (2018). Samo-organizacija procesov informacijskih storitev [Doctoral dissertation, D. Kopina]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=48120>
21. Kozlovič, T. (2016). Prenova procesov vodenja in obdelave podatkov o prihodih ter nočitvah turistov in turistični taksi v Sloveniji [Master's thesis]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=61515>
22. Kshetri, N. (2025). Economics of open source software and AI models. *Computer*, 58(1), 134–141. <https://doi.org/10.1109/mc.2024.3488974>
23. Kulibaba, I. and Barinov, V. (2024). Software solution for growing crops on an individual land plot. *BIO Web of Conferences*, 141, 01018. <https://doi.org/10.1051/bioconf/202414101018>
24. Levstek, A. (2022). Razvoj prilagodljivega modela strateškega upravljanja informatike za srednje velika podjetja [Doctoral dissertation]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=81461>
25. Lojk, J. (2016). Analiza projekta prenove informatike v slovenski javni upravi [Master's thesis]. Repository of the University of Ljubljana. <http://www.cek.ef.uni-lj.si/magister/lojk5358.pdf>
26. Madauss, B. (2024). IT support in projects: Project management software. In Springer eBooks (pp. 597–614). https://doi.org/10.1007/978-3-662-69057-4_18
27. Milošič, N. (2023). Opredelitev, uvajanje in prakse zelenega računalništva v Sloveniji in tujini [Master's thesis, N. Milošič]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=84781>
28. Mohorič Kenda, A. (2018). Stalno izboljševanje modela kazalnikov kakovosti zdravstva s povratno informacijo sistema e-pritožb [Doctoral dissertation]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=66447>
29. Money, W. H., Kaisler, S. H. and Cohen, S. J. (2021). Understanding Failed Software Projects through Forensic Analysis. *Journal of Computer Information Systems*, 62(5), 940–953. <https://doi.org/10.1080/08874417.2021.1950076>
30. Nikitashin, M. (2025). AI and UI Development: A Case Study of Mobile Application X. *Uporabna Informatika*. <https://doi.org/10.31449/upinf.244>

31. Nikitashin, M., Kaluža, M. and Werber, B. (2024). Analysis of Methodologies and Tools for Software Development in Different Architectures. In 2024 47th MIPRO ICT and Electronics Convention (MIPRO) (pp. 1999–2007). <https://doi.org/10.1109/mipro60963.2024.10569545>
32. Number of enterprises by YEAR, ELECTRONIC EXCHANGE OF INFORMATION IN THE ENTERPRISE and ENTERPRISE SIZE CLASS-PxWeb. (n.d.). PxWeb. <https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/2965311S.px/table/tableViewLayout2/>
33. Number of enterprises by YEAR, PURCHASE OF CLOUD COMPUTING SERVICE and ENTERPRISE SIZE CLASS-PxWeb. (n.d.). PxWeb. <https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/2973709S.px/>
34. Oršič, J. (2023). Merjenje in upravljanje trajnostnega delovanja pri zunanjih izvajalcih logističnih storitev v realnem času [Doctoral dissertation, J. Oršič]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=86362>
35. Osborne, C., Sharratt, P., Foster, D. and Boehm, M. (2024). A toolkit for measuring the impacts of public funding on open source software development. arXiv (Cornell University). <https://doi.org/10.48550/arxiv.2411.06027>
36. Primec, A. (2023). Centralizacija informacijske komunikacijske tehnologije v javni upravi: študija na izbranem ministrstvu [Bachelor's thesis]. Repository of the University of Ljubljana. <https://repozitorij.uni-lj.si/IzpisGradiva.php?lang=eng&id=146758>
37. Prša, M. (2015). Prosta in odprtokodna programska oprema v gradbeništvu : diplomska naloga [Bachelor's thesis, M. Prša]. Repository of the University of Ljubljana. <https://repozitorij.uni-lj.si/IzpisGradiva.php?lang=eng&id=79934>
38. Qiang, Y., Pa, N. C. and Ismail, R. (2024). Sustainable Software Solutions: a tool integrating life cycle analysis and ISO quality models. *International Journal on Advanced Science Engineering and Information Technology*, 14(5), 1728–1737. <https://doi.org/10.18517/ijaseit.14.5.11268>
39. Rusakova, E. and Bystrov, M. (2024). METHODOLOGY, TOOLKITS AND ORGANIZATION OF ADVANCED SOFTWARE OF INFORMATION SYSTEMS IN ECONOMICS SYSTEMS IN ECONOMICS. *Ekonomika I Predprinimatel'stvo*, 12(161), 1088–1095. <https://doi.org/10.34925/eip.2023.161.12.213>
40. Schott, V. and Ovtcharova, J. (2024). Integrating Sustainability into Software Development: A Global Categorization. In *Contributions to finance and accounting* (pp. 59–69). https://doi.org/10.1007/978-3-031-67547-8_6
41. Shi, M. (2010). Software Functional Testing from the Perspective of Business Practice. *Computer and Information Science*, 3(4). <https://doi.org/10.5539/cis.v3n4p49>
42. Smirnov, P. (2024). Generiranje poslovnih procesov z uporabo inteligentnega sistema chatgpt in orodja process space [Bachelor's thesis]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=90621>
43. Sneed, H. M. (1991). Economics of software re-engineering. *Journal of Software Maintenance Research and Practice*, 3(3), 163–182. <https://doi.org/10.1002/smr.4360030304>
44. The usage of ICT hardware and computer networks in enterprises with 10 or more persons employed (NACE Rev. 2) by YEAR, ICT USAGE IN ENTERPRISES and ACTIVITY-PxWeb. (n.d.). PxWeb. <https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/2965102S.px/>
45. Thurimella, A. K. and Padmaja, T. M. (2014). Economic Models and Value-Based Approaches for product line architectures. In *Elsevier eBooks* (pp. 11–36). <https://doi.org/10.1016/b978-0-12-410464-8.00002-7>
46. Upelj, B. (2010). Odprti standardi in odprtokodne rešitve v javni upravi : diplomsko delo [Bachelor's thesis, B. Upelj]. Repository of the University of Ljubljana. <http://dk.fdv.uni-lj.si/diplomska/pdfs/upelj-boris.pdf>
47. Usman, M., Britto, R., Börstler, J. and Mendes, E. (2017). Taxonomies in software engineering: A Systematic mapping study and a revised taxonomy development method. *Information and Software Technology*, 85, 43–59. <https://doi.org/10.1016/j.infsof.2017.01.006>

48. Yanchenko, A. Y. (2024). Modeling of an information and economic system for the development of software for shipbuilding safety. *Scientific Notes of the Russian Academy of Entrepreneurship*, 23(3), 72–79. <https://doi.org/10.24182/2073-6258-2024-23-3-72-79>
49. Zabukovšek, U. (2016). Integracija celovitih informacijskih rešitev in sistemov za upravljanje proizvodnih procesov [Master's thesis, U. Zabukovšek]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=60346>
50. Zabukovšek, U. (2024). Usklajenost poslovnih rešitev s poslovnimi zahtevami [Doctoral dissertation, U. Zabukovšek]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=86194>
51. Žatuchin, D. (2024). Job Market Indicators in Software Development Sector: A Data-Driven Analysis of Poland and the Baltics. *Research Square (Research Square)*. <https://doi.org/10.21203/rs.3.rs-5195074/v1>
52. Zhu, W. and He, Y. (2016). ECONOMICS OF SOFTWARE DEVELOPMENT. *Pacific Asia Conference on Information Systems*, 247. <http://dblp.uni-trier.de/db/conf/pacis/pacis2016.html#ZhuH16a>
53. Žvar, B. (2023). Storitve videa na zahtevo in digitalno video piratstvo [Master's thesis]. Digital library of University of Maribor. <https://dk.um.si/IzpisGradiva.php?lang=eng&id=84599>

Education As A Strategic Priority: Evaluation Of The Financing Of The Education System In The Republic Of Srpska

DOI: <https://doi.org/10.55707/eb.v12i1.149>

Review article

UDC 336.531.2:37(497.11)

KEYWORDS: investment, financing, education, quality
ABSTRACT – The paper deals with the evaluation of the financing of the education system in the Republic of Srpska in the period from 2014 to the end of 2023, with special reference to the importance of education for overall social and economic development. Education is a key factor for the development of human resources, innovation and competitiveness, and is vital for the long-term progress of the country. However, the results of the analysis show that less than 2% of the total investments are invested in the education sector, which is significantly below the international standards and recommendations. This lack of investment can threaten the quality of education, reduce the availability of resources and lead to long-term consequences for the economic growth and social stability. Through a review of quantitative data, the paper identifies weaknesses in the structure of education financing and points to the necessary reforms to enable a better investment in the education sector, which is of essential importance for the sustainable development of the Republic of Srpska

Pregledni znanstveni članek

UDK 336.531.2:37(497.11)

KLJUČNE BESEDE: investicije, financiranje, izobrazavanje, kvaliteta

POVZETEK – Članek obravnava evalvacijo financiranja izobraževalnega sistema v Republiki Srbski v obdobju 2014–2023 s posebnim poudarkom na pomeni izobraževanja za celovit družbeni in ekonomski razvoj. Izobraževanje predstavlja ključni dejavnik razvoja človeških virov, inovacij in konkurenčnosti ter je bistvenega pomena za dolgoročni napredek države. Rezultati analize kažejo, da sta v izobraževalni sektor vložena manj kot 2 % celotnih investicij, kar je občutno pod mednarodnimi standardi in priporočili. Pomanjkanje vlaganj lahko ogrozi kakovost izobraževanja, zmanjša dostopnost virov ter povzroči dolgoročne negativne posledice za gospodarsko rast in družbeno stabilnost. V članku na podlagi pregleda kvantitativnih podatkov identificiramo pomanjkljivosti v strukturi financiranja izobraževanja ter opozarjamo na nujnost reform, ki bi omogočile učinkovitejše vlaganje v ta sektor, kar je ključno za trajnostni razvoj Republike Srbije.

1 Introduction

Education is a fundamental pillar of the development of any modern state, especially in countries in transition that are going through economic, political and social changes. Investing in the education system is not only an obligation in the context of satisfying basic human rights, but is also a key factor for achieving long-term sustainable development. Quality education contributes to the development of human capital, increases innovative capacities, improves social cohesion and enhances the country's competitiveness on the global market. For the countries in transition, such as the Re-

public of Srpska, education is a key tool for overcoming structural challenges, reducing unemployment and accelerating economic growth.

Education is much more than a mere acquisition of knowledge – it shapes the individual, influences the formation of their skills and competences, and directly contributes to their integration into the social and economic flows. Investing in the education sector is not only a financial obligation of the state but also a strategic investment in the future of its citizens and society as a whole. Through education, individuals acquire the ability to think critically, develop innovative approaches to solving problems and strengthen their capacities for productive work, which ultimately leads to the improvement of economic productivity and the strengthening of the competitive position of the country at the international level.

Investing in education means providing adequate infrastructure, teaching materials, technological resources, and continuous education for the teaching staff. Investing in modern teaching technologies and the digitalization of the educational process is of particular importance, which enables pupils and students to access global sources of knowledge and the latest research. In addition, reforms in the educational system concerning the curriculum and teaching methods must follow dynamic changes in the economic and technological environment, so that education remains relevant and adaptable to the needs of the labor market. Such investments not only increase the quality of the educational process, but also contribute to strengthening the innovation potential of the entire society.

For the countries in transition, such as the Republic of Srpska, education plays a key role in the process of modernization and achieving long-term stability. These countries often face a number of challenges, such as high unemployment rates, weak economic growth, low productivity and a lack of skilled personnel. Quality education and properly directed financing can significantly help in overcoming these obstacles by creating new generations of experts who are able to face the challenges of the modern labour market. Investing in education not only improves the living standards of individuals, but also ensures economic growth and social progress as a whole.

Countries that do not invest enough in the education sector in the long term risk facing serious consequences, including reduced economic growth, increased unemployment and reduced chances for social inclusion of the marginalized groups. Education, especially at the primary and secondary school level, is important not only for individuals but also for strengthening democratic institutions, increasing civic engagement and improving social cohesion. Also, investment in higher education and research centers directly leads to the development of new technologies and innovations that can improve the competitiveness of the economy. Therefore, education must remain in the focus of strategic development plans, as it represents a key mechanism for improving the quality of life.

It is important to emphasize that adequate financing of education must be the priority of every society that strives for sustainable development. Increasing investment in the education sector, especially in the countries in transition, can bring multiple benefits – from faster economic recovery and reduced unemployment to increased social

justice and equality. The Republic of Srpska, as part of a wider global integration process, must recognize the importance of education as a means for long-term progress and place education as the basis of its development policy.

Despite the recognized importance of education, the existing trends in the financing of the education system of the Republic of Srpska point to a significant gap between declarative goals and real investment. Investment in education, according to the data from the period 2014-2023, amounts to less than 2% of the total investments, which indicates the need for a systemic reform in the direction of increasing the funds allocated to this sector. In this context, the aim of the paper is to analyze the financing structure of the education system, assess its adequacy and offer proposals for improvement, with the aim of achieving sustainable development and prosperity in the future.

2 Theoretical Framework

Education financing is a key factor in achieving the quality of the educational process and long-term economic development. According to research, investments in the education system directly affect the formation of human resources, the strengthening of innovative capacities and productivity of the country, which results in long-term sustainable development (Nazukova, 2020). Optimal financing of educational institutions enables improvement of educational programs, improvement of infrastructural conditions and support for teaching staff, which directly affects the quality of education and the professionalism of students (Tamam, 2018).

The special importance of adequate financing of education is reflected in the possibility of harmonizing educational programs with the needs of the labour market. Investments in modern technology and teaching methods enable the creation of personnel who are ready to respond to contemporary challenges, which ultimately contributes to economic stability and the reduction of unemployment (Rusina, 2022). In addition, investments in teacher salaries and professional training of teachers directly contribute to the improvement of educational results, which is a key prerequisite for the development of society and raising the quality of education at all levels.

Studies indicate that countries that invest significant resources in the education sector are more successful in creating a quality workforce, which is reflected in growing gross domestic product (GDP) and economic stability. Nazukova (2020) points out that there is a positive relationship between state financing of education and the country's productivity, and similar findings are present in numerous other studies that link investments in education with long-term economic benefits (Kasradze et al., 2019).

Insufficient financing of the education sector, especially in the countries in transition, represents a significant challenge for educational development and economic progress. Countries facing a lack of investment in education often face challenges in retaining quality teaching staff, as well as in providing adequate infrastructure, which directly affects the quality of educational services (Hastina et al., 2020). On the other

hand, increasing investment in education contributes to a greater responsibility of educational institutions and improving the efficiency of educational programs (Tindra & Kadri, 2019).

Investing in education must be thought out and aimed at creating long-term benefits, both for individuals and for society as a whole. Some authors point out that investments in the education system not only raise the level of educational quality, but also have far-reaching consequences for the economic growth of the country (Nazukova, 2020). That is why the education sector should remain the focus of the development policies, with special emphasis on adequate financing that supports innovation, expertise and comprehensive development of human resources.

As already emphasized, the financing of the education sector plays a key role in shaping the quality of education, which is further reflected in a comprehensive economic development. According to Nazukova (2020), adequate state investment in education contributes to the growth of the country's overall productivity, and thus to the strengthening of its economic and technological context. With this in mind, investment in education should be considered and aimed at improving the quality of educational programs, thus contributing to the creation of competitive human capital at the global level.

Analyses also show that financial support for the education system at all levels of education increases the chances of achieving better educational results. Musah and Aawaar (2022) point out that optimal investment in education has positive effects on all levels of education, which can be seen as a model that indicates how much investment in education is connected to the broader social progress. In addition, investments should not be viewed only through the prism of infrastructure but also through teachers' salaries and the maintenance of adequate working conditions, which is reflected in the motivation of employees and the quality of the educational process (Rusina, 2022).

One of the key problems in many countries, including the countries in transition, is the insufficient financing of educational institutions. Mahputriono (2022) emphasizes that the lack of resources for education can have a negative impact on the infrastructure, salaries of the teaching staff, as well as on the general management of the educational processes. This can further lead to a decline in the quality of educational services and, in the extreme cases, to poorer educational achievements. Precisely for these reasons, it is crucial to focus efforts on the efficient management of educational finances and ensure sustainable and adequate funding.

Finally, as Gabrichidze (2022) states, effective education financing strategies are crucial not only for achieving high quality education, but also for promoting equality and fairness within the education system. Increasing investment in education directly affects the creation of conditions for better educational outcomes, which in turn contributes to the general economic and social development of the country. This aspect of investment becomes especially important in the countries in transition, where educational resources are limited and the need for skilled labour is great.

3 Research Methodology

In this research, investments in the education sector of the Republic of Srpska in the period from 2014 to 2023 were analyzed. The focus was on the assessment of total investments in education, with the data taken from the database of the Republic Institute of Statistics. The collected data include the total amount of investments in education, expressed in the domestic currency (convertible mark - KM, where 1€ = 1.955830 KM), as well as the percentage that these investments represent in relation to the total state investments in the given period.

The data were analyzed at the level of aggregated investments in the education sector, without a detailed distribution by the education level (primary, secondary and higher education). This methodological approach enables an overview of the general investment trends, but indicates limitations in terms of more precisely determining how much financial resources are directed to different levels of education each year. The lack of detailed data on the distribution of funds by education level makes it difficult to analyze the effectiveness and impact of investments in depth.

The data analysis included an assessment of the absolute amounts of investments, as well as percentage values related to the total investments of the Republic of Srpska. This approach provides an insight into the relative importance of investment in education in the broader context of state investments, but does not provide a detailed insight into the specific programs or priorities within the education sector. Given this methodological limitation, further research is recommended that would analyze in more detail the distribution of funds by educational levels in order to enable a better understanding of financial priorities in education.

Nevertheless, this analysis has a significant practical contribution because it provides insight into the educational investment trends in the Republic of Srpska over a ten-year period. The results of the analysis are useful for policy makers, as they enable the evaluation of the effectiveness of previous investments in the education sector and provide a basis for future planning and budget optimization. An insight into the percentage of state investments aimed at education can serve as an indicator of the state's priorities and help identify areas that require additional investments. Also, the results are relevant for the academic community and researchers, as they can serve as a basis for further research on the connection between education financing and the quality of educational outcomes, especially in the context of changes in the economic and social environment.

4 Analysis Of The Financing Of The Education System In The Republic Of Srpska

The analysis of the financing of the education system in the Republic of Srpska includes the assessment of annual investments in education in the period from 2014 to

2023, with special reference to the absolute amounts of investments and their percentage in relation to total state investments. This analysis was conducted in order to gain insight into the dynamics of education financing and to assess the extent to which the education sector is recognized as a priority in the state budget. The obtained results provide significant information for decision-makers and the professional public, as they indicate trends in budget allocations for education, as well as possible challenges in providing adequate funds for the development of educational institutions and improving the quality of educational services. The data contribute to a better understanding of the current state of the education system and provide a basis for formulating strategies for future investments in the education sector in order to enable sustainable development and progress.

The data on the annual investments in the education sector of the Republic of Srpska in the period from 2014 to 2023 are graphically presented below in order to more clearly show the investment trends and dynamics.

Chart 1

Trend of investing in education; Investment amount in thousands of marks

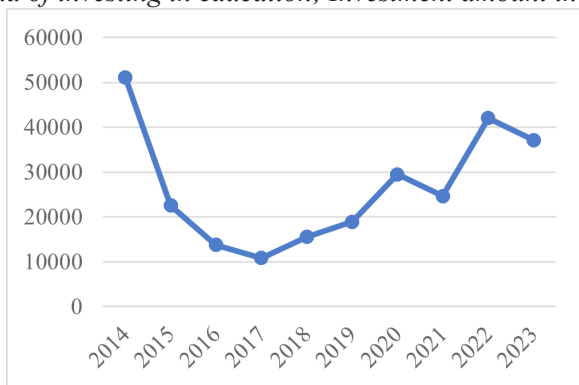
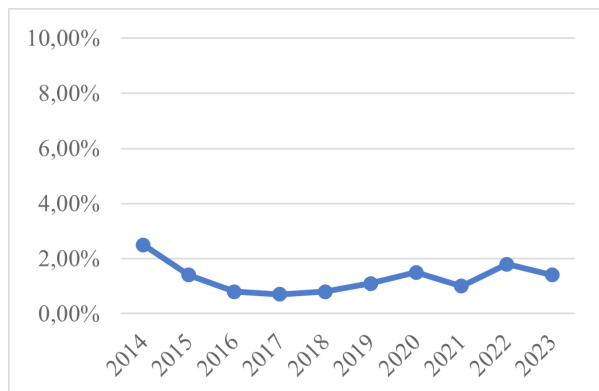


Chart 2

Participation in total state investments; The share of investments in education



The analysis of the financing of the education system in the Republic of Srpska shows significant variations in annual investments during the period from 2014 to 2023. Investments in education are expressed in thousands of convertible marks (KM) and vary from the highest value in 2014 with 51,061,000 KM to the lowest value in 2017 when investments amounted to 10,865,000 KM. This decline represents a dramatic change in the financing of the education sector in a short period of time, indicating potential challenges in the distribution of budget funds.

By assessing the percentage share of these investments in the total state investments in the same period, it becomes clear that education was not a priority compared to other sectors. In 2014, when investments were at their peak, they amounted to 2.5% of the total state investments. However, this percentage decreased significantly in the following years, reaching a minimum of 0.7% in 2017. In 2018 and 2019, investments ranged between 0.8% and 1%, which indicates stabilization, but at a low level compared to the beginning of the analyzed period.

The presented data suggest that the education sector suffered from insufficient funds in most of the analyzed period, with the percentage of investments and absolute amounts declining drastically. Such a trend could have long-term negative consequences for the quality of education and the development of human capital. In recent years, although there has been a slight growth in absolute terms, the percentage in relation to total investment remains low, indicating that education is still not among the top priorities when it comes to government investment. This trend should be seen in the context of the long-term economic goals of the Republic of Srpska and the need for greater investment in human resources through the education sector.

5 Impact Of Low Investments On The Quality Of Education And Recommendations For Improvement

The results of the analysis show that investments in the education system of the Republic of Srpska are very low. Low investments directly affect the quality of education, which in the long run can have negative consequences for the development of human resources, the economy and society as a whole. In order to improve the quality of educational services, it is necessary to analyze the key aspects that are affected by the lack of adequate funding, as well as to devise recommendations for improving the system.

One of the basic problems faced by the education system of the Republic of Srpska is the lack of funds for the improvement of infrastructure and teaching materials. The quality of educational institutions and their equipment with modern technology are key factors that directly affect educational outcomes. According to research, in countries with lower investment in the infrastructure of the education sector, the level of education decreases, and students have less access to quality resources (Nazukova, 2020). In the Republic of Srpska, low investment in infrastructure leads to outdated teaching materials, inadequate classrooms and lack of access to modern technologies,

which can limit students' ability to develop the necessary skills for the 21st century labour market.

In addition to the infrastructure, low investments also affect the motivation of the teaching staff. In many cases, teachers' salaries do not follow economic growth and inflation, which leads to a decrease in their motivation and quality of work (Rusina, 2022). The quality of teaching directly depends on the expertise and motivation of teachers, and it is essential to increase investments in teachers' salaries and professional development. Investments in the continuous professional development of teachers would enable them to access modern teaching methods, which would directly affect the improvement of the quality of teaching and the educational outcomes of students.

Also, insufficient investments in research and development within higher education institutions reduce their ability to follow modern scientific and technological trends. In countries with significant investments in scientific research, higher education becomes the engine of innovation and technological development (Manolescu, 2009). In the Republic of Srpska, where investments in this field are significantly lower compared to international standards, universities do not have enough resources to finance research, which limits their contribution to the society and the economy. The academic community can play a key role in this process by actively participating in the proposals to reform the education system, designing and implementing scientific projects aimed at improving education, and connecting with international partners to secure additional funds.

Recommendations for improving the education system in the Republic of Srpska are based on several key measures. The first recommendation is to increase the budget for education, especially in the segments related to infrastructure investments, technological equipment and teacher training. These areas are essential for raising the level of education and adapting the education system to the needs of the modern labour market. The second measure refers to the introduction of incentive programs for teachers, which would include continuous professional training, but also better financial conditions, in order to increase their motivation and efficiency in work (Gabrichidze, 2022).

The third recommendation refers to the strengthening of the cooperation between the educational system and the private sector. The private sector can play a key role in financing educational programs, scholarships and research, thus filling the gaps in government investment. Through public-private partnerships, specific programs that meet the needs of the labour market can be developed, which would improve the quality of education and ensure that graduates have the necessary skills to successfully enter the labour market (Sutansyah & Ramdani, 2023).

Finally, the academic community must take a more active role in the process of reforming the education system. Academic workers can contribute to the research on the effects of the existing investments in education, as well as to the development of concrete proposals for improving the quality of education. Also, it is important that the academic community actively participates in the creation of policies and reforms of the educational system, through engagement in advisory bodies, cooperation with

state institutions, and through cooperation with international partners in order to provide additional sources of funding and the opportunity to apply best practices from other countries.

Through increased investments, strategic partnerships and the active role of the academic community, it is possible to achieve sustainable development of the education system of the Republic Srpska, which will ensure long-term quality education that meets the needs of society and the economy.

6 Conclusion

The fact that education plays a key role in the development of the individual, state and society does not need to be proven. Investing in the education sector goes far beyond a mere financial obligation; it is a strategic decision that shapes the future of every society. For an individual, quality education opens the door to new opportunities, enabling the acquisition of skills necessary for the modern labour market and contributes to personal development, encouraging critical thinking and innovation.

For the state, investment in education represents the basis for sustainable economic development. The education sector is a key source of human resource development, which directly affects the productivity, innovative capacity and competitiveness of the country. Countries that continuously and strategically invest in education achieve faster economic growth, more stable social progress and better positioning in the global framework.

At the level of society, education strengthens social cohesion and contributes to the reduction of inequality. A quality education system helps create informed, engaged citizens who actively participate in social life and bring about changes. The long-term benefits of investing in education are reflected in the strengthening of democratic values, the creation of a fairer society and the building of more resilient institutions. That is why it is crucial that education becomes a priority in the planning and implementation of public policies, because its benefits are returned multiple times through economic growth, social stability and the progress of society as a whole.

Investing in the education system of the Republic of Srpska during the past decade shows an unsatisfactory trend, which is also confirmed by the analysis of budget funds intended for education. With the percentage of investments that in some years amounted to less than 1% of the state's total investments, it is evident that education is not recognized as a priority. This approach has serious consequences for the quality of education, access to modern technologies, teacher motivation, as well as the development of human resources, which are crucial for the progress of the economy and society. Low investments contribute to the lagging in technological development, the reducing of competitiveness on the labour market, and can lead to increased migration of qualified specialists to other countries, which further weakens the potential for sustainable development.

The proposed measures to improve the financing of education in the Republic of Srpska include an increase in budget funds for the education sector, especially in the segments related to infrastructure, teacher training and technological equipment of schools and universities. In addition, it is important to strengthen the cooperation between educational institutions and the private sector in order to secure additional funds through scholarships, public-private partnerships and research programs. Increasing investments in education would achieve a number of positive effects, including improving educational outcomes, increasing the quality of the teaching process and raising the level of competitiveness of young professionals on the global market. In the long term, such investments would lead to the strengthening of the economic growth, reducing of unemployment and creating a more stable and fair society.

Dr. Zorana Agić, dr. Svetlana Dušanić Gačić, dr. Mirjana Milovanović

Izobraževanje kot strateška prioriteta: evalvacija financiranja izobraževalnega sistema v Republiki Srbski

Izobraževanje je ključni dejavnik družbeno-ekonomskega razvoja in predstavlja temeljno podlago za dolgoročno blaginjo države. Kakovostno izobraževanje prispeva k razvoju človeških virov, krepitvi inovacijskega potenciala, izboljšanju konkurenčnosti gospodarstva ter večji socialni koheziji. Raziskave v različnih državah potrjujejo pozitivno korelacijo med vlaganji v izobraževalni sistem in stopnjo gospodarske produktivnosti, saj dobro izobražena delovna sila ustvarja večjo dodano vrednost, spodbuja tehnološki napredek in prispeva k stabilnosti družbenih struktur.

Ta članek se osredotoča na analizo financiranja izobraževalnega sistema v Republiki Srbski v obdobju 2014–2023. Posebna pozornost je namenjena oceni obsega javnih sredstev, namenjenih izobraževanju, ter njihovemu deležu v skupnih državnih investicijah. Rezultati analize kažejo, da so vlaganja v izobraževalni sektor v večini analiziranega obdobja ostala pod mejo 2 % vseh javnih investicij, kar je občutno pod priporočili mednarodnih organizacij, kot so OECD, UNESCO in Svetovna banka, ki priporočajo, da bi morale države v izobraževanje vlagati med 4 in 6 % svojega BDP. Tako nizka raven financiranja lahko resno ogrozi kakovost izobraževanja, zmanjša dostopnost virov za učence in učitelje ter povzroči dolgoročne negativne posledice za razvoj človeškega kapitala in gospodarsko rast.

Financiranje izobraževanja v Republiki Srbski se je v analiziranem obdobju soočalo z nihanji, kar je dodatno vplivalo na stabilnost in učinkovitost izobraževalnega sistema. Leta 2014 je bil delež javnih investicij v izobraževanje najvišji in je znašal 2,5 % vseh državnih sredstev, vendar je v naslednjih letih prišlo do drastičnega zmanjšanja, pri čemer je bila najnižja raven financiranja v letu 2017 z le 0,7 %. Po tem letu se je delež vlaganj nekoliko povečal, a ostal bistveno pod priporočenimi standardi.

Izobraževalni sistemi, ki so jim namenjena zadostna finančna sredstva, dosegajo višje ravni kakovosti, kar se odraža v boljših učnih rezultatih, nižji stopnji osipa ter večji prilagodljivosti učnega procesa na zahteve trga dela. Vlaganja v izobraževanje se kažejo tudi v izboljšanju socialne mobilnosti, zmanjšanju neenakosti in krepitvi demokratičnih institucij.

V kontekstu držav v tranziciji, kot je Republika Srbska, je vlaganje v izobraževanje še posebej pomembno, saj omogoča prehod iz gospodarstva, ki temelji na nižje kvalificirani delovni sili, v gospodarstvo, ki temelji na znanju in inovacijah. Ugotovitve študije potrjujejo, da ima pomanjkanje sistematičnega financiranja izobraževanja številne negativne posledice:

- 1. Slaba infrastruktura in pomanjkanje sodobnih učnih pripomočkov: prenizka vlaganja v šolsko infrastrukturo vodijo v slabše učne pogoje, kar neposredno vpliva na kakovost poučevanja in učnih dosežkov.*
- 2. Pomanjkanje tehnološke opreme in digitalizacije: sodobne izobraževalne ustanove morajo slediti tehnološkemu napredku, kar vključuje digitalne učne pripomočke, dostop do spletnih virov in razvoj e-učenja. Pomanjkanje sredstev na tem področju pomeni, da izobraževalne ustanove v Republiki Srbski ne morejo slediti trendom digitalizacije.*
- 3. Slabe delovne razmere in nizke plače učiteljev: nizke plače in pomanjkanje priložnosti za strokovni razvoj učiteljev zmanjšujejo motivacijo pedagoškega osebja, kar vodi do nižje kakovosti poučevanja.*
- 4. Nezadostno financiranje raziskovalnih programov: visokošolske in raziskovalne ustanove so ključne za razvoj inovacij in gospodarstva, vendar Republika Srbska namenja izjemno malo sredstev za raziskovalno dejavnost.*

Primerjalna analiza financiranja izobraževalnih sistemov v drugih tranzicijskih gospodarstvih, kot so Estonija, Poljska in Češka, kaže, da države, ki so povečale investicije v izobraževanje, dosegajo hitrejšo gospodarsko rast in boljšo konkurenčnost na globalnem trgu. Estonija, na primer, v izobraževanje vlaga približno 6 % svojega BDP, kar je vodilo do izboljšanih učnih rezultatov in močnega tehnološkega sektorja.

Da bi Republika Srbska izboljšala svoj izobraževalni sistem, so nujni naslednji ukrepi:

- 1. Povečanje državnega financiranja izobraževanja: javne investicije morajo doseči vsaj 4 % BDP, kar bi omogočilo izboljšanje kakovosti infrastrukture, digitalizacije in učnih programov.*
- 2. Uvedba spodbud za učitelje in profesorje: zvišanje plač, dodatno izobraževanje ter večje možnosti za strokovni razvoj bi izboljšali kakovost poučevanja.*
- 3. Razvoj javno-zasebnih partnerstev: sodelovanje med akademskimi ustanovami in zasebnim sektorjem bi omogočilo dodatna vlaganja v izobraževanje ter razvoj specializiranih programov, usmerjenih v potrebe trga dela.*
- 4. Povečanje vlaganj v raziskovalno dejavnost: spodbujanje raziskav in inovacij je ključno za dolgoročni razvoj gospodarstva in tehnološkega napredka.*
- 5. Boljši nadzor nad porabo sredstev: transparentno in učinkovito upravljanje financiranja izobraževanja je ključnega pomena za preprečevanje napačne razporedi-*

tve sredstev.

Izobraževanje ni zgolj segment družbenega razvoja, temveč predstavlja temeljno orodje za oblikovanje dolgoročne vizije države in njenega gospodarskega napredka. Države, ki so sistematično vlagale v izobraževalne reforme in povečale financiranje tega sektorja, so dosegle večjo socialno stabilnost, tehnološki napredek in konkurenčno prednost na globalnem trgu. Republika Srbska mora prepoznati pomen teh vlaganj in jih obravnavati kot strateško prioriteto.

Izvajanje predlaganih reform bo omogočilo izobraževalnemu sistemu, da bolje odgovori na izzive digitalizacije, globalizacije in naraščajočih zahtev trga dela. Nujno je, da vlada, izobraževalne institucije in zasebni sektor združijo moči ter oblikujejo celovito strategijo razvoja izobraževanja, ki bo temeljila na merljivih kazalnikih uspešnosti. Vzpostavitev dolgoročnega finančnega načrta in stabilnega sistema spremljanja izobraževalnih investicij bo ključna za zagotavljanje trajnostne kakovosti izobraževalnih programov.

Če Republika Srbska ne bo pravočasno povečala vlaganj v izobraževanje, obstaja resno tveganje za nadaljnje poslabšanje kakovosti izobraževalnega sistema, povečanje brezposelnosti in zmanjšanje konkurenčnosti delovne sile. Vlaganje v izobraževanje je zato ena izmed najpomembnejših odločitev, ki jih lahko sprejme država, saj se pozitivni učinki ne odražajo le na posameznikovi ravni, temveč prispevajo k širši družbeni blaginji in dolgoročni gospodarski stabilnosti.

Za dosego teh ciljev moramo zagotoviti sistematično izboljšanje obstoječih politik, povečanje proračunskih sredstev, spodbujanje raziskovalnih in razvojnih dejavnosti ter večjo integracijo sodobnih tehnologij v učni proces. Republika Srbska ima priložnost, da skozi strateško načrtovane reforme preoblikuje svoj izobraževalni sistem in zagotovi prihodnjim generacijam pogoje za kakovostno izobraževanje, s čimer bo prispevala k svojemu trajnostnemu razvoju.

LITERATURE

1. Gabrichidze, T. (2022). Higher Education Funding Strategies: Towards Equity, Efficiency, and Quality. *European Scientific Journal*, 18(19), 20–34. <https://dx.doi.org/10.19044/esj.2022.v18n19p20>
2. Hastina, H., Safiltri, D. and Ramadhan, R. (2020). Analisis Kebijakan Pendidikan Terkait Akuntabilitas Pembiayaan Pendidikan. *Journal of Educational Policies*, 1(1), 45–67. <https://doi.org/10.31004/edukatif.v2i2.126>
3. Kasradze, T., Antia, V. and Gulua, E. (2019). Challenges of Financial Management of the Higher Education Institutions in Georgia. *European Journal of Educational Studies*, 5(1), 187–206. <https://doi.org/10.26417/ejes.v5i1.p187-206>
4. Mahputriono, M. (2022). Determination of education quality and graduate quality: Funding and curriculum management analysis. *Dinasti International Journal of Management Science*, 3(6), 1–18. <https://dx.doi.org/10.31933/dijms.v3i6.1306>
5. Manolescu, G. (2009). The reform of education funding: principles, options, modalities. *Economic Journal*, 8(2), 45–58.
6. Musah, A. and Aawaar, G. (2022). Financial development and educational quality in Sub-Saharan Africa. *Cogent Economics & Finance*, 10(1). <https://doi.org/10.1080/23322039.2022.2131115>

7. Nazukova, N. (2020). Public funding of education as a factor of economic growth. *Economic Forecast*, 2, 72–88. <http://dx.doi.org/10.15407/econforecast2020.02.072>
8. Rusina, H. (2022). Education Financing and Assessment in Improving the Quality of Education in Indonesia. *INJOE Journal*, 3(2), 34–45. <https://dx.doi.org/10.54443/injoe.v3i2.26>
9. Rusina, H. (2022). Education Financing and Assessment in Improving the Quality of Education in Indonesia. *Indonesian Journal of Education (INJOE) Journal*, 3(2), 207–215. <https://dx.doi.org/10.54443/injoe.v3i2.26>
10. Sutansyah, L. and Ramdani, A. (2023). Pembiayaan Pendidikan: Urgensi, Tantangan, dan Solusi. *Pelita Nusantara Journal*, 1(2), 87–102. <https://doi.org/10.59996/jurnalpelitanusantara.v1i2.197>
11. Tamam, B. (2018). Reorientasi Pendanaan Pendidikan Dalam Membangun mutu Sekolah. *Majalah Alamanda*, 29(2), 234–256. <https://doi.org/10.24853/ma.1.2.44-57>
12. Tindra, N. and Kadri, H. (2019). Efektivitas dan Efisiensi Pembiayaan Pendidikan. *Educational Financing Studies*, 48(4), 23–35. <https://dx.doi.org/10.31227/osf.io/48btr>

Zorana Agić, PhD, assistant professor at Banja Luka College, Bosnia and Herzegovina
E-naslov: zorana.agic@blc.edu.ba

Svetlana Dušanić Gačić, PhD, full professor at Banja Luka College, Bosnia and Herzegovina
E-naslov: svetlanadg@blc.edu.ba

Mirjana Milovanović, PhD, assistant Professor at Banja Luka College, Bosnia and Herzegovina
E-naslov: mirjana.milovanovic@blc.edu.ba

Računovodenje kriptovalut v Sloveniji

DOI: <https://doi.org/10.55707/eb.v12i1.147>

Strokovni članek

UDK 657:336.74:004(497.4)

KLJUČNE BESEDE: kriptovaluta, računovodski vidik, nabavna vrednost, poštena vrednost prek poslovnega izida.

POVZETEK – Poslovanje s kriptovalutami v Sloveniji je zahtevno zaradi pomanjkanja specifične zakonodaje in smernic. Kriptovalute se po SRS 2024 ne obravnavajo kot denarna sredstva, temveč kot založbe, če so namenjene trgovanju, ali neopredmetena sredstva pri dolgoročnih naložbah. Na podlagi SRS 3 jih je mogoče knjižiti po nabavni vrednosti, kar zagotavlja stabilnost, ali po pošteni vrednosti prek poslovnega izida, kar bolje odraža tržno stanje, a povzroča volatilnost. Kljub izboljšavam, ki so vsebovane v SRS 2024, standardi ne zajemajo vseh vidikov, kot so zamenjave kriptovalut in DeFi operacije, kar povzroča razhajanja v praksi. To povečuje kompleksnost računovodenja kriptovalut in zahteva prilagoditve ter dodatno izobraževanje računovodij. Spremljanje mednarodnih praks in prilagoditev slovenskim razmeram bi lahko izboljšala skladnost in preglednost. Za prihodnost je ključno oblikovanje celovitih smernic in davčne ureditve, ki bi zajele vse vidike poslovanja s kriptovalutami. Jasnejša pravila bi zmanjšala nejasnosti, izboljšala zanesljivost računovodskih praks ter povečala zaupanje v poslovanje s kriptovalutami. Kljub napredku na področju računovodske obravnave kriptovalut, le te zaradi svoje dinamične narave ostajajo izziv za slovensko računovodstvo.

Professional article

UDC 657:336.74:004(497.4)

KEYWORDS: cryptocurrency, accounting perspective, cost price, fair value through profit and loss

ABSTRACT – The cryptocurrency business in Slovenia is challenging due to the lack of specific legislation and guidelines. According to the Slovenian Accounting Standards (SRS 2024), cryptocurrencies are not considered cash equivalents, but rather inventory if intended for trading, or intangible assets for long-term investments. Based on SRS 3, they can be recorded at cost, which ensures stability, or at fair value through profit and loss, which better reflects the market conditions but causes volatility. Despite the improvements in SRS 2024, the standards do not cover all aspects, such as cryptocurrency exchanges and DeFi operations, leading to discrepancies in practice. This increases the complexity of the cryptocurrency accounting and requires adjustments and further education for accountants. Monitoring international practices and adapting them to the Slovenian conditions could improve compliance and transparency. For the future, it is crucial to develop comprehensive guidelines and tax regulations that would address all aspects of cryptocurrency business operations. Clearer rules would reduce ambiguities, enhance the reliability of the accounting practices, and increase trust in cryptocurrency business operations. Despite the progress in the accounting treatment of cryptocurrencies, their dynamic nature still presents challenges in the Slovenian accounting.

1 Uvod

Poslovanje s kriptovalutami se je od prvega pojava le-teh v letu 2008 razvijalo v vse možne smeri. S tem pa je nastala tudi potreba po evidentiranju poslovnih dogodkov s kriptovalutami, ki pa glede na razmeroma novo opredelitev, ki jim jo je bilo moč pripisati zaradi njihovih ključnih vsebinskih lastnosti, ni bilo ustrezno ovrednoteno, posledično pa tako ni bila dogovorjena enotna obravnava. Razlog pa je seveda preprosta. Kriptovalute ne izdaja država oziroma centralna banka tako kot fiat valute, zato

Prejeto/Received: 31. 1. 2025
Sprejeto/Accepted: 26. 3. 2025

Besedilo/Text © 2025 Avtor(ji)/The Author(s)
To delo je objavljeno pod licenco CC BY Priznanje avtorstva 4.0 Mednarodna.
/ This work is published under a CC BY Attribution 4.0 International license.
<https://creativecommons.org/licenses/by/4.0/>

njihova obravnava ni regulirana in s tem ni umeščena v zakonodajno pravni okvir računovodske obravnave. V Sloveniji se kljub razmeroma skromnemu deležu globalnih poslov s kriptovalutami pojavljajo pomembna vprašanja glede računovodske obravnave tovrstnih sredstev. Podjetja in posamezniki, ki poslujejo s kriptovalutami, se srečujejo z izzivi evidentiranja teh poslovnih dogodkov, še posebej glede njihovega pripoznavanja, merjenja in poročanja v skladu z veljavnimi računovodskimi standardi. Zaradi odsotnosti specifične zakonodaje in jasnih smernic v slovenskem prostoru pogosto prihaja do razhajanj v interpretaciji, kar povečuje kompleksnost računovodenja kriptovalut. Računovodenje kriptovalut v Sloveniji vključuje več vidikov, ki jih je treba upoštevati, in sicer poleg računovodskega vidika še pravni in davčni vidik. V okviru tega prispevka se osredotočamo le na računovodski vidik, po katerem se kriptovalute ne štejejo za denarno sredstvo. Večina strokovnjakov meni, da se lahko pripoznajo kot zaloge, če so namenjene trgovanju, ali kot neopredmeteno sredstvo, če predstavljajo dolgoročno naložbo. V okviru pravnega vidika je prav, da izpostavimo le, da kriptovalute niso zakonsko regulirane in niso zakonito plačilno sredstvo, vendar je plačevanje z njimi legalno pri tistih ponudnikih, ki tovrstni način plačila omogočajo. Prav je, da izpostavimo še davčni vidik, v okviru katerega se obravnava dohodek iz poslovanja s kriptovalutami, odvisno od tega, ali dohodek doseže fizična oseba, ki ne opravlja dejavnosti, ali fizična oseba, ki jo opravlja.

V Sloveniji je uvedba Slovenskih računovodskih standardov 2024 (SRS 2024) sicer prinesla določene smernice za ustrežnejšo računovodsko obravnavo kriptovalut, vendar pa te še vedno puščajo odprta vprašanja glede njihove uporabe v praksi. Praksa pogosto zahteva prilagoditve, saj standardi ne zajemajo vseh specifik poslovanja s kriptovalutami. Cilj obravnave te tematike je razumeti, kako kriptovalute vplivajo na računovodske prakse v Sloveniji, na kakšen način se jih lahko pripoznava za namene računovodenja ter katere rešitve in smernice bi bile primerne za njihovo obravnavo v prihodnje.

2 Teoretična izhodišča

2.1 Razvoj in pojem kriptovalut

Ideja o kriptovaluti je bila prvič omenjena s strani Davida Chauma leta 1989 in kasneje leta 1990. David Chaum je ameriški kriptograf, ki je izumil digitalno valuto. Izhajal je iz pomanjkljivosti, ki jih imata ustaljeni sredstva, papirni denar in kreditne kartice, ki temeljijo na zaupanju vseh vpletenih strani. Vsaka stran je ranljiva za goljufije drugih, še posebej imetnik kartice, ki nima zaščite pred nadzorom. Papirni denar ima sicer pomembno prednost pred kreditnimi karticami glede zasebnosti, čeprav so serijske številke na denarju načeloma sledljive. Prav zaradi težnje po nesledljivosti je Chaum uvedel brezpogojno nesledljiv elektronski denar. Pri tem se je v okviru težnje po preprečitvi možnosti zlorabe kriptovalute spraševal, kaj preprečuje komur koli, da bi naredil več kopij elektronskega kovanca in jih uporabil v različnih trgovinah. Kot edino možno rešitev je našel spletno čiščenje, ki pa ga je ocenil kot precej drago reši-

tev, in s tem omejil možnosti zlorabe na tveganje najnižje stopnje. Pri papirnatem denarju tega problema ni, saj se zdi, da je izdelava natančnih kopij nemogoča. Prav tako ne pri kreditnih karticah, ker njihova edinstvena identiteta omogoča banki, da sproži pravne postopke za povrnitev prekoračenih stanj in jo lahko doda na črni seznam. V splošnem je ocenil, da bi generiranje elektronskega denarja moralo biti težko za kogar koli, razen če se to izvaja v sodelovanju z banko (Chaum idr., 1990, str. 319).

Naslednji pomemben korak pri razvoju področja kriptoeconomije se je zgodil leta 2008, ko je bil s psevdonimom skupine programerjev, imenovane Satoshi Nakamoto, objavljen članek z naslovom Bitcoin: peer-to-peer elektronski denarni sistem. Kriptovalute so se rodile v času finančne krize v letih 2007–2009. Finančna kriza je namreč opustošila svetovno gospodarstvo in zamajala zaupanje ljudi v delovanje finančnega sistema. To je bila priložnost za zagon kriptovalut. Zgodovinsko gledano je prva transakcija s kriptovaluto, natančneje z bitcoinom, potekala 12. januarja 2009 med Nakamotom in Halom Finneyjem (Owolabi in Osanyinbi, 2023, str. 56). Kriptoban (b. d.) navaja, da so bila obljuba kriptovalut plačila, ki so splošno dostopna. Čeprav se sliši nemogoče, mnoge decentralizirane aplikacije že omogočajo avtomatizacijo posojila med dvema neznancema, ki sta lahko iz različnih koncev sveta, in to brez banke ali tretje osebe. Obstajajo DeFi aplikacije, ki omogočajo stabilne kovance (kriptovalute, katerih vrednosti so vezane na USD, EUR, GBP in ostale valute), posojilo denarja in zaslužek z obrestmi, najem posojila, menjavo enega kovanca za drugega, odpiranje dolgih ali kratkih pozicij in izvajanje naprednih naložbenih strategij. Decentralizirane aplikacije so zgrajene na decentralizirani tehnologiji (blockchain) namesto na centraliziranem in kontroliranem strežniku, ki je v lasti podjetja. Navaja tudi, da so DeFi aplikacije alternativa vsem finančnim storitvam, ki jih uporabljamo danes – prihranki, posojila, trgovanje, zavarovanje in ostale finančne storitve –, in dostopne komur koli na svetu s pametnim telefonom in internetno povezavo.

Na tehnologiji veriženja blokov (blockchain) pa je zasnovana tudi kriptovaluta, ki je digitalna valuta. Digitalna valuta je oblika valute, ki obstaja izključno v avtomatizirani ali digitalni obliki. Imenuje se tudi digitalni denar, elektronska valuta, e-denar ali kibernetični denar. Te valute nimajo fizičnih lastnosti in obstajajo zgolj v digitalnem sistemu. Transakcije, povezane z digitalnimi izmenjavami, se izvajajo prek procesorjev in elektronskih denarnic, povezanih z omrežji ali internetom (Sudra, 2024, str. 1). Evropski organi namesto izraza kriptovaluta uporabljajo izraz virtualna valuta. Virtualne valute obravnavajo kot plačilno sredstvo. Vendar pa je Evropska centralna banka (ECB) to opredelitev kritizirala, saj meni, da je definicija kriptovalute kot virtualne valute nepopolna. Poleg tega ECB poudarja, da kriptovaluta ni plačilno sredstvo, temveč medij izmenjave, in da ni denar niti valuta (Solodan, 2019, str. 67).

V nasprotju z digitalnimi valutami so fiat valute fizične valute, kot so bankovci in kovanci, ki so oprijemljivi in imajo določene fizične lastnosti. Transakcije, ki vključujejo tovrstne izmenjave, se lahko izvedejo le pod fizičnim nadzorom njihovih imetnikov. Digitalne valute in kovanci so računalniško generirane valute, ki za varnost uporabljajo kriptografijo in delujejo neodvisno od centralnih organov, kot so vlade in finančne institucije. So decentralizirane in običajno uporabljajo tehnologijo veriženja

blokov za varno beleženje transakcij (Sudra, 2024, str. 1), medtem ko so fiat valute regulirane.

Digitalne valute, ki temeljijo na žetonih in se močno zanašajo na tehnologijo veriženja blokov ter delujejo neodvisno od centralnih organov, lahko predstavljajo težave pri nadzoru denarnih tokov, saj ne zagotavljajo enake ravni preglednosti v transakcijah kot nakupi z gotovino. Pomanjkanje nadzora otežuje delo organom pregona in kaže, da tovrstne digitalne valute potrebujejo dodatne varnostne ukrepe za varno in uspešno delovanje (Švagan idr., 2022, str. 27).

2.2 Kriptovalute v Slovenskih računovodskih standardih

Slovenski računovodski standardi (SRS) so pravila o strokovnem ravnanju na področju računovodenja, ki jih oblikuje Slovenski inštitut za revizijo. Njihovo oblikovanje je spodbudil 5. člen Zakona o računovodstvu iz leta 1989, ki je vrhovno strokovno organizacijo pooblastil, naj namesto države, ki je dotlej z zakoni in drugimi predpisi urejala računovodenje, samostojno ter skladno z razvojem stroke v svetu in domačimi dosežki oblikuje svoje standarde. V Republiki Sloveniji so takšno pooblastilo za razvoj strokovnih standardov nadaljevali Zakon o gospodarskih družbah in Zakon o revidiranju ter drugi zakoni, ki se sklicujejo nanju (SRS 2024, 2023, str. 3).

SRS ne smejo biti v nasprotju z Zakonom o gospodarskih družbah, povzemati morajo vsebino Direktive 2013/34/EU in v zasnovi ne smejo biti v nasprotju z mednarodnimi standardi računovodskega poročanja. SRS in pojasnila SRS tako določijo podrobnejša pravila o računovodenju (ZGD-1, 2009, čl. 54).

SRS se nanašajo predvsem na gospodarske družbe, uporabljajo pa jih tudi druge organizacije, samostojni podjetniki posamezniki, zavodi, društva, agencije in celo državne organizacije, če to posebej določajo področni predpisi. Zato se v prenovljenih SRS uporablja izraz organizacija kot najširši pojem za vse uporabnike SRS (SRS 2024, 2023, str. 4). Slovenija je imela med prvimi državami v letu 2019 urejeno računovodenje kriptovalut s Pojasnilom 1 k SRS 11 – Časovne razmejitve v okviru SRS 2016. Pojasnilo z naslovom Računovodsko izkazovanje žetonov začetne ponudbe ureja vrednotenje kriptosredstev pri imetnikih in obveznosti pri izdajateljih (Pojasnilo 1 k SRS 11, 2018).

Pojasnilo 1 k SRS 11 (2018) v zvezi z razvrščanjem določa, da organizacija sredstva, ki jih vplača v kriptovalute, izkazuje kot posebno vrsto finančnih sredstev. Finančna sredstva razvrsti po ročnosti: če jih namerava odtujiti v kratkem roku, jih razvrsti med kratkoročna, sicer med dolgoročna. Kriptovalute bo razvrstila med kratkoročna sredstva običajno le, če z njimi aktivno trguje. V nasprotnem primeru jih bo razvrstila med dolgoročna sredstva. Kriptovalut pa podobno kot vrednostnih papirjev, če jih je ob začetnem pripoznanju razvrstila med dolgoročna sredstva, na bilančni presečni datum ne prerazvršča med kratkoročne finančne naložbe, čeprav jih ima morda namen odtujiti. Po splošnem pravilu SRS 3.7. (2015) organizacija naložbo ob začetnem pripoznanju razvrsti glede na namen in vrsto finančne naložbe, in sicer med:

- ☐ finančna sredstva, izmerjena po pošteni vrednosti prek poslovnega izida;
- ☐ finančne naložbe v posesti do zapadlosti v plačilo;

- finančne naložbe v posojila ali
- za prodajo razpoložljiva finančna sredstva.

Finančne naložbe so finančna sredstva, ki jih ima organizacija naložbenica, da bi z donosi, ki izhajajo iz njih, povečevala svoje finančne prihodke. Ti se razlikujejo od poslovnih prihodkov, ki izhajajo iz prodaje proizvodov in opravljanja storitev v okviru njenega rednega poslovanja (SRS 3.1., 2023, str. 52). Finančne naložbe so večinoma naložbe v kapital drugih organizacij ali v finančne dolgove drugih organizacij, države, območja in občine ali drugih izdajateljev (finančne naložbe v posojila), pojavljajo pa se tudi kot finančna sredstva drugačne narave, ki niso vezana na proizvodnje in opravljanje storitev v proučevani organizaciji. Poslovne in finančne terjatve se ne štejejo kot finančne naložbe, razen tistih, ki so v posesti za trgovanje (SRS 3.2., 2023, str. 52).

Kriptoalut že po osnovnem pravilu ni mogoče razvrstiti v drugo in tretjo skupino – kriptoalute namreč nimajo roka zapadlosti, kot denimo velja za dana posojila in depozite. Zato jih organizacija skladno s splošnim pravilom SRS 3 (2015) razvrsti zgolj v prvo ali četrto skupino, torej med finančna sredstva, izmerjena po pošteni vrednosti prek poslovnega izida, ali za prodajo razpoložljiva finančna sredstva (Bajuk Mušič, 2021). SRS 2024 (SRS 3.6., 2023, str. 52–53) so razčlenili finančne naložbe v kapital in finančne naložbe v posojila na tiste, ki se nanašajo na odvisne organizacije v skupini, pridružene organizacije in skupne podvige ter druge. Druge finančne naložbe se ob začetnem pripoznanju razvrsti med finančna sredstva, izmerjena po pošteni vrednosti prek poslovnega izida, finančna sredstva, izmerjena po odplačni vrednosti, ali finančna sredstva, izmerjena po pošteni vrednosti prek kapitala (SRS 3.7., 2023, str. 53).

Merjenje po pošteni vrednosti prek poslovnega izida predstavlja glede na SRS 3.7. (2015) in tudi SRS 3.7. (2023) prvo skupino. Pojasnilo pa ne dopušča, da bi organizacija kriptoalute merila po pošteni vrednosti prek kapitala. Ne more jih torej razvrstiti v skupino za prodajo razpoložljivih finančnih sredstev in jih meriti po pošteni vrednosti, učinek spremembe pa prikazovati prek kapitala (oziroma drugega vseobsegajočega donosa). SRS 3.21. (2015) pa določa, da organizacija finančne naložbe meri po nabavni vrednosti tudi v vseh tistih primerih, kjer njihove poštene vrednosti ne more zanesljivo ugotoviti. Ker so kriptoalute pogosto špekulativne, njihova vrednost pa podvržena volatilnosti, kar posledično vpliva na volatilnost prihodkov in odhodkov v izkazu poslovnega izida, se lahko organizacija odloči, da kriptoalute meri po nabavni vrednosti (Bajuk Mušič, 2021).

Merjenje po začetnem pripoznanju kriptoalut je, skladno s Pojasnilom 1 k SRS 11, odvisno od izbrane metode: po pošteni vrednosti prek poslovnega izida ali po nabavni vrednosti. Organizacija lahko za različne kriptoalute izbere različne metode merjenja (npr. kriptoaluto A meri po nabavni vrednosti, kriptoaluto B pa po pošteni vrednosti). Ko je metoda določena, je ni dovoljeno spreminjati vse do odprave pripoznanja kriptoalute. Pojasnila 1 k SRS 11 ne morejo uporabiti tiste organizacije, ki računovodijo po MSRP. Kot navaja Bajuk Mušič (2021), organizacije, ki računovodske izkaze sestavljajo po MSRP, pri sestavi računovodskih izkazov upoštevajo le pravila, ki jih določajo MSRP. Nikakor za opredelitev ne smejo uporabljati določb, ki jih MSRP ne vsebujejo, ali opredelitev, ki so morda vsebovane v nacionalni zakonodaji,

a je ta v nasprotju z opredelitvijo v MSRP. Organizacija takih računovodskih izkazov ne sme opisovati kot skladnih z MSRP.

Mnoge organizacije so Slovenskemu inštitutu za revizijo očitale, da je računovodska obravnava kriptovalut napačno umeščena v standard, ki sicer obravnava razmejitev, in da bi bila smiselna uvrščenost pod SRS 3 – Finančne naložbe (Bajuk Mušič, 2021). Očitane pomanjkljivosti ureditve so odpravili. V predlogu novega SRS 3.40 (2023) je namreč Slovenski inštitut za revizijo omogočil, da organizacije med finančne naložbe lahko razvrstijo tudi plemenite kovine, kriptovalute in druga podobna sredstva, katerih namen je ohranjanje vrednosti (Mušič, 2023). Druge finančne naložbe, med katere so bile uvrščene kriptovalute že v okviru Pojasnila 1 k SRS 11, so torej tudi s SRS 2024 (SRS 3.40., 2023, str. 62) dobile svojo obravnavo. Te posebne vrste naložb organizacija po začetnem pripoznanju lahko meri po pošteni vrednosti prek poslovnega izida ali po nabavni vrednosti. Tovrstna usmeritev merjenja je bila, kot smo že omenili, prav tako že vsebovana tudi v Pojasnilu 1 k SRS 11.

Organizacije torej obravnavajo kriptovalute kot posebno vrsto finančnih sredstev, za katera lahko uporabijo dve metodi merjenja: po nabavni vrednosti ali po pošteni vrednosti prek poslovnega izida. Pri vrednotenju po pošteni vrednosti je pomembno, da se učinki sprememb vrednosti prikažejo izključno prek poslovnega izida, saj vrednotenje prek kapitala (konta 95) ni dovoljeno. Računovodski izzivi so najbolj izraziti pri uporabi modela nabavne vrednosti, še posebej pri upravljanju zalog kriptovalut. Pogosto se pojavijo vprašanja, kako tehnično voditi zalogo v primerih, ko podjetje izvaja pogoste nakupe in prodaje, pri čemer so količine in cene transakcij različne. Ker nobeni računovodski standardi ne predpisujejo natančnih postopkov za zmanjšanje zaloge ob delnih odtujitvah, morajo organizacije z internimi akti opredeliti lastne usmeritve za spremljanje zalog in poenostavitev tega procesa. Merjenje po pošteni vrednosti prek poslovnega izida pa je enostavnejše, saj se vrednost kriptovalut na dan bilance stanja vedno prilagodi na njihovo pošteno vrednost. Vsi učinki sprememb, ne glede na vmesne transakcije, so samodejno vključeni v poslovni izid na kumulativni ravni. Zato je ta metoda posebej primerna za organizacije z velikim številom transakcij. V skladu z zahtevo SRS 3.40 organizacije ne smejo spreminjati izbrane računovodske usmeritve za vrednotenje kriptovalut vse do odprave njihovega pripoznanja (Vuković in Kermat, 2024).

2.3 Nakup in prodaja kriptovalut

Glede na SRS 3.39 se za običajen nakup ali običajno prodajo šteje nakup ali prodaja finančnega sredstva po pogodbi, katere določbe zahtevajo izročitev tega sredstva v roku, ki ga na splošno določajo predpisi ali dogovor na zadevnem trgu (SRS, 2023, str. 62). Eden izmed ponudnikov prodaje in nakupa kriptovalut je podjetje Kriptovalute, d. o. o., ki v okviru spletne platforme Kriptomat omogoča poceni, hiter, varen in enostaven nakup, menjavo ter prodajo več kot 300 kriptovalut v lokalnem jeziku in z lokalno podporo. Za koriščenje storitev spletne platforme je potrebno ustvariti uporabniški račun, ki omogoča vpogled v stanje kripto in fiat valut. Kriptovalute lahko kadar koli kupite, prodate, prejmete ali pošljete. Hrani se jih v zaščiteni centralni de-

narnici ponudnika, zato za varnost ključev in gesel ni potrebno skrbeti (Kriptovalute, si, b. d.). Sam postopek nakupa prve kriptovalute za začetnike po mnenju Kryptocoin. Si (b. d.) ni zapleten, če sledite priporočilu naslednjih petih korakov.

□ Registracija na borzi kriptovalut

Začetnik mora najprej opraviti registracijo na eni od borz kriptovalut. Registracija vključuje vpis podatkov: ime, naslov, e-poštni naslov, telefonska številka in geslo.

□ Opravite KYC

Po registraciji na borzi je potrebno opraviti tudi KYC ali Know Your Customer zahteve, ki vključujejo vpis osebnih podatkov in s telefonom fotografiran osebni dokument, ki je lahko potni list ali osebna izkaznica. Opraviti je potrebno tudi fotografijo obraza.

□ Pregled verifikacije

Borza običajno potrebuje od enega do treh dni, da podatke pregleda in jih potrdi, o čemer pošlje elektronsko sporočilo. Če je sporočeno, da je bil pregled uspešen, se lahko opravi nakup.

□ Nakazilo denarja na borzo kriptovalut

Plačila so možna v okviru SEPA plačila, s kreditno kartico in PayPalom.

□ Nakup kriptovalute

Poišče in izbere se eno izmed kriptovalut med razpoložljivimi kovanci.

Kot vidimo iz zgornjih korakov, se nakup kriptovalute začne z registracijo na borzi in preverjanjem identitete. Po potrditvi podatkov sledita nakazilo denarja na lasten račun in izbira želene kriptovalute. S temi preprostimi koraki se opravi nakup kriptovalute, s čimer se ustvari tudi podlaga za njihovo menjavo ali prodajo in s tem potrebo po računovodski pripoznavi v poslovnih knjigah uporabnikov.

3 Metodologija

3.1 Namen in cilji raziskave

Namen raziskave je prikazati kriptovalute kot sredstvo, ki je predmet obravnave v okviru SRS. Cilj raziskave je predstaviti kriptovalute in način njihove računovodske obravnave v Sloveniji, glede na ureditev SRS, v primeru njihovega nakupa in prodaje.

3.2 Raziskovalno vprašanje

Glede na namen in cilje raziskave smo zastavili raziskovalno vprašanje, in sicer:

RV 1: Ima Slovenija ustrezno računovodsko ureditev, ki omogoča računovodsko obravnavo v primeru nakupa in prodaje kriptovalute?

3.3 Metode in tehnike zbiranja podatkov

Tekom raziskovanja so bile uporabljene metode družboslovnega raziskovanja. Raziskovanje se je pričelo z metodo zbiranja, s pomočjo katere je bila pregledana

obstoječa literatura na temo kriptovalut s pomočjo svetovnega spleta, baze Cobiss in dLib. V nadaljevanju je bila za njihovo kratko predstavitev uporabljena zgodovinska metoda in za proučitev pravnih podlag in strokovne literature metoda deskriptivne analize. Citati stališč avtorjev so bili obravnavani v okviru metode kompilacije. V okviru kvalitativne analize smo opravili pregled in analizo računovodskih standardov ter praktičnih primerov, interpretirali vsebino računovodskih standardov ter njihovo uporabo na praktičnem primeru nakupa in prodaje kriptovalute.

3.4 Opis instrumenta

Podatke knjižb smo oblikovali v tabelah na podlagi določil računovodske obravnave kriptovalut po SRS 2024 in strokovnega članka, iz katerega izhaja prikaz osnovne knjižbe prodaje in nakupa kriptovalute za podjetja.

3.5 Opis vzorca

Osnovno množico predstavljajo vse organizacije, ki računovodijo v skladu s SRS.

3.6 Opis zbiranja in obdelave podatkov

Za namen prikaza knjiženja nakupa in prodaje kriptovalute smo glede na teoretični izhodišči, iz katerih izhaja, da organizacije o začetni pripoznavi kriptovalute le-to lahko merijo po pošteni vrednosti prek poslovnega izida ali po nabavni vrednosti in te računovodske usmeritve ne smejo spreminjati vse do odprave pripoznanja takšne naložbe, podatke nakupa in prodaje kriptovalute prikazali v okviru knjiženja za oba primera računovodske usmeritve. Rezultati so tabelarično in opisno prikazani v nadaljevanju.

3.7 Rezultati raziskave

V nadaljevanju prispevka so prikazani rezultati raziskave. Za namen prikaza knjiženja nakupa in prodaje kriptovalut v okviru računovodske obravnave, kot jo določajo SRS 2024, podatke prikazujemo na primeru organizacije, ki opravi nakup kriptovalute v višini 50.000 EUR in zanj plača še posredniško provizijo v višini 2 %, ki znaša 1.000 EUR. Nakup kriptovalute se lahko poknjiži na dva načina, ki ju prikazujemo v tabeli 1 in 2. Po določenem času se organizacija odloči, da bo kriptovalute, ki jih ima izkazane po knjigovodski vrednosti 50.000 EUR, prodala za 55.000 EUR. Prodajo lahko poknjiži na dva načina, kot ju prikazujemo v tabeli 3 in 4.

Tabela 1

Knjiženje nakupa kriptovalut po pošteni vrednosti preko poslovnega izida

Zap. št.	Oznaka dok.	Znesek v EUR	V breme	V dobro
1.	PRAČ	50.000	067 ali 177	220
		1.000	415	220

Prirejeno po Vuković in Kermat. (2024). Kriptovalute (primeri knjiženja po SRS 2024).

Pri nakupu kriptovalut, ki se jih vrednoti po pošteni vrednosti, organizacija zabeleži nabavno vrednost kriptovalut na konto 067 – druge dolgoročne finančne naložbe, razporejene in izmerjene po pošteni vrednosti prek poslovnega izida, ali konto 177

– druge kratkoročne finančne naložbe, razporejene in izmerjene po pošteni vrednosti prek poslovnega izida, odvisno od vrste transakcije, v višini 50.000 EUR. Če obstajajo povezani stroški nakupa (npr. provizije ali drugi stroški), se te knjiži na konto 415 – stroški plačilnega prometa, stroški bančnih storitev, stroški poslov in zavarovalne premije, kar pomeni dodatni strošek v višini 1.000 EUR. Pri tem načinu knjiženja se spremembe vrednosti kriptovalut obravnava kot poslovni izid, saj se poštena vrednost lahko spreminja glede na tržne razmere.

Tabela 2

Knjiženje nakupa kriptovalut po nabavni vrednosti

Zap. št.	Oznaka dok.	Znesek v EUR	V breme	V dobro
1.	PRAC	50.000	066	220
		1.000	066	220

Prirejeno po Vuković in Kermat. (2024). Kriptovalute (primeri knjiženja po SRS 2024).

V tem primeru, ki ga prikazujemo v tabeli 2, se kriptovalute obravnava po nabavni vrednosti. Organizacija ob nakupu zabeleži vrednost kriptovalut na konto 066 – druge dolgoročne finančne naložbe, razporejene in izmerjene po nabavni vrednosti, v višini 50.000 EUR. Če obstajajo dodatni stroški nakupa, se tudi te knjiži na isti konto, saj se vrednost kriptovalut obravnava po nabavni vrednosti in ni potrebna prilagoditev zaradi sprememb po pošteni vrednosti.

Tabela 3

Knjiženje prodaje kriptovalut po pošteni vrednosti preko poslovnega izida

Zap. št.	Oznaka dok.	Znesek v EUR	V breme	V dobro
1.	IRAC	55.000	155	
		50.000		067 ali 177
		5.000		778

Prirejeno po Vuković in Kermat. (2024). Kriptovalute (primeri knjiženja po SRS 2024).

Ko organizacija proda kriptovalute za 55.000 EUR, prihodke iz prodaje knjiži na konto 155 – druge kratkoročne terjatve, povezane s finančnimi prihodki. Ker so kriptovalute sprva knjižene po pošteni vrednosti, se ob prodaji izkaže dobiček ali izguba. V tem primeru je prodajna cena 55.000 EUR, medtem ko je knjigovodska vrednost 50.000 EUR, kar pomeni, da je dobiček v višini 5.000 EUR knjižen na konto 778 – finančni prihodki iz finančnih sredstev, razporejenih po pošteni vrednosti prek poslovnega izida. Ta dobiček predstavlja razliko med prodajno ceno in knjigovodsko vrednostjo ob prodaji.

Tabela 4

Knjiženje prodaje kriptovalut po nabavni vrednosti

Zap. št.	Oznaka dok.	Znesek v EUR	V breme	V dobro
1.	IRAC	55.000	155	
		50.000		067 ali 177
		5.000		778

Prirejeno po Vuković in Kermat. (2024). Kriptovalute (primeri knjiženja po SRS 2024).

Pri prodaji kriptovalut, ki so bile prvotno knjižene po nabavni vrednosti, organizacija proda kriptovalute za 55.000 EUR. Prihodke od prodaje se knjiži na konto 155 – druge kratkoročne terjatve, povezane s finančnimi prihodki. Ker je knjigovodska vrednost kriptovalut 50.000 EUR, organizacija ob prodaji izkaže dobiček v višini 5.000 EUR. V tem primeru se dobiček knjiži na konto 773 – finančni prihodki iz drugih naložb, ker je bil nakup opravljen po nabavni vrednosti brez prilagoditev po poštenu vrednosti.

4 Razprava

V okviru razprave opravljene raziskave podajamo odgovor na raziskovalno vprašanje, ki se glasi:

RV 1: Ima Slovenija ustrezno računovodsko ureditev, ki omogoča računovodsko obravnavo v primeru nakupa in prodaje kriptovalute?

Pridobljene kriptovalute začetno pripoznamo po nakupni vrednosti. Eventualne stroške posla (provizije posrednikom) se izkaže neposredno med stroški. Na vsak dan bilance stanja se vrednost kriptovalut ponovno izmeri (po borznem tečaju) in razliko v vrednosti neposredno pripiše nakupni vrednosti oziroma se le-ta ustrezno zmanjša, protiknjižba pa so vsakokrat finančni prihodki ali finančni odhodki v izkazu poslovnega izida (konto 77 oziroma 74). Tudi razliko, ki nastane med knjigovodsko vrednostjo pripoznanih kriptovalut in prodajno vrednostjo, se ob njihovi odtujitvi izkaže kot finančni prihodek oziroma odhodek. Če smo za držanje pridobljene kriptovalute izbrali model nabavne vrednosti, tak način merjenja pomeni, da bomo kriptovalute začetno pripoznali po nakupni vrednosti, v katero bomo všteli tudi eventualne neposredne odvisne stroške pridobitve, to je stroške posla (provizije posrednikom). Na vsak dan bilance stanja bomo sicer preverjali njihovo pošteno vrednost, a je v primeru rasti ne bomo knjižili, v primeru padca pa preverjali še druge znake. Le če bi ugotovili, da gre za trajno oslabiljenost naložb, bi jih slabili in izkazali prevrednotovalne finančne odhodke. Ob prodaji kriptovalut bomo razliko med prodajno vrednostjo in njihovo knjigovodsko vrednostjo vključili med finančne prihodke oziroma odhodek v izkazu poslovnega izida (konto 74 ali 77) (Vuković in Keramat, 2024).

V obeh primerih nakupa (tako po poštenu vrednosti kot po nabavni vrednosti) organizacija izkaže naložbo na kontu drugih finančnih naložb. Medtem ko stroške provizije pri modelu poštene vrednosti prek poslovnega izida izkaže ločeno, na kontu stroškov, pri modelu nabavne vrednosti pa stroške provizije izkazuje skupaj z naložbo na kontu drugih finančnih naložb. V obeh primerih prodaje (tako po poštenu vrednosti kot po nabavni vrednosti) organizacija izkaže dobiček zaradi razlike med prodajno ceno in knjigovodsko vrednostjo. Razlika med metodama je v tem, da se pri prodaji po poštenu vrednosti dobiček knjiži na konto 778, medtem ko se pri prodaji po nabavni vrednosti dobiček knjiži na konto 773, saj ni bilo prilagoditev vrednosti kriptovalut na tržno vrednost. Pri knjiženju kriptovalut je zato izredno pomembno, da je računovodja

v prvi vrsti dobro seznanjen z vsebino posameznega dogodka, da ga lahko pravilno uvrsti v računovodske standarde in zanj določi pravilno računovodsko obravnavo.

Čeprav SRS 2024 prinašajo določene smernice za računovodsko obravnavo kriptovalut, ostaja praksa zaradi omejenega obsega teh standardov kompleksna in pogosto zahteva prilagoditve. Ključna vprašanja, s katerimi se srečujejo uporabniki, vključujejo pravilno pripoznavanje in merjenje vrednosti kriptovalut ter poročanje o njih v skladu z obstoječimi računovodskimi standardi. Na podlagi SRS 3 – finančne naložbe smo v analizi predstavili dva načina knjiženja nakupa in prodaje kriptovalut, in sicer z uporabo metode merjenja po nabavni vrednosti ali metode merjenja po pošteni vrednosti prek poslovnega izida. Prva metoda omogoča stabilnost in preglednost v računovodskih izkazih, vendar ne odraža trenutne tržne vrednosti kriptovalut, kar lahko vodi do pomanjkanja relevantnih informacij za uporabnike računovodskih poročil. Druga metoda, ki temelji na pošteni vrednosti prek poslovnega izida, sicer bolj natančno odraža trenutne tržne razmere, vendar prinaša večjo volatilnost, kar lahko oteži analizo dolgoročnih finančnih rezultatov in poveča računovodsko kompleksnost. Slabost trenutnega računovodskega pristopa je predvsem pomanjkanje enotnih smernic, kar vodi v različne interpretacije in neenotno obravnavo poslovanja s kriptovalutami. Prav tako veljavni standardi ne zajemajo vseh specifik poslovanja, kot so vprašanja, povezana s hrambo, zamenjavami kriptovalut ali njihovim evidentiranjem pri decentraliziranih finančnih operacijah, ki se odvijajo v okviru DeFi aplikacij, kot so na primer posojanje in izposojanje valut in menjalnica za avtomatizirano izmenjavo žetonov. To povečuje potrebo po prilagoditvah in dodatnih računovodskih razlagah, kar predvsem za računovodje in organizacije predstavlja dodaten izziv.

Za enostaven primer nakupa in prodaje kriptovalute s strani uporabnika smo nakup in prodajo ustrezno prikazali v okviru računovodske obravnave, kot je določena s SRS 3, s čimer lahko pritrdilno odgovorimo na zastavljeno raziskovalno vprašanje.

5 Sklep

Računovodenje kriptovalut v Sloveniji se sooča s številnimi izzivi, ki izvirajo iz pomanjkanja specifične zakonodaje in jasnih rešitev. Glede na strmo rast obsega in razvoj področja kriptovalut bi bilo nujno razviti bolj specifične in celovite rešitve, ki bi zajele vse ključne vidike poslovanja s kriptovalutami, od njihovega pripoznavanja in merjenja do poročanja. Hkrati bi bilo smiselno zagotoviti usmerjena izobraževanja za računovodje, da bi bolje razumeli obstoječe standarde in jih pravilno uporabili v praksi. Učinkovito bi bilo tudi spremljanje mednarodnih praks in standardov v tistih delih, kjer so morda bolj napredni, ter jih prilagoditi slovenskim razmeram. To bi lahko zagotovilo večjo usklajenost in enotnost v računovodski obravnavi kriptovalut ter zmanjšalo razhajanja v njihovi interpretaciji. Navsezadnje bi bile koristne, če ne celo nujne, tudi prilagoditve zakonodajnega okvira, ki bi vključeval specifične davčne smernice za kriptovalute s povezavo na računovodsko obravnavo. Učinkovita regulacija bi lahko prispevala k boljši preglednosti in večjemu zaupanju uporabnikov v

poslovanje s kriptovalutami, hkrati pa računovodjem v vsebinskem delu ponudila jasnejši pogled na področje računovodenja kriptovalut.

Čeprav smo nakup in prodajo kriptovalute lahko ustrezno prikazali v okviru računovodske obravnave, pa zaključujemo, da so kriptovalute zaradi svoje unikatne narave in dinamičnega trga v Sloveniji še vedno predmet številnih nejasnosti in izzivov tudi v računovodski obravnavi. Čeprav ureditev v SRS 2024 pomeni pomemben korak naprej in jo kot tako v računovodskem smislu pozdravljamo, je za zagotavljanje enotnosti in zanesljivosti v prihodnje nujno zagotoviti bolj specifične in celovite smernice ter krepiti usposabljanja računovodskih strokovnjakov. S tem bi se povečala skladnost v računovodskih praksah, izboljšala preglednost in omogočila bolj zanesljiva ter celovitejša obravnava kriptovalut v slovenskem poslovnem okolju.

Anita Blažič

Accounting of Cryptocurrencies in Slovenia

Cryptocurrencies have emerged as a response to the shortcomings of the traditional financial systems, making them one of the most innovative and controversial topics in the modern financial world. Their development was driven by various deficiencies in the existing financial systems, such as centralization, long transaction execution times, intermediary costs, and a lack of transparency and privacy. The first concept of digital currency was introduced by David Chaum in 1989, presenting the idea of digital money based on cryptographic protection that enabled private transactions without intermediaries. However, the real breakthrough in the history of cryptocurrencies came in 2008, when the pseudonymous author Satoshi Nakamoto published the Bitcoin white paper. Bitcoin was designed as a decentralized electronic cash system based on blockchain technology. Thus, Bitcoin became the first practical example of a digital currency that allows direct value exchange between users without intermediaries, such as banks or other financial institutions. Through this decentralized model, the need for a central authority to regulate and verify transactions was eliminated. As a result, Bitcoin has received both enthusiastic and skeptical reactions since its inception. Its value was initially highly volatile, but over time, it gained popularity among users and investors. This interest led to the expansion of new digital currencies and cryptocurrencies, whose number and types have significantly increased over time.

However, cryptocurrencies have also introduced numerous challenges and issues, particularly in the legal, regulatory, and accounting domains. Cryptocurrencies are not recognized as legal tender in many countries, including the European Union, where they have been primarily regarded as exchange assets. The European Central Bank has emphasized that cryptocurrencies do not represent a legally recognized means of payment but merely a way to exchange value between parties. This classification has influenced the accounting treatment of cryptocurrencies, necessitating the deve-

lopment of appropriate guidelines to address these assets, which do not fall under traditional monetary instruments.

In Slovenia, the accounting treatment of cryptocurrencies has raised several questions and dilemmas. Legally, cryptocurrencies are not officially classified as monetary assets, but can be treated as inventory, intangible assets, or even financial assets, depending on the circumstances. This has led to various interpretations in practice since the Slovenian Accounting Standards (SRS) are not directly adapted to the treatment of cryptocurrencies, whose nature and market behaviour differ significantly from the traditional financial assets. The first attempt at accounting regulation appeared with Interpretation 1 to SRS 11, which classified cryptocurrencies as financial assets. The Slovenian Accounting Standards 2024 (SRS 2024) now allow them to be treated as financial investments, meaning that companies can measure them either at acquisition cost or at fair value through profit or loss. However, the standards do not cover all the specifics of cryptocurrency transactions, leading to inconsistencies in practice.

Based on these changes, companies have gained greater flexibility in accounting for cryptocurrencies in the financial statements. However, in the broader context of accounting treatment, regulation remains incomplete. Cryptocurrencies can be accounted for in various ways, often requiring companies to adopt internal guidelines and practices, which can lead to inconsistencies in general accounting practices. Cryptocurrencies are highly volatile, and their value fluctuates rapidly, leading companies to choose between two main methods for accounting for them: fair value measurement through profit or loss or acquisition cost measurement.

Fair value measurement means that the value of cryptocurrencies is regularly adjusted according to the market conditions. This allows for a more accurate tracking of the real value of cryptocurrencies in a company's portfolio, but also introduces a greater volatility in the financial statements. In cases of high cryptocurrency market fluctuations, a company's financial results can vary significantly, requiring a precise strategy to manage these changes. On the other hand, acquisition cost measurement means that cryptocurrencies are recorded at their initial purchase price, with adjustments made only in the event of a permanent impairment of their value. While this method provides a greater stability in the financial statements, it can create discrepancies between the book value and actual market value, especially in cases of long-term cryptocurrency holdings. This approach to typical cryptocurrency purchases, sales, and treatment as financial investments is consistent with SRS 3.39. Companies must choose one method and cannot change it until the recognition of the cryptocurrency is terminated.

In Slovenia, in addition to the two most common approaches mentioned in the previous paragraph, other methods are also used for recording cryptocurrencies, as there are no unified guidelines that clearly define how to treat cryptocurrencies in all possible situations. Companies often encounter difficulties in handling specific transactions, such as cryptocurrency exchanges or payments made with cryptocurrencies, which are not directly covered in the accounting standards. Additional challenges ari-

se in dealing with decentralized financial products, which are becoming increasingly popular and require specific accounting practices that current standards do not provide. The lack of clear guidelines also means that companies and accountants often rely on their own interpretations, leading to varying accounting practices. This can create difficulties in comparing the financial statements between different companies, as different approaches and methodologies are applied.

Given this issue, the research focused on the key challenge of whether Slovenia provides an adequate accounting framework for correctly recording cryptocurrency purchases and sales, considering the growing use of these assets in economic transactions. Accordingly, the research conducted a thorough analysis of the applicable Slovenian Accounting Standards, particularly the Slovenian Accounting Standards (SRS 2024), which aim to ensure appropriate treatment of both new and traditional financial instruments. The general accounting principles and specific provisions related to cryptocurrencies were considered, including their treatment in companies dealing with digital assets as part of their operations or whose main business involves digital assets.

Various methodologies were used in the analysis, with descriptive analysis and compilation prevailing. The descriptive analysis enabled an in-depth understanding of the current state of the accounting practices in Slovenia, particularly in the context of cryptocurrency accounting, while the compilation facilitated the comparison of different approaches to maintaining cryptocurrency accounting records. The research examined concrete practical examples of bookkeeping, highlighting the key differences in how cryptocurrencies are accounted for in Slovenian companies regarding purchases, sales, and changes in their value.

The analysis of specific bookkeeping cases revealed that Slovenian companies primarily use two main measurement methods for cryptocurrencies: fair value through profit or loss and acquisition cost. Each of these methods presents specific challenges in the accounting for cryptocurrency value changes. The first method allows for a more dynamic and market-aligned valuation, while the second provides stability in long-term asset review. However, both approaches involve uncertainties in recording specific transactions, such as cryptocurrency exchanges, payments made with these assets, or the inclusion of decentralized financial products in the financial statements.

The analysis of these cases also helped determine how cryptocurrency value changes impact company financial statements and how these changes are reflected in balance sheets and income statements. In this context, the research focused on whether the current accounting framework ensures compliance with the recommendations that help companies achieve greater transparency and consistency in the cryptocurrency accounting within their financial statements.

The analysis concluded that despite the use of SRS 2024 for cryptocurrency accounting, Slovenian companies still face challenges due to the lack of clear guidelines for specific types of transactions, such as cross-border transactions, decentralized finance, trading fees, and transaction costs. The absence of precise guidelines for these special cases can lead to inconsistencies in recording business events among different

companies and make financial statement comparisons more difficult. This is a key factor affecting transparency and trust in the financial statements of companies dealing with cryptocurrencies.

This research contributed to a better understanding of the current state in Slovenia and highlighted the need for additional clarifications, harmonization of accounting standards, and education of professionals to ensure a greater consistency and compliance in the cryptocurrency accounting in the future.

Based on the research, it can be concluded that Slovenia has established certain accounting frameworks for recording cryptocurrencies, but they are not sufficient for a comprehensive and unified treatment of all aspects of cryptocurrency transactions. Companies and accountants are thus left to their own interpretations and adaptations, increasing the risk of inconsistent accounting practices. In the future, it will be necessary to provide the conditions for further professional training and upgrade the accounting rules to ensure a greater consistency and transparency in the cryptocurrency accounting in Slovenia. Clear and well-defined accounting standards not only reduce the risk of inconsistencies but also minimize opportunities for misuse and fraudulent financial reporting. When accounting guidelines are precise, the accuracy of financial statements improves, reducing the likelihood of tax evasion or hidden transactions. This, in turn, facilitates the work of supervisory authorities, ensuring a better oversight and compliance with the financial regulations.

LITERATURA

1. Bajuk Mušič, A. (2021). Razvrščanje in merjenje kriptovalut po SRS. Pridobljeno s <https://www.revijaiks.si/2021/05/Racunovodstvo/clanek/5822282/razvrscanje-in-merjenje-kriptovalut-po-srs?h=pojasnilo%201%20k%20srs%2011>
2. Chaum, D., Fiat, A. in Naor, M. (1990). Untraceable electronic cash. V S. Goldwasser (ur.), *Advances in Cryptology - CRYPTO'88. CRYPTO 1988. Lecture Notes in Computer Science* (str. 319-327). Springer.
3. Kriptoban. (b. d.). Kaj so decentralizirane finance - DeFi? <https://kriptoban.si/kaj-so-decentralizirane-finance-defi/>
4. Kriptocoin.si. (b. d.). Kriptovalute za začetnike - popoln vodič. <https://kriptocoin.si/kriptovalute-za-zacetnike/>
5. Kriptovalute.si. (b. d.). Kupi, prodaj, menjaj in hrani kriptovalute. <https://kriptovalute.si/kupi-prodaj-hrani-kriptovalute/>
6. Mušič, A. (2023). Predlagane spremembe SRS 3 (2024). <https://www.revijaiks.si/2023/11/Racunovodstvo/clanek/6195126/predlagane-spremembe-srs-3-2024>
7. Owolabi, S. A. in Osanyinbi, T. G. (2023). The historical evolution, developments and accounting implications of cryptocurrency operations. *European Journal of Accounting, Auditing and Finance Research*, 11(10), 55–72. <https://eajournals.org/ejaaf/vol11-issue10-2023/the-historical-evolution-developments-and-accounting-implications-of-cryptocurrency-operations/> <https://doi.org/10.37745/ejaaf.2013/vol11n105572>
8. Pojasnilo 1 k SRS 11 (2016). (2018). Uradni list RS, št. 81/2018. <https://si-revizija.si/standardi/slovenski-racunovodski-standardi-2016>
9. Pravila skrbnega računovodenja (PSR 2016). (2015). <https://si-revizija.si/komisija-za-srs/srs-2024>
10. Slovenski računovodski standardi (SRS 2016). (2015). Uradni list RS, št. 95/15, 74/16 - popr., 23/17, 57/18, 81/18 in 129/23. <https://si-revizija.si/standardi/slovenski-racunovodski-standardi-2016>

11. Slovenski računovodski standardi (SRS 2024). (2023). Uradni list RS, št. 129/23. <https://si-revizija.si/komisija-za-srs/srs-2024>
12. Solodan, K. (2019). Legal regulation of cryptocurrency taxation in European countries. *European Journal of Law and Public Administration*, 6(1), 64–74.
13. Sudra, R. (2024). Crypto currency and digital coins overtaking the traditional banking sector. *Journal of Economics & Management Research*, 1-8. <https://www.onlinescientificresearch.com/articles/crypto-currency-and-digital-coins-overtaking-the-traditional-banking-sector.pdf> [https://doi.org/10.47363/JESMR/2024\(5\)238](https://doi.org/10.47363/JESMR/2024(5)238)
14. Švagan, B., Godec, T. in Beznec, H. (2022). Centralnobačne digitalne valute in primer Kitajske. *Management*, 17(1), 27–32. <https://www.dlib.si/stream/URN:NBN:SI:DOC-T8CQZDE0/2bc208e6-9c4d-4fc9-888b-144d2ebce6ae/PDF>
15. Vukovič, K. in Kermat, S. (2024). Kriptovalute (primeri knjiženja po SRS 2024). Pridobljeno s <https://onbkaz.dashofer.si/onb/33/kriptovalute-primeri-knjiženja-po-srs-2024-uniqueidmRRWSbk196EAafnF40AQgLgX4F61gYtFHZxeFmrCRC4hB0ms5jd7Lw/>
16. Zakon o gospodarskih družbah (ZGD-1). (2009). Uradni list RS, št. 65/09 – uradno prečiščeno besedilo, 33/11, 91/11, 32/12, 57/12, 44/13 – odl. US, 82/13, 55/15, 15/17, 22/19 – ZPosS, 158/20 – ZIntPK-C, 18/21, 18/23 – ZDU-10, 75/23 in 102/24. <https://pisrs.si/pregledPredpisa?id=ZAKO4291>

Generativna umetna inteligenca na Univerzi v Novem mestu

DOI <https://doi.org/10.55707/eb.v12i1.142>

Strokovni članek

UDK 004.8:378(497.4 Novo mesto)

KLJUČNE BESEDE: generativna umetna inteligenca, GUI, ChatGPT, izobraževalni proces

POVZETEK – Z javno objavo generativnega umetno-inteligenčnega klepetalnika ChatGPT konec leta 2022 smo dobili novo orodje, katerega pomen nekateri primerjajo celo z revolucijo, ki jo je prinesla vzpostavitev interneta v devetdesetih letih 20. stoletja. Generativna umetna inteligenca (GenUI) je posegla na vsa področja in vsak dan se dodaja nove možnosti uporabe. Izobraževalni proces pri tem ni izjema. V tem prispevku s pomočjo deskriptivne metode s kvantitativnim raziskovalnim pristopom za pridobivanje primarnih podatkov predstavimo poznavanje in uporabo GenUI na Univerzi v Novem mestu, njen vpliv na študij ter delovanje same ustanove, etičnost uporabe in vpliv na prihodnost. Ker smo na Univerzi v Novem mestu že sprejeli smernice za etično uporabo GenUI in v šolskem letu 2023/2024 v uvajalnem tednu študente že seznanili s predstavljenimi temati, smo ocenili, da je primeren čas za oceno razširjenosti poznavanja in uporabe GenUI. Rezultati kažejo na pomembne ugotovitve, ki bodo služile kot osnova za nadaljnje prilagajanje izobraževalnih procesov, ki jih GenUI, želimo ali ne, temeljito spreminja.

Professional article

UDC 004.8:378(497.4 Novo mesto)

KEYWORDS: Generative Artificial Intelligence, GenAI, ChatGPT, educational processes

ABSTRACT – With the public release of the generative AI chatbot ChatGPT at the end of 2022, we have gained a new tool, the importance of which some compare to the revolution brought about by the internet in the 1990s. Generative Artificial Intelligence (GenAI) has reached into all fields, with new applications being discovered daily. Education has not been left behind. In this paper, we use a descriptive method with a quantitative research approach to obtain primary data to determine the knowledge and use of GenAI at the University of Novo mesto, its impact on the studies and services, the ethicality of its use and its impact on the future. As the University of Novo mesto has already adopted the guidelines for the ethical use of GenAI and has already introduced the topic to the students during the induction week in the academic year 2023/2024, we considered it an appropriate time to evaluate the prevalence of knowledge and use of GenAI.

1 Uvod

V zadnjih letih je umetna inteligenca (UI) doživela pravi razcvet, zlasti generativna umetna inteligenca (GenUI) kot ena izmed najnaprednejših vej UI, in vzbuja zanimanje raziskovalne skupnosti in industrije zaradi svojih impresivnih zmogljivosti, raznovrstnih aplikacij in obetavnih perspektiv za prihodnji razvoj. Temelji na modelih globokega učenja, ki z uporabo nevronske mreže omogočajo ustvarjanje visokakovostnih besedil, povzetkov, slik, zvoka in videov. Njen hiter razvoj odpira mnoga vrata in priložnosti, vendar prinaša tudi izzive, kot so vprašanja o etičnosti uporabe ter zanesljivost in točnost podatkov.

Prejeto/Received: 21. 6. 2024
Sprejeto/Accepted: 15. 11. 2024

Besedilo/Text © 2025 Avtor(ji)/The Author(s)
To delo je objavljeno pod licenco CC BY Priznanje avtorstva 4.0 Mednarodna.
/ This work is published under a CC BY Attribution 4.0 International license.
<https://creativecommons.org/licenses/by/4.0/>

Da bi pridobili poglobljeno razumevanje vpliva GenUI na Univerzi v Novem mestu v nadaljevanju - UNM, smo pripravili anketni vprašalnik za študente in zaposlene. Pri tem smo si postavili več specifičnih ciljev:

- Analizirati razširjenost in pogostost uporabe GenUI, da bi pridobili vpogled v priljubljenost orodij GenUI in ugotovili, v katerih kontekstih se najpogosteje uporabljajo.
- Raziskati mero zaupanja v GenUI orodja in vpliv na delo in študij, da bi ugotovili, v kolikšni meri uporabniki zaupajo rezultatom, ki jih podaja GenUI, ter kako to zaupanje vpliva na njihovo študijsko, akademsko in raziskovalno delo.
- Ugotoviti pravilnost in etičnost uporabe GenUI z namenom pridobitve izhodišča za sprejetje ukrepov za izboljšanje stanja.
- Ugotoviti, kako uporabniki čutijo trenutni nadzor nad uporabo in kakšna so stališča uporabnikov glede ustreznosti nadzora.
- Preveriti prednosti in slabosti uporabe GenUI, da bi pridobili vpogled v glavne koristi in potencialne pomanjkljivosti, ki jih uporabniki zaznavajo pri uporabi te tehnologije.

Prispevek smo razdelili na več poglavij. V drugem poglavju povzemamo zgodovino GenUI, ki je doživela izjemno hiter razvoj v zadnjih nekaj letih. V tretjem poglavju je predstavljena uporabljena raziskovalna metodologija in v četrtem pa so predstavljeni rezultati raziskave. Sledi še peto poglavje z razpravo, navedbo omejitev in predlogi za nadaljnje raziskovalno delo.

Z različnih zornih kotov so področje našega zanimanja obravnavali tudi drugi avtorji. Avtorici Chan in Hu (Chan in Hu, 2023) sta raziskovali percepcijo, prednosti in izzive GenUI v visokošolskem izobraževanju. Njune ugotovitve kažejo, da imajo študentje v večini pozitiven odnos do uporabe GenUI. Po njunem mnenju je bolje sprejeti nove tehnologije, namesto da se jim izogibamo. Kljub vsem prednostim pa so študentje pokazali skrb glede prevelikega zanašanja na te tehnologije. Kot veliko težavo sta izpostavili plagiatorstvo, ki je že dolgo časa velik problem v izobraževanju. Problem se je z uporabo GenUI le še povečal. Poleg tega se je pojavljala zaskrbljenost za človeške vrednote, v smislu, da lahko GenUI povečuje nepravilnost in neenakost med študenti, ki uporabljajo to tehnologijo, in tistimi, ki je ne. V visokem šolstvu je veliko odvisno od znanja predavateljev. Ghimire, Prather in Edwards (Ghimire, Prather in Edwards, 2024) so raziskovali izkušnje in odnos predavateljev do GenUI. Zlasti jih je zanimala stopnja ozaveščenosti glede uporabe. Ugotovili so, da GenUI 73 % predavateljem povečuje produktivnost, 68 % predstavlja pomoč pri oblikovanju idej in 53 % hitri dostop do informacij. Pri negativni strani uporabe GenUI pa so se pojavile skrbi glede goljufanja (38 %) in zmanjšanja ustvarjalnosti (38 %). Velik izziv predstavljata ugotavljanje plagiatov, narejenih s pomočjo GenUI, in ocenjevanje znanja študentov, saj tradicionalne metode ne zadostujejo več. Avtorji menijo, da bo potrebno ocenjevanje izvajati na način, ki bo testiral kritično razmišljanje. Tudi v tej raziskavi so izjavili, da se bo treba na razvoj GenUI prilagoditi, saj bo ta imel enak ali še večji vpliv na izobraževanje, kot ga je imela iznajdba interneta. Širši pregled priporočene in etične uporabe GenUI v visokošolskem sistemu je izvedel Makovec

(Makovec, 2024). V njem je med drugim predstavil predloge različnih avtorjev glede uporabe GenUI v visokem šolstvu. Ugotavljal je, da še ni generalno sprejetega načina in da še poteka preizkušanje različnih pristopov.

2 Zgodovina generativne umetne inteligence

Na zgodovino GenUI moramo gledati v luči razvoja UI, saj je GenUI samo del UI. Tudi avtorji, ki so opisovali zgodovino UI, si niso povsem enotni, kaj izpostaviti. Razvoj UI se je začel z modelom umetnega nevrona, ki sta ga leta 1943 predlagala Warren McCulloch in Walter Pitts (IFLA, 2020; Lawton, 2023; Dash, 2023; Jaiswal, b. d.; Levine, 2023; Karjian, 2023; Nadeem, 2023 in Coursera Staff, 2024). Leta 1950 je matematik Alan Turing objavil članek z naslovom *Computing Machinery and Intelligence*. Predlagal je poskus, danes imenovan Turingov test, za ugotavljanje inteligentnega vedenja stroja (Karjian, 2023; Mijwel, 2015). Leto pozneje, leta 1951, sta Marvin Minsky in Dean Edmonds sestavila prvo umetno nevronske mrežo, imenovano SNARC. Posnemala je delovanje 40 nevronov. Leta 1956 so John McCarthy, Marvin Minsky in Claude Shannon v Dartmouthu (USA) organizirali poletno delavnico za raziskovalce. Ta delavnica je pripeljala do nove znanosti, poimenovane umetna inteligenca (Jaiswal, b. d.). Leta 1966 je Joseph Weizenbaum (MIT) ustvaril prvi klepatalni robot ELIZA, ki je simuliral terapevtske pogovore. Številni uporabniki so mislili, da se pogovarjajo s človekom (Coursera Staff, 2024). Leta 1968 je Terry Winograda ustvaril prvo multimodalno umetno inteligenco SHRDLU (Lawton, 2023).

Med letoma 1974 in 1980 se je začela prva »zima« umetne inteligence. V tem obdobju sta se bistveno zmanjšala financiranje raziskav in zanimanje za UI (Haenlein in Kaplan, 2019). Leta 1980 se je UI vrnila z ekspretnimi sistemi, ki so bili programirani za posnemanje človeškega obnašanja. Leta 1981 je Danny Hillis ustvaril vzporedne računalnike za umetno inteligenco (Jaiswal, b. d.). Nemški znanstvenik Ernst Dickmanns je leta 1986 izumil prvi samovozeči avtomobil. To je bil mercedesov kombi, ki ga je sam opremil z računalniškim sistemom in senzorji (Coursera Staff, 2024).

Leta 1987 se je začela še druga »zima« umetne inteligence, ki je trajala do leta 1993. Vlada in vlagatelji so ponovno prenehali financirati raziskave, vendar se razvoj vseeno ni popolnoma ustavil (Jaiswal, b. d.). IBM-ov ekspertni sistem Deep Blue je leta 1997 dosegel zgodovinski mejnik, ko je v šahu premagal svetovnega prvaka Garija Kasparova (Dash, 2023). Istega leta pa sta Sepp Hochreiter in Jürgen Schmidhuber predstavila nevronske mreže s kratkoročnim pomnilnikom (Jaiswal, b. d.). Leta 2000 so na Univerzi v Montrealu v članku predlagali metodo za modeliranje jezika s pomočjo nevronske mreže (Lawton, 2023). V naše domove je UI prvič vstopila leta 2002 v obliki sesalnika (Jaiswal, b. d.). Dve leti kasneje je tudi NASA na Mars poslala dva roverja, opremljena z UI (Coursera Staff, 2024).

Leto 2009 je bilo ključno za razcvet UI, saj je Fei-Fei Li začel ustvarjati vizualno podatkovno zbirko ImageNet, Rajat Raina, Anand Madhavan in Andrew Ng pa so predstavili idejo o uporabi grafičnih procesorjev (angl. graphics processing unit

– GPU) za usposabljanje nevronske mreže (Karjian, 2023). Naslednji velik dogodek je bila predstavitev glasovne pomočnice Siri podjetja Apple leta 2011, ki ustvarja odgovore in izvaja dejanja na glasovni ukaz (Dash, 2023). Tri leta kasneje je Amazon predstavil inteligentno virtualno pomočnico Alexo, ki ima glasovni vmesnik za opravljanje nakupovalnih nalog (Coursera Staff, 2024). Istega leta je Eugene Goostman ustvaril klepetalni robot EUGENE, Facebook pa je razvil DeepFace za prepoznavo obrazov na slikah. Leta 2016 je program AlphaGo v Seulu premagal znanega igralca igre Go Leeja Sedola. Istega leta je Uber v Pittsburghu začel izvajati programe za samovozeče avtomobile (Jaiswal, b. d.).

Za razvoj velikih jezikovnih modelov, kot so GPT-3.5, GPT-4, Gemini, Claude, LLaMA in drugi, je bilo odločilno leto 2017, ko je razvojna skupina Google Brain objavila koncept nevronske mreže, imenovane Transformer. Novo je bilo to, da zna nevronska mreža zakodirati poleg besed tudi kontekst besed v stavkih (Lawton, 2023). Leta 2018 je podjetje OpenAI predstavilo GPT-1 (angl. Generative Pre-trained Transformer – GPT). Nevronska mreža tega prvega jezikovnega modela je vsebovala 117 milijonov parametrov. Uspešnost nenadzorovanega učenja pri razumevanju jezikovnih nalog je bila že zelo prepričljiva. Februarja 2019 je bil predstavljen ChatGPT-2 z 1,5 milijarde parametrov. Generiranje besedila je postalo zmogljivejše in ga zaradi bojazni pred njegovo zlorabo sprva javnosti niso pokazali. S postopnim uvajanjem so novembra 2019 objavili GPT-2 (Levine, 2023). S GPT-3 je bil junija 2020 narejen še korak naprej s 175 milijardami parametrov. Imel je napredne možnosti ustvarjanja besedila. Lahko je tudi odgovarjal na zastavljena vprašanja in prevajal v tuje jezike. Novembra 2022 je OpenAI objavil klepetalnik ChatGPT 3.5 (temelji na modelu GPT-3.5) in leta 2023 je izšla nova verzija ChatGPT 4 (Coursera Staff, 2024). Danes podjetja tekmujejo med sabo, katero bo izdalo boljši jezikovni model oziroma katero ga bo bolje vključilo kot pomoč pri vsakdanjem delu. GenUI je postala novo orodje in njen pomen nekateri primerjajo s pojavom interneta v 90. letih prejšnjega stoletja (Nadeem, 2023).

3 Metodologija

V raziskavi smo uporabili deskriptivno metodo dela s kvantitativnim raziskovalnim pristopom za pridobivanje primarnih podatkov. Glede na namen raziskave in zastavljene cilje je bila uporaba kvantitativnega pristopa najustrežnejša, saj smo potrebovali zanesljive, objektivne in empirične podatke, ki omogočajo robustno statistično analizo ter odkrivanje vzorcev uporabe GenUI.

Uporabili smo nenaključno vzorčenje, saj so podatki zbrani od specifične ciljne populacije, to so bili študenti in zaposleni na UNM. Nenaključno vzorčenje je bilo izbrano, da bi zagotovili osredotočenost na specifično populacijo, neposredno povezano s preučevano tematiko, kar je bilo ključno za verodostojnost in natančnost naših ugotovitev.

Podatke smo zbrali s tehniko spletnega anketiranja, pri čemer smo uporabili strukturiran anketni vprašalnik, sestavljen iz skrbno formuliranih, jasnih in razumljivih vprašanj. Uporaba strukturiranega pristopa je omogočila primerljivost podatkov in zmanjšala verjetnost napačne interpretacije vprašanj s strani anketirancev. Anketni vprašalnik je bil implementiran na spletnem portalu lka. To je omogočilo učinkovito distribucijo in spremljanje odzivov v realnem času. Vabilo za sodelovanje smo po elektronski pošti poslali vsem študentom in zaposlenim na UNM. S tem smo tudi zagotovili širok doseg in učinkovito zajemanje ciljne populacije.

Anketiranje je potekalo od 12. do 28. aprila 2024. V tem času smo prejeli zadostno število odgovorov za izvedbo statistično zanesljive analize. Rezultate smo zbrali, obdelali s kvantitativnimi statističnimi metodami in grafično predstavili. S kritično analizo rezultatov smo dosegli cilje raziskave in dodatno osvetlili izzive in priložnosti, povezane z uporabo GenUI v izobraževalnem okolju.

4 Izvedba raziskave in rezultati

Anketo je sestavljalo 16 vprašanj, od tega štiri sociodemografska. Vprašanja so bila različnih vrst, nekaj jih je bilo odprtega tipa, nekaj zaprtega ali kombiniranega. Uporabili smo tudi 5-stopenjsko Likertovo lestvico, da so lahko anketiranci označevali stopnjo strinjanja s postavljenimi trditvami. Raziskovalno populacijo so sestavljali študenti in zaposleni na UNM. Anketni vprašalnik sta rešila 302 anketirancev. Izločili smo vse, ki so bili nepopolni oziroma delno izpolnjeni. V celoti je anketni vprašalnik izpolnilo 147 anketirancev. Vprašalnik je izpolnilo več žensk (59 %). Največ (50 %) anketirancev je starih med 12 in 25 let, najmanj (7 %) pa 56 let in več. Malo več kot polovica (57 %) anketirancev je študentov in študentk 1. stopnje, sledijo jim študenti in študentke 2. stopnje (18 %) in redni oz. pogodbeni zaposleni (15 %). Glede na študijsko oz. zaposlitveno usmeritev je največ anketirancev s Fakultete za zdravstvene vede (41 %) in Fakultete za ekonomijo in informatiko (41 %). V tabeli 1 je predstavljena analiza sociodemografskih vprašanj. Za obdelavo podatkov smo uporabili osnovno opisno statistično analizo, ki vključuje predstavitev velikosti vzorca (n), odstotkov (%), frekvenc (f), srednjih vrednosti (μ) in standardnega odklona (σ). Podatke smo analizirali in obdelali s pomočjo spletne strani lka in računalniškega programa Excel.

Tabela 1

Značilnosti anketirancev – sociodemografska vprašanja ankete ($n = 147$)

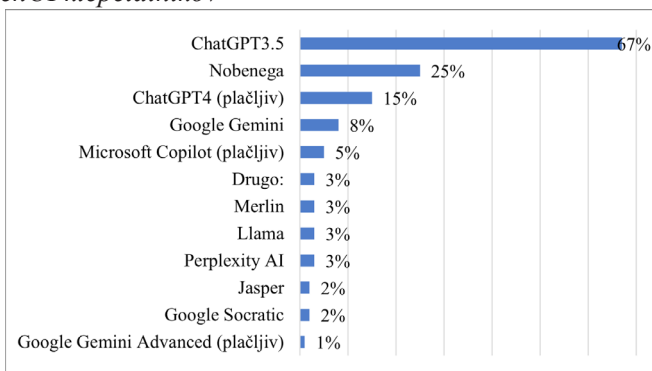
Značilnosti	Kategorija	f	f%
Spol	moški	60	41%
	ženski	87	59%
Starost	18-25	73	50%
	26-40	36	24%
	41-55	27	18%
	56 in več	11	7%

Status na univerzi	študent/ka 1.stopnje	84	57%
	študent/ka 2.stopnje	26	18%
	študent/ka 3.stopnje	6	4%
	zaposleni (redno/pogodbeno) predavatelj/ica	22	15%
	administrativni ali drugi sodelavec/ka	9	6%
Študij ali zaposlitev	Fakulteti za zdravstvene vede	60	41%
	Fakulteti za poslovne in upravne vede	2	1%
	Fakulteti za ekonomijo in informatiko	61	41%
	Fakulteti za strojništvo	16	11%
	Univerzi v Novem mestu	8	5%

Graf 1 prikazuje klepetalnike GenUI, ki jih anketiranci uporabljajo.

Graf 1

Uporaba GenUI klepetalnikov

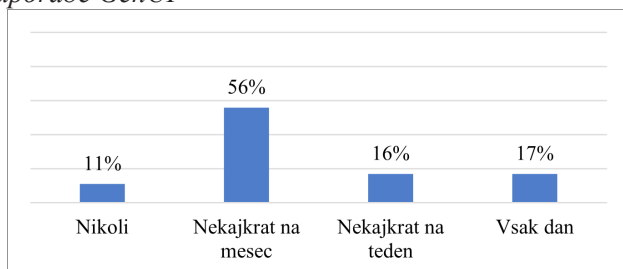


Največ (67 %) jih uporablja brezplačno verzijo ChatGPT 3.5, plačljivo verzijo ChatGPT 4 pa jih uporablja kar 15 %. Skupaj uporablja plačljive verzije 21 % anketirancev. Uporaba drugih klepetalnikov se je gibala od 2 do 8 %. 3 % anketirancev so izbrali odgovor »drugo«, kjer so našli klepetalnike Blackbox ai, Phind in Aria. Četrtnina (25 %) anketirancev je po tem vprašanju z anketo zaključila, saj niso še nikoli uporabljali klepetalnikov GenUI, zato niso mogli odgovarjati na nadaljnja vprašanja o njihovi uporabi.

Graf 2 prikazuje pogostost uporabe prej omenjenih klepetalnikov med anketiranci. Želeli smo izvedeti, kako pogosto in intenzivno se uporablja klepetalnike.

Graf 2

Pogostost uporabe GenUI

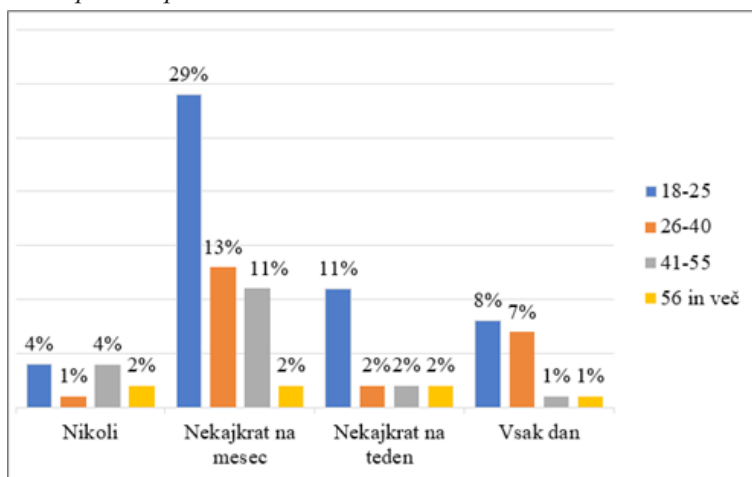


Največji delež anketirancev (56 %) klepetalnike GenUI uporablja nekajkrat na mesec, največ, 45 %, študenti. Manjši delež (17 %) jih uporablja vsak dan, pri čemer delež študentov predstavlja 14 %. Malo manjši delež (16 %) jih uporablja nekajkrat na teden, v tem delu predstavljajo zaposleni le 4 %, najmanj (11 %) jih sploh nikoli ne uporablja, pri čemer kar 8 % predstavljajo študenti. Srednja vrednost (μ) je 2,39, kar kaže, da anketiranci v povprečju klepetalnike GenUI uporabljajo redko, torej nekajkrat na mesec. Nizek standardni odklon pa (0,89) nakazuje, da so odgovori zbrani predvsem okoli vrednosti »nekajkrat na mesec«.

Če k pogostosti uporabe dodamo še spremenljivko leta anketirancev, dobimo informacijo za primerjavo uporabe po starosti (graf 3).

Graf 3

Pogostost uporabe po starosti anketirancev

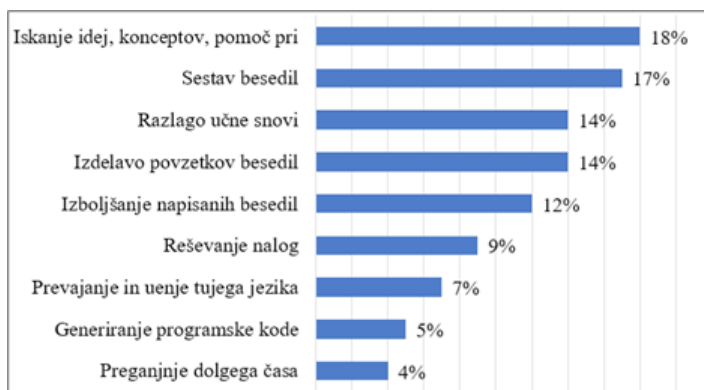


Graf kaže pogostost uporabe in absolutno število odgovorov po letih. Na hitro bi lahko sklepali, da starejše generacije manj pogosto uporabljajo GenUI od mlajših generacij. Vendar temu vseeno ni tako. Če pri pregledu tega grafa upoštevamo število anketirancev po letih (tabela 1), pridemo do zanimive ugotovitve, da pri najbolj pogosti uporabi (nekajkrat na teden in vsak dan) pravzaprav ni velikih razlik med generacijami. Primer za najpogostejšo uporabo (vsak dan): 1 % pri vseh odgovorih je za najstarejšo generacijo skoraj enak kot 8 % za najmlajšo generacijo ($1 \% \cdot 50 \% / 7 \% = 7,1 \%$). Iz grafa tudi razberemo, da je najstarejša generacija (56 let in več) zelo enakomerno odgovorila glede na dane možnosti pogostosti uporabe (2 %, 2 %, 2 %, 1 %). Pri mlajših generacijah je delež odgovorov največji pri uporabi nekajkrat na mesec. Vsekakor pri pregledu pogostosti uporabe ne moremo trditi, da mlajše generacije pogosteje uporabljajo GenUI kot starejše.

Želeli smo tudi izvedeti, za kaj konkretno anketiranci najpogosteje uporabljajo GenUI in v kolikšni meri. Anketiranci so lahko izbrali največ štiri odgovore. Rezultati so predstavljeni z grafom 4.

Graf 4

Namen uporabe GenUI

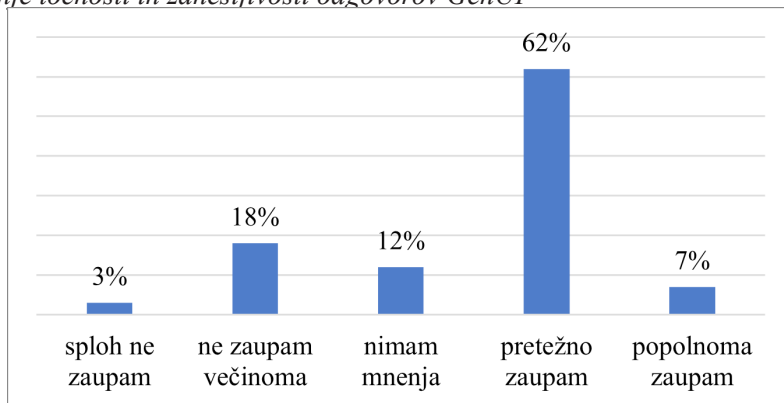


Največ anketirancev (18 %) uporablja GenUI za iskanje idej, konceptov in pomoč pri raziskavah, malo manj (17 %) pa za sestavo besedil. Najmanj (4 %) vprašanih jo uporablja za preganje dolgega časa, kar ni presenetljivo, saj imamo danes na voljo mnogo drugih stvari, s katerimi se lahko zamotimo. Relativno malo jih uporablja GenUI za generiranje programske kode (5 %) ter prevajanje in učenje tujega jezika (7 %). To je zanimiv podatek, saj je GenUI ravno na teh dveh področjih zelo močna. Razvidno je, da nobeden od odgovorov ne prevladuje, kar kaže na vsestranskost GenUI in njene uporabe na mnogih področjih.

Ena od slabosti GenUI je haluciniranje oziroma sestavljanje besedil, ki so videti verodostojna, a so faktografsko napačna. V grafu 5 so zbrani rezultati glede zaupanja anketirancev v odgovore, ki jih poda GenUI. S prikazom stopnje zaupanja lahko bolje razumemo pripravljenost anketirancev za uporabo GenUI.

Graf 5

Zaupanje točnosti in zanesljivosti odgovorov GenUI



Največ anketirancev (62 %) pretežno zaupa v točnost odgovorov, ki jih poda GenUI. Na višjo stopnjo zaupanja kaže tudi stopnja uporabe te tehnologije. Zelo majhen

odstotek (7 %) anketirancev popolnoma zaupa GenUI, še manjši (3 %) pa ji sploh ne zaupa. Srednja vrednost (3,525) kaže, da anketiranci na splošno pretežno zaupajo odgovorom, ki jih generirajo klepetalniki GenUI. Nizek standardni odklon (0,94) nam pove, da so odgovori anketirancev pretežno zbrani okoli odgovora 4, kar kaže na pretežno zaupanje.

Za oceno vpliva GenUI na študij oz. zaposlitev smo postavili tri vprašanja. Anketirance smo prosili, da na Likertovi lestvici označijo stopnjo strinjanja s podanimi izjavami. Za lažjo preglednost smo rezultate prikazali v tabeli 2.

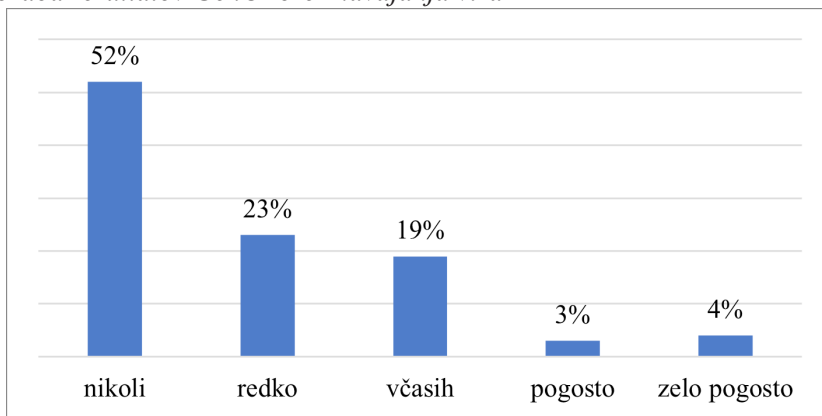
Tabela 2

Tri trditve o vplivu GenUI

Trditve	Odgovori				
	Nikakor se ne strinjam	se ne strinjam	Niti se ne strinjam niti se strinjam	se strinjam	popolnoma se strinjam
Uporaba GenUI ima pozitiven vpliv na moj študij/delo.	5%	4%	17%	49%	25%
GenUI skrajša čas potreben za izvedbo dela.	3%	5%	16%	43%	33%
Menim, da bo uporaba GenUI pozitivno spremenila visokošolsko izobraževanje na splošno.	5%	10%	23%	33%	28%

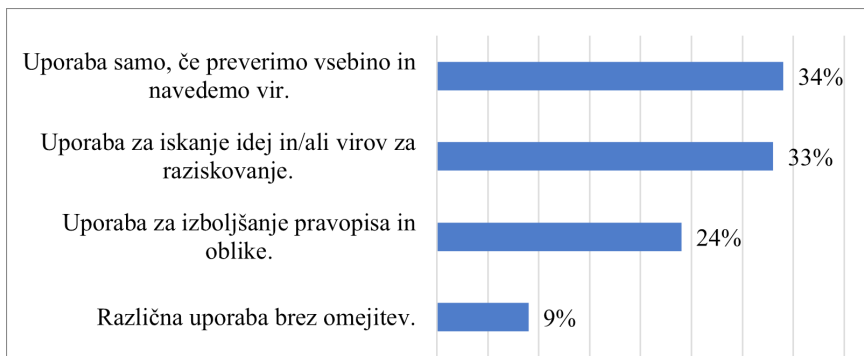
Anketiranci so morali izraziti svoje strinjanje s podanimi trditvami na 5-stopenjski Likertovi lestvici. Z vsemi tremi trditvami se večina anketirancev strinja oz. popolnoma strinja. Skoraj polovica (49 %) se jih strinja s prvo trditvijo, četrtna (25 %) pa se z njo popolnoma strinja. Podobno je pri drugi trditvi: 43 % se jih strinja s trditvijo, 33 % pa se jih popolnoma strinja. Malo manj strinjanja je bilo pri zadnji trditvi, in sicer tretjina (33 %) se z njo strinja, 28 % pa se jih popolnoma strinja s trditvijo. Vse tri srednje vrednosti (3,85; 3,975; 3,7) nakazujejo strnjenost odgovorov okoli kategorije 4 (se strinjam). Najmanjši standardni odklon (0,99) je bil pri drugi trditvi, kar nam pove, da se v tej točki anketiranci najbolj strinjajo. Največji standardni odklon (1,28) je imela trditev tri, kar kaže na večje odstopanje pri tem odgovoru, vendar še vedno prevladuje strinjanje s podano izjavo.

Velika skrb pri uporabi GenUI je potencialno plagiatorstvo. Z vprašanjem o etični uporabi GenUI smo ugotavljali, v kolikšni meri študentje in zaposleni etično uporabljajo GenUI. Rezultati so predstavljeni z grafom 6.

Graf 6*Uporaba rezultatov GenUI brez navajanja vira*

Približno polovica (52 %) anketirancev ni nikoli uporabila rezultatov GenUI brez navedbe vira. Manj kot četrtina (23 %) jih to stori redko, zelo malo anketirancev pa to počne pogosto (3 %) ali zelo pogosto (4 %). To potrjuje tudi srednja vrednost (1,85), ki nam pove, da večina anketirancev nikoli ali redko uporablja rezultate, pridobljene z GenUI, kot svoje. Nizek standardni odklon (1,08) kaže, da je večina odgovorov zbranih okoli odgovora 2 (redko). To nam pove, da študenti in zaposleni v veliki meri etično uporabljajo GenUI.

Pri tem je bilo pomembno tudi vedeti, kaj študentje in zaposleni sploh razumejo pod etično uporabo GenUI, predvsem pri pisanju pisnih izdelkov, kar smo ugotavljali z naslednjim vprašanjem (graf 7).

Graf 7*Kakšna uporaba GenUI pri pisanju pisnih izdelkov je pravilna oz. etična*

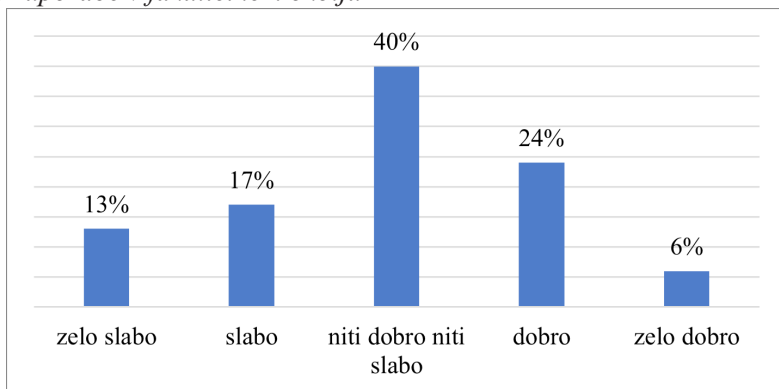
Večina anketirancev (34 %) ocenjuje, da je etična uporaba GenUI pri pisanju pisnih izdelkov, če preverimo vsebino in pravilno navedemo vir. Malo manj (33 %) jih meni, da je etično, če jo uporabljamo za iskanje idej in/ali virov. Najmanj (9 %) pa jih meni, da je etična uporaba brez omejitev. Rezultati povedo, da se študentje in

zaposleni v veliki večini zavedajo etične uporabe GenUI in potrebe po preverjanju in navajanju virov.

Poleg etične uporabe nas je zanimalo tudi, kako dobro je po mnenju anketirancev uporaba GenUI nadzirana v fakultetnem okolju (graf 8). S tem smo želeli spoznati, kako dobro se je UNM prilagodila novi tehnologiji in ali bodo potrebne še nadaljnje izboljšave na tem področju.

Graf 8

Nadzor uporabe v fakultetnem okolju

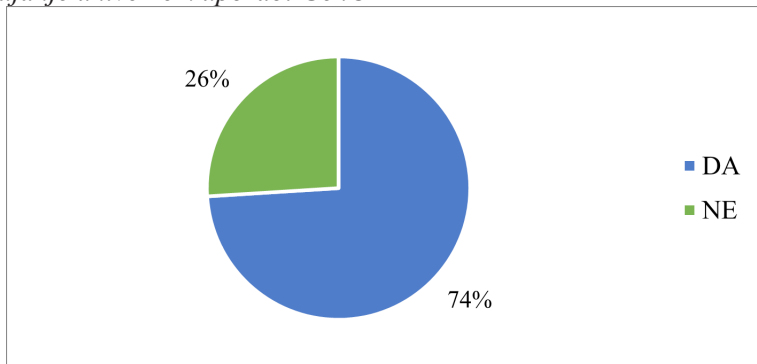


Večina (40 %) anketirancev meni, da uporaba GenUI ni ne dobro ne slabo nadzirana, 30 % jih meni, da je nadzor slabo ali zelo slabo izveden, 30 % pa jih meni, da je dobro ali zelo dobro izveden. Na takšno ravnovesje odgovorov kaže tudi srednja vrednost (2,917), ki jo podpira tudi nizek standardni odklon (1,07). To nam pove, da so odgovori zbrani predvsem okoli odgovora 3 (niti dobro niti slabo). Rezultati kažejo na razdeljeno mnenje o nadzoru, kar lahko razumemo, da je potrebno izboljšanje in bolj skrbno izvajanje pravil glede uporabe GenUI.

V grafu 9 predstavljamo odgovore anketirancev na vprašanje glede potrebne angažiranosti UNM pri uporabi GenUI.

Graf 9

Spodbujanje univerze k uporabi GenUI

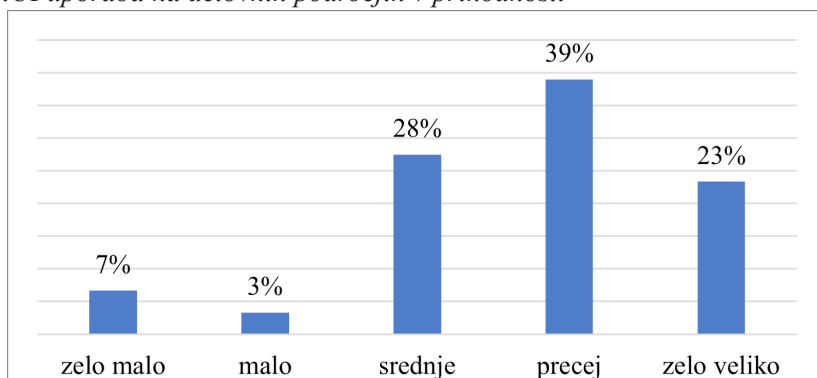


Večina (74 %) anketirancev meni, da bi UNM morala bolj spodbujati uporabo GenUI.

Posledično smo želeli ugotoviti mnenje anketirancev, ali se bo GenUI uporabljalo v njihovi prihodnosti in v kolikšni meri. Rezultate predstavljamo z grafom 10.

Graf 10

GenUI uporaba na delovnih področjih v prihodnosti



Največ (39 %) anketirancev pravi, da se bo GenUI v njihovi prihodnosti precej uporabljalo. Najmanj (3 %) jih meni, da bodo GenUI v prihodnosti malo uporabljali. Srednja vrednost (3,658) nakazuje, da velika večina anketirancev meni, da bo tehnologija GenUI igrala pomembno vlogo na njihovem delovnem področju v prihodnosti, kar potrjuje tudi nizek standardni odklon (1,07).

Naslednji dve vprašanji smo zaradi boljše preglednosti prikazali v obliki besednega oblaka. Zanimalo nas je mnenje anketirancev o prednostih in slabostih GenUI. Večja kot je neka beseda, večkrat je bila zapisana kot odgovor. Na sliki 1 vidimo, da je za anketirance najpomembnejša in najprepoznavnejša prednost GenUI njena hitrost, sledijo pa ji dostopnost, pospešitev, pomoč, ideje in učinkovitost.

Slika 1

Največje prednosti GenUI.



Na sliki 2 so prikazani odgovori glede največjih slabosti GenUI. Večina anketirancev

pravi, da je največja slabost GenUI podpiranje lenobe. Največkrat so omenili nepreverljivost, poneumljanje, nezanesljivost, netočnost in haluciniranje.

Slika 2

Največje slabosti GenUI



6 Razprava

Raziskava je dosegla vse v uvodu navedene cilje. Odgovori po posameznih ciljeh so navedeni pri analizi rezultatov v poglavju Izvedba raziskave in rezultati. Tu naj navedemo samo nekaj ključnih področij, kot so uporaba GenUI, vpliv na študijski in službeni del življenja, etičnost uporabe in pogled na prihodnost.

Glede uporabe GenUI (graf 1) ugotavljamo, da velike jezikovne modele uporablja 75 % anketirancev. Pomemben delež anketirancev (21 %) uporablja plačljive verzije, kar kaže na prepoznano vrednost teh orodij. Razpršen namen uporabe (graf 4) in pretežno zaupanje v odgovore GenUI (graf 5) kažeta, da so anketiranci ugotovili uporabnost na različnih domenskih področjih.

Glede vpliva GenUI (tabela 2) na študij oz. zaposlitev raziskava ugotavlja, da se anketiranci strinjajo o pozitivnem vplivu, skrajšanju časa dela in da bo prišlo do sprememb visokošolskega izobraževanja. To potrjuje tudi graf 10. Zavedanje o pomenu in vplivu GenUI na delovna mesta v prihodnosti je večinsko. To in mnenje treh četrtin anketirancev (graf 9), da bi morala UNM spodbujati uporabo GenUI, sta kazalca razumevanja, kakšno orodje smo z GenUI dobili.

Glede etične uporabe (grafi 6–8) je raziskava pokazala, da anketiranci GenUI večinoma uporabljajo etično, vendar je ta večina zgolj 52-odstotna. Sicer je etična uporaba GenUI slabo regulirano področje, ker ni načina, s katerim bi lahko 100-odstotno preverili, ali je tekst sestavila GenUI ali človek. V več virih (Eke, 2023; Generative AI, 2024; Memarian in Doleck, 2023; Nagpal, 2024; Spencer, 2024) je navedeno, da je uporaba generiranih tekstov brez navedbe vira plagiatstvo. Še vedno potekajo razprave, ali lahko GenUI modele navajamo kot avtorje. Dilema je v tem, ker GenUI modeli tekst ne generirajo samostojno, ampak na osnovi našega ukaza (prompt). Torej teksta v celoti ne generira niti model niti mi. Rešitev verjetno ni samo v sankcioniranju

prepovedane uporabe, ampak tudi v integraciji uporabe. GenUI je postala novo orodje, na uporabo katerega se bomo morali še navaditi.

Pri uporabi GenUI na delovnih področjih v prihodnosti (graf 10) je 62 % anketirancev menilo, da se bo GenUI precej oziroma zelo veliko uporabljalo. To kaže, da je večina anketirancev že prepoznala koristnost novih orodij.

Raziskava ima nekaj omejitev. Izpostavimo manjše število anketirancev in prostovoljnost njihovega sodelovanja, kar lahko vodi do pristranskosti odgovorov.

Izboljšave so možne. Za nadaljnje raziskovalno delo predlagamo:

razširitev vzorca: raziskavo bi lahko izvedli v okviru vaj, kar bi zagotovilo večje število anketirancev in odpravilo pristranskost, ki izhaja iz prostovoljnega sodelovanja;

izvedbo primerjalne raziskave med fakultetami in med študenti ter zaposlenimi;

izvedbo longitudinalne raziskave oziroma ponovitev raziskave čez kako leto, ko bo lahko sodelovala že nova generacija in ko bo praktična uporaba GenUI še večja;

premik raziskave od uporabe na vsebino uporabe, obenem bi bilo dobro raziskati tudi poznavanje načinov uporabe GenUI.

7 Zaključek

Namen raziskave je bil ugotoviti uporabo in vpliv GenUI na UNM. Prva ugotovitev je bila, da 75 % študentov in zaposlenih že uporablja GenUI na sicer zelo razpršenih področjih. GenUI anketirancem skrajšuje čas dela in ima pozitiven vpliv na njihovo delo in študij. Pri tem se zavedajo etičnosti uporabe, zlasti v povezavi s plagiatorstvom in navajanjem virov. Večina anketirancev se zaveda potrebe po etični uporabi GenUI, vendar je po njihovi oceni nadzor nad njeno uporabo povprečen, kar nakazuje na potrebo po izboljšanju. UNM je že naredila prve korake v tej smeri z implementacijo Smernic za odgovorno uporabo orodij generativne umetne inteligence.

Ugotovitev raziskave je tudi, da ima že sedaj GenUI velik vpliv na izobraževanje, ki se bo v prihodnosti brez dvoma še povečeval. Večinsko mnenje anketirancev, da bi morale fakultete bolj spodbujati uporabo GenUI, daje sporočilo, da se mora visokošolski izobraževalni sistem hitro prilagoditi potrebam prihodnosti, saj se anketiranci zavedajo, da bo GenUI imela velik vpliv na njihovo prihodnost. Kako to storiti, je morda tema druge razprave. Ker sprememba kurikulumov traja nekaj časa in tega časa ni, menimo, da je rešitev v organiziranju izobraževalnih delavnic, seminarjev in vključitvi GenUI pri vajah različnih predmetov.

GenUI je naša prihodnost, uporabna vrednost je dokazana na praktično vseh področjih človekovega delovanja. Da bodo študenti pridobili potrebna znanja, so odgovorne tudi univerze. Razprave in predlogi o vključevanju GenUI v kurikulum bodo zagotovo sledili. Ne nazadnje gre za povečanje digitalne pismenosti. Zavedati se moramo, da bodo študenti s poznavanjem GenUI bolj konkurenčni na trgu in zaposleni na univerzah bolj učinkoviti.

Marija Žugič, Uroš Gal, Igor Makovec, MSc

Generative Artificial Intelligence at the University of Novo mesto

Artificial Intelligence (AI) has experienced rapid growth in recent years, particularly in the field of Generative Artificial Intelligence (GenAI). GenAI, as one of the most advanced branches of AI, has captured the interest of both the research community and industry due to its impressive capabilities, diverse applications, and promising prospects for future development. It utilizes deep learning models using neural networks to generate high-quality text, summaries, images, audio, and video. While its rapid development opens many doors and opportunities, it also brings challenges, such as ethical concerns about its use and questions regarding the reliability and accuracy of the generated data.

To gain a deeper understanding of the impact of GenAI at the University of Novo mesto, we have developed a survey questionnaire for students and staff. In doing so, we established several specific objectives:

- To analyze the prevalence and frequency of GenAI use, providing insight into the popularity of GenAI tools and identifying the contexts in which they are most commonly used.*
- To investigate the level of trust in GenAI tools and their impact on work and study, determining to what extent users trust the outputs of GenAI and how this trust affects their academic, study, and research activities.*
- To assess the regularity and ethicality of GenAI use, establishing a baseline for taking actions to improve any identified issues.*
- To assess user opinions regarding the current controls of the GenAI use and assess their views on the adequacy of these controls.*
- To examine the advantages and disadvantages of using GenAI, providing insights into the main benefits and potential drawbacks perceived by users when employing this technology.*

The paper is divided into several chapters. In Chapter 2, the paper summarises the history of generative artificial intelligence, which has developed very rapidly in the last few years. Chapter 3 presents the research methodology used and Chapter 4 presents the results. This is followed by a fifth chapter discussing limitations and suggestions for further research work.

In this condensed version of the paper, we summarize only the latest part of the historical development that led to GenAI. The decisive year for the development of large language models, including today's ChatGPT, Gemini, Claude, Llama, and others, was 2017, when the Google Brain development team published the concept of a neural network called the Transformer. The novelty was that the neural network could encode not only words but also the context of words in sentences (Lawton, 2023). In 2018, OpenAI introduced GPT-1 (Generative Pre-trained Transformer). The neural network of this first language model contained 117 million parameters. The success of unsu-

pervised learning in understanding language tasks was already very convincing. In February 2019, GPT-2 with 1.5 billion parameters was demonstrated. Text generation became more powerful, and due to fears of misuse, it was initially not released to the public. GPT-2 was released in November 2019 (Levine, 2023). GPT-3 took another step forward in June 2020 with 175 billion parameters. It had advanced text generation capabilities and could also answer questions and translate into foreign languages. In November 2022, OpenAI released the chatbot ChatGPT 3.5, and in 2023, a new version, ChatGPT 4, was published (Coursera Staff, 2024). Today, companies are competing over who will release a better language model or better integrate it to assist in everyday work. GenAI has become a new tool and its importance has been compared by some to the emergence of the internet in the 1990s (Nadeem, 2023).

Artificial Intelligence (AI) has experienced rapid growth in recent years, particularly in the field of Generative Artificial Intelligence (GenAI). GenAI, as one of the most advanced branches of AI, has captured the interest of both the research community and industry due to its impressive capabilities, diverse applications, and promising prospects for future development. It utilizes deep learning models using neural networks to generate high-quality text, summaries, images, audio, and video. While its rapid development opens many doors and opportunities, it also brings challenges, such as ethical concerns about its use and questions regarding the reliability and accuracy of the generated data.

The study used a descriptive method of working with a quantitative research approach to obtain primary data. Given the purpose of the research and the objectives, the use of a quantitative approach was most appropriate as we needed reliable, objective, and empirical data to enable robust statistical analysis and to detect patterns of GenAI use.

We used non-random sampling as the data were collected from a specific target population, i.e. students and employees at the University of Novo mesto. Non-random sampling was chosen to ensure the focus on a specific population directly related to the topic under study, which was crucial for the credibility and accuracy of our findings.

Data were collected using an online survey technique, employing a structured questionnaire consisting of carefully worded, clear, and understandable questions. The use of a structured approach allowed for the comparability of data and reduced the likelihood of misinterpretation of questions by the respondents. The questionnaire was implemented on the Ika web portal, allowing for efficient distribution and real-time monitoring of responses. The invitation to participate was sent by email to all students and employees of the University of Novo mesto, ensuring a wide reach and effective coverage of the target population.

The survey was conducted from April 12 to 28, 2024, during which time we received a sufficient number of responses to perform a statistically reliable analysis. The results were compiled, processed using quantitative statistical methods, and presented graphically. A critical analysis of the results helped us achieve the objectives of the survey and provide additional insights into the challenges and opportunities related to the use of GenAI in an educational context.

The survey included 16 questions, four of which focused on socio-demographic information. The questions varied in format, including open-ended, closed-ended, and combined types. A 5-point Likert scale was also utilized to capture respondents' levels of agreement with specific statements. The research population consisted of students and employees from the University of Novo Mesto. A total of 302 respondents began the survey. All incomplete or partially completed questionnaires were discarded. Ultimately, 147 respondents provided complete and usable responses.

Table 1 provides an analysis of the socio-demographic questions. Basic descriptive statistical methods were used to process the data, including sample size (n), percentages (%), frequencies (f), means (μ), and standard deviation (σ). The data were analyzed using the Ika website and Microsoft Excel. The majority of respondents (50%) are between the ages of 12 and 25, while only 7% are aged 56 or older. Slightly over half (57%) of the respondents are undergraduate students, followed by postgraduate students (18%) and full-time or contract employees (15%). Regarding study or employment orientation, the largest number of respondents come from the Faculty of Health Sciences (41%) and the Faculty of Economics and Informatics (41%).

Graph 1 shows the GenAI chatbots used by the respondents. The majority (67%) use the free version of ChatGPT 3.5, while 15% use the paid version of ChatGPT 4. In total, 21% of the respondents use paid versions. The use of other chatbots ranged from 2% to 8%. Three percent of the respondents chose the answer "other," listing chatbots like Blackbox AI, Phind, and Aria. A quarter (25%) of the respondents ended the survey after this question, as they had never used GenAI chatbots and could not answer further questions about their use.

Graph 2 shows the frequency of use of the GenAI chatbots among the respondents. We aimed to discover how often and intensively the chatbots are used. The largest share of the respondents (56%) use GenAI chatbots a few times a month; 17% use them a few times a week, another 17% use them daily, and 11% never use them. The mean value (μ) is 2.39, indicating that the respondents, on average, use GenAI chatbots infrequently – that is, a few times a month. The low standard deviation (0.89) suggests that responses are mainly clustered around "a few times a month."

Graph 3 is essentially Graph 2 with the added variable of the year of age of the respondents.

The graph illustrates the frequency of use and the absolute number of the responses by year of age. At first look, it may appear that older generations use GenUI less frequently compared to younger generations. However, this is not actually the case. By examining the graph in conjunction with the respondent numbers by year (Table 1), we reach an interesting conclusion: there are no significant generational differences in the highest frequency of use (i.e. "Several times a week" and "Every day"). For instance, when considering the most frequent use ("Every day"), the percentage of the responses is almost identical across generations – 1% for the oldest generation is comparable to 8% for the youngest when adjusted for the proportion of the respondents ($1\% * 50\% / 7\% = 7.1\%$). Additionally, the graph shows that the oldest generation (aged 56 and over) has a consistent distribution of responses across all frequencies

of use (2%, 2%, 2%, 1%). For younger generations, the most common frequency is "A few times a month".

Overall, when analyzing the frequency of use, it cannot be conclusively said that younger generations use GenUI more frequently than older generations.

We also wanted to determine for what specific purposes the respondents most frequently use GenAI and to what extent. The respondents could select up to four answers. The results are presented in Graph 4. The largest number of the respondents (18%) use GenAI for searching for ideas, concepts, and assistance in research; a slightly fewer number (17%) use it for composing texts. The fewest (4%) use it to pass the time, which is not surprising given the many other activities available today. Relatively few use GenAI for generating program code (5%) and for translating and learning a foreign language (7%). This is an interesting finding, as GenAI is particularly strong in these two areas. It is evident that none of the answers dominates, indicating the versatility of GenAI and its application across many fields.

One of the weaknesses of GenAI is hallucination or composing texts that appear credible but are factually incorrect. Graph 5 presents the results regarding the respondents' trust in the answers provided by GenAI. By showing the level of trust, we can better understand the respondents' willingness to use GenAI. The majority of the respondents (62%) mostly trust the accuracy of the answers provided by GenAI. A higher level of trust correlates with greater use of this technology. A very small percentage (7%) of the respondents completely trust GenAI, and even fewer (3%) do not trust it at all. The mean value (3.525) indicates that the respondents generally mostly trust the answers generated by GenAI chatbots. The low standard deviation (0.94) shows that the respondents' answers are mainly clustered around "mostly trust," indicating a predominant level of trust.

To assess the impact of GenAI on their study or professional life, we asked three questions. The respondents were asked to indicate their level of agreement with the statements on a Likert scale. For clarity, we presented the results in Table 2. The respondents had to express their agreement with the statements on a 5-point Likert scale. Almost half (49%) agree with the first statement, and a quarter (25%) completely agree. Similar results were seen with the second statement: 43% agree, and 33% completely agree. There was slightly less agreement with the last statement; a third (33%) agree, and 28% completely agree. All three mean values (3.85; 3.97; 3.70) indicate that the responses cluster around "agree." The smallest standard deviation (0.99) was for the second statement, which tells us that the respondents agree most on this point. The largest standard deviation (1.28) was for the third statement, showing a greater variation in the responses, but agreement with the statement still prevails.

A major concern with the use of GenAI is the potential for plagiarism. The question on ethical use of GenUI asked to what extent students and staff use GenUI ethically. The results are presented in Graph 6. Approximately half (52%) of the respondents have never used GenAI results without citing sources. Less than a quarter (23%) do this rarely, and very few respondents do this often (3%) or very often (4%). The mean value (1.85) tells us that the majority of the respondents never or rarely use the results

obtained from GenAI as their own. The low standard deviation (1.08) indicates that most answers are clustered around "rarely." This suggests that students and staff largely use GenAI ethically.

It was also important to understand what the students and staff actually consider ethical use of GenAI, especially in writing assignments, which we investigated with a separate question (Graph 7). The majority of the respondents (34%) believe that the ethical use of GenAI in writing assignments is when we verify the content and correctly cite the source. Slightly fewer (33%) think it is ethical to use it for searching for ideas and/or sources. The fewest (9%) believe that unrestricted use is ethical. The results indicate that the vast majority of the students and staff are aware of the ethical considerations when using GenAI and the need for verification and citation of sources.

In addition to ethical use, we were also interested in how well the respondents thought GenUI is controlled in the faculty environment (Graph 8). We wanted to determine how well our university has adapted to the new technology and whether further improvements are necessary in this area. The majority (40%) of the respondents believe that the use of GenAI is neither well nor poorly monitored; 30% think that the monitoring of GenAI is poorly or very poorly executed, and 30% believe that it is well or very well executed. This balance of the responses is also indicated by the mean value (2.917), supported by the low standard deviation (1.07). The results show a divided opinion on supervision, which can be understood as a need for improvement and more careful implementation of the rules on the use of GenUI.

In Graph 9, we present the responses of the respondents to the question on the necessary engagement of the university in the use of GenUI. The majority (74%) of the respondents thought that the university should do more to promote the use of GenUI.

Consequently, we wanted to determine the respondents' opinions on whether GenAI will be used in their future and to what extent. We presented the results Graph 10. The majority (39%) of the respondents say that GenUI will be used a lot in their future. The lowest (3%) say they will use GenUI a little in their future. The mean value (3.66) indicates that the vast majority of the respondents think that the GenUI technology will play an important role in their work area in the future, which is also confirmed by the low standard deviation (1.07).

For better clarity, we presented the next two questions in the form of a word cloud. We were interested in the respondents' opinions on the advantages and disadvantages of GenAI. The larger a word is, the more frequently it was mentioned. In Figure 1, we see that for the respondents, the most important and recognizable advantage of GenAI is its speed, followed by accessibility, acceleration, assistance, ideas and efficiency. Figure 2 shows the responses on the biggest weaknesses of GenUI. The majority of the respondents say that the biggest weakness of GenUI is supporting laziness. The most frequently mentioned were unverifiability, misunderstanding, unreliability, inaccuracy and hallucination.

The survey successfully met all the objectives outlined in the introduction. The detailed responses to each objective are provided in the chapter "Survey Implementation

and Results”. Here, we highlight a few key areas, including the use of GenUI, its impact on study and work life, the ethical considerations of its use, and future prospects.

Regarding the use of GenUI (Graphs 1), we find that 75% of the respondents use large language models. A significant proportion of the respondents (21%) use the paid versions, indicating the recognised value of these tools. The diverse purposes of use (Graph 4) and predominant trust in GenAI's answers (Graph 5) show that the respondents have recognized its utility across various domains.

Regarding the impact of GenUI (Table 2) on the study/work part of the lived experience, the survey finds that the respondents agree on the positive impact, the reduction of working time and that there will be changes in higher education. This is also confirmed by Graph 10. There is a widespread awareness of the importance and impact of GenAI on future jobs. Additionally, three-quarters of the respondents (Graph 9) believe that the University should promote the use of GenAI, indicating the understanding of the significance of this tool.

Regarding ethical use (Graphs 6–8), the research showed that the respondents mostly use GenAI ethically, but this majority is only 52%. Ethical use of GenAI is a poorly regulated area, because there is no way to verify with absolute certainty whether a text was composed by GenAI or a human. Several sources (Eke, 2023; Generative AI, 2024; Memarian & Doleck, 2023; Nagpal, 2024; Spencer, 2024) argue that using a generated text without acknowledging the source constitutes plagiarism. The question of whether GenUI models can be cited as authors remains unresolved. The core of the dilemma lies in the fact that GenUI models do not create text independently but rather generate content based on user input (prompts). Thus, neither the model nor the user can be considered the sole author of the generated text. A potential solution is not simply to sanction unauthorized usage but to integrate the GenUI use into acceptable practices. GenUI has become a new tool that we will need to adapt to and incorporate.

Regarding the future use of GenUI in various fields (Graph 10), 62% of the respondents believe that it will be used extensively or very extensively. This indicates that the majority of the respondents have already recognized the potential usefulness of these new tools.

The research has some limitations. We highlight the small number of the respondents and the voluntary nature of their participation, which can lead to response bias. Improvements are possible. For further research, we propose:

- Expanding the sample size – conducting the research within course activities to ensure a larger sample size and eliminate bias from voluntary participation;
- Conducting comparative studies between faculties and between students and staff;
- Implementing a longitudinal study or repeating the research in about a year, when a new generation may participate and the practical use of GenAI will be even greater;
- Shifting the research focus from usage patterns to the content of use and exploring the knowledge of methods for using GenAI.

In conclusion, the aim of the study was to determine the use and impact of GenAI at the University of Novo mesto. The first finding was that 75% of the students and staff are already using GenAI in otherwise widely dispersed areas. GenAI is reducing the work time for the respondents and having a positive impact on their work and studies. They are aware of the ethical use of GenAI, especially in relation to plagiarism and citation of sources. Most respondents are aware of the need for an ethical use of GenAI, but their perception of the control over its use is average, suggesting a need for improvement. The University of Novo mesto has already taken the first steps in this direction by implementing the Guidelines for the Responsible Use of Generative Artificial Intelligence Tools. The research has also found that GenAI is already having a significant impact on education, which will no doubt increase in the future. The majority of the respondents believe that faculties should do more to promote the use of GenAI, sending a clear message that the higher education system needs to adapt quickly to the demands of the future, as respondents recognize that GenAI will significantly impact their future. How to achieve this may be a topic for another discussion. Given that curriculum change takes time – and time is limited – we believe that educational workshops, seminars, and incorporating GenAI into exercises across various subjects could provide a viable solution.

GenAI is our future; its utility value is proven in practically all fields of human work. It is also the responsibility of the University to ensure that the students acquire the necessary knowledge. Discussions and proposals on the integration of GenAI in the curriculum will surely follow. After all, it is about increasing digital literacy. We need to be aware that the students with knowledge of GenAI will be more competitive in the market and university staff more efficient.

LITERATURA

1. Chan, C. K. Y. in Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, 20(1), 43. <https://educationaltechnologyjournal.springeropen.com/counter/pdf/10.1186/s41239-023-00411-8.pdf>
2. Coursera Staff. (2024, 16. maj). The history of AI: A timeline of artificial intelligence. Coursera. <https://www.coursera.org/articles/history-of-ai>
3. Dash, J. (2023). Brief history in time: Decoding the evolution of generative AI. LinkedIn. <https://www.linkedin.com/pulse/brief-history-time-decoding-evolution-generative-ai-csmtechnologies/>
4. Eke, D. O. (2023). ChatGPT and the rise of generative AI: Threat to academic integrity? *Journal of Responsible Technology*, 13, 100060. <https://doi.org/10.1016/j.jrt.2023.100060>
5. Ghimire, A., Prather, J. in Edwards, J. (2024). Generative AI in education: A study of educators' awareness, sentiments, and influencing factors. Utah State University in Abilene Christian University. <https://arxiv.org/pdf/2403.15586>
6. Haenlein, M. in Kaplan, A. (2019, julij). A brief history of artificial intelligence: On the past, present and future of artificial intelligence. *California Management Review*, 61(4), 3–4. https://www.researchgate.net/publication/334539401_A_Brief_History_of_Artificial_Intelligence_On_the_Past_Present_and_Future_of_Artificial_Intelligence

7. Jaiswal, S. (b. d.). History of artificial intelligence. Javatpoint. <https://www.javatpoint.com/history-of-artificial-intelligence>
8. Karjian, R. (2023, 16. avgust). The history of artificial intelligence: Complete AI timeline. TechTarget. <https://www.techtarget.com/searchenterpriseai/tip/The-history-of-artificial-intelligence-Complete-AI-timeline>
9. Lawton, G. (2023). History of generative AI innovations spans 9 decades. TechTarget. <https://www.techtarget.com/searchenterpriseai/tip/history-of-generative-ai-innovations-spans-9-decades>
10. Levine, Y. (2023, 20. november). A timeline of OpenAI's technology, funding, and history. Medium. <https://medium.com/@DiscoverLevine/a-timeline-of-openais-technology-funding-and-history-c91cbc071a85>
11. Makovec, I. (2024). Generativna UI kot nova paradigma v izobraževanju in v življenju. Pedagoška obzorja, 39(1), 109–129.
12. Memarian, B. in Doleck, T. (2023). ChatGPT in education: Methods, potentials and limitations. Computers in Human Behavior: Artificial Humans, 100022. <https://doi.org/10.1016/j.chbah.2023.100022>
13. Mijwel, M. M. (2015). History of artificial intelligence. https://www.researchgate.net/profile/MaadMijwil/publication/322234922_History_of_Artificial_Intelligence/links/5a4d34e5a6fdcc3e99d15c1c/History-of-Artificial-Intelligence.pdf
14. Nagpal, H. (2024). Policies, procedures, and guidelines: Are universities effectively ensuring AI (academic integrity) in the era of generative AI? [Doktorska disertacija].
15. Nadeem, A. (2023). The evolution of generative AI and generative machine learning. LinkedIn. <https://www.linkedin.com/pulse/evolution-generative-ai-machine-learning-nadeem-amin/>
16. Spencer, J. (2024, 6. maj). Promoting academic integrity in the age of generative AI. John Spencer. <https://spencereducation.com/ai-academic-integrity/>
17. University of the Sunshine Coast. (2024, 11. oktober). Generative AI. University of the Sunshine Coast Library Guides. <https://libguides.usc.edu.au/gen-AI#:~:text=The%20unauthorised%20use%20of%20generative%20AI%20in%20the%20completion%20of,misrepresents%20your%20abilities%20and%20understanding>

Marija Žugič, študentka na Fakulteti za ekonomijo in informatiko Univerze v Novem mestu, Slovenija
E-naslov: marijazugic4@gmail.com

Uroš Gal, študent na Fakulteti za ekonomijo in informatiko Univerze v Novem mestu, Slovenija
E-naslov: urh8gal@gmail.com,

mag. Igor Makovec, predavatelj na Fakulteti za ekonomijo in informatiko Univerze v Novem mestu, Slovenija
E-naslov: igor.makovec@uni-nm.si

NAVODILA AVTORJEM

Revija za ekonomske in poslovne vede objavlja znanstvene, strokovne in druge prispevke. Kategorijo članka predlaga avtor, končno presjelo pa na osnovi strokovnih recenzij opravi uredništvo oziroma odgovorni urednik. Članki, ki so objavljeni, so recenzirani.

Avtorje prosimo, da pri pripravi znanstvenih in strokovnih člankov upoštevajo naslednja navodila:

1. Članke v tiskani obliki z vašimi podatki in povzetkom v skladu z navodili pošljete na naslov: Revija za ekonomske in poslovne vede, Na Loko 2, SI-8000 Novo mesto, Slovenija. Članke sprejemamo tudi po elektronski pošti na elektronski naslov uredništva. Prejetega gradiva ne vračamo.
2. Članek s povzetkom priložite na ustreznem podatkovnem mediju. Ime datoteke članka naj bo priimek avtorja ali naslov članka – kar naj bo jasno označeno tudi na poslanem podatkovnem mediju. Članek naj bo napisan z urejevalnikom besedil Microsoft Word. V primeru, da nam članek posredujete izključno v elektronski obliki, nam poslani material posredujete tudi v PDF obliki.
3. Znanstveni članki lahko obsegajo do 30.000 znakov.
4. Vsak članek naj ima na posebnem listu naslovno stran, ki vsebuje ime in priimek avtorja, leto rojstva, domači naslov, telefonsko številko, naslov članka, akademski in strokovni naslov, naslov ustanove, kjer je zaposlen in elektronski naslov. V primeru, da je avtorjev več, se napišejo zahtevani podatki za vsakega avtorja posebej. Vodilni avtor mora biti med avtorji napisan na prvem mestu.
5. Znanstveni in strokovni članki morajo imeti povzetek v slovenskem (od 1.000 do 1.200 znakov s presledki) in v angleškem jeziku. Povzetek in ključne besede naj bodo napisani na začetku članka. Priložiti je treba tudi razširjeni povzetek (10.000 znakov s presledki) v angleškem jeziku.
6. Tabele in slike naj bodo v besedilu smiselno vključene. Slike naj bodo priložene tudi kot samostojne datoteke v ustreznem slikovnem (jpeg), oziroma vektorskem (eps, pdf, png) zapisu v ločljivosti vsaj 600 pik na palec. Slikovno gradivo, ki ne zadošča minimalnim zahtevam, bo v končni tehnični pripravi zaradi neustreznosti izpuščeno.
7. Pri citiranju, povzemanju in navajanju literature priporočamo upoštevanje standarda APA (American Psychological Association) in sicer na naslednji način:
 - Za knjige: priimek in ime avtorja, leto izdaje, naslov, kraj, založba. Primer: Samuelson, P. A. and Nordhaus, W. D. (2010). Economics. Boston: McGraw Hill.
 - Za članke v revijah: priimek in ime avtorja, leto objave, naslov revije, letnik, številka, strani. Primer: Mauer, P. (2013). V posel s treznim premislekom. Podjetnik, 22 (7/8) str. 52–55.
 - Za članke v zbornikih: priimek in ime avtorja, leto objave, naslov članka, podatki o knjigi ali zborniku, strani. Primer: Senjur, M. (2009). Strategija razvoja Slovenije in gospodarska recesija. V: Nared, J. and Perko, D. (ur.). Razvojni izzivi Slovenije. Ljubljana: Založba ZRC, str. 21–28.
 - V primeru spletnih referenc je obvezno navajanje točne spletne strani skupaj z imenom dokumenta ter datumom povzema informacije. Primer: Gostiša, M. (2001). Vloga kadrovskih služb pri razvoju delavskega samoupravljanja. Referat na Dnevih kadrovskih delavcev v Portorožu. Dostopno na: <http://www.delavska-participacija.com/clanki/vlogakadrovsluzb.doc> (pridobljeno 25.11.2021).
8. Vključevanje reference v tekst: Če gre za točno navedbo, napišemo v oklepaju priimek avtorja, leto izdaje in stran (Starc, 2013, str. 15). Če pa gre za splošno navedbo, stran izpustimo (Bobek, 2013).

Vsa dodatna pojasnila glede priprave in objave prispevkov, za katere menite, da niso zajeta v navodilih, dobite pri glavnem in odgovornem uredniku. Za splošnejše informacije in tehnično pomoč pri pripravi prispevka se lahko obrnete na uredništvo oziroma na naš elektronski naslov: urednistvo@eb-nm.si.

INSTRUCTIONS FOR AUTHORS

The Journal of Economic and Business Sciences publishes scientific and professional papers as well as other relevant papers. The category of the paper is proposed by the author, and the final assessment is based on peer review and made by the Editor-in-Chief. The published papers are reviewed.

In the preparation of scientific paper, please observe the following instructions:

1. Papers in printed form with your details and the abstract in accordance with the instructions should be sent to the Editorial Board of Journal of Economic and Business Sciences, Na Loko 2, SI-8000 Novo mesto, Slovenia. We also accept papers sent to our email address. The material received will not be returned.
2. The paper and the abstract should be submitted on the relevant data media. The file name should include the surname of the author or the title of the paper – which should also be clearly marked on the data media. The paper should be written with Microsoft Word text editor. If the paper is sent only in electronic form (not in printed form as well), it should also be sent in PDF format.
3. Scientific papers may include up to 30,000 characters.
4. Each paper should have a cover page on a separate sheet, containing the author's name and surname, year of birth, home address, telephone number, title, academic and professional title, the address of the institution where the author works and the email address. If there are several authors, the form should include the required information for each author separately. The primary author must be written in the first place.
5. Scientific and professional papers should have an abstract in Slovene (from 1,000 up to 1,200 characters with spaces) and English. The abstract and key words should be written at the beginning of the paper. There should also be an extended abstract (10,000 characters with spaces) in English.
6. Tables and figures should be included in the text where they belong. As separate files, images should also be attached in the corresponding image (jpeg) or vector (eps, pdf, png) format with the resolution of at least 600 dots per inch. Images that do not meet the minimum requirements shall be omitted in the final technical preparation of the Journal.
7. When quoting, summarising and citing literature, we recommend following the APA (American Psychological Association) standard as follows:
 - For books: the author's surname and name, year of publication, title, place, publisher. For example: Samuelson, P. A. and Nordhaus, W. D. (2010). Economics. Boston: McGraw Hill.
 - For articles in journals: the author's surname and name, year of publication, title of the journal, volume, number, pages. For example: Mauer, P. (2013). V posel s treznim premislekom. Podjetnik, 22(7/8) pp. 52–55.
 - For articles in proceedings: the author's surname and name, year of publication, title, information about the book or the journal, pages. For example: Senjur, M. (2009). Strategija razvoja Slovenije in gospodarska recesija. In: Nared, J. and Perko, D. (ed.). Razvojni izzivi Slovenije. Ljubljana: Založba ZRC, pp. 21–28.
 - In the case of online references, the exact website must be cited, together with the name of the document and the date on which the information was summarised. For example: Gostiša, M. (2001). Vloga kadrovskih služb pri razvoju delavskega samoupravljanja. Paper at HR Managers Days in Portorož. Available at: <http://www.delavska-participacija.com/clanki/vlogakadrovsluzb.doc> (retrieved 25.11.2021).
8. The inclusion of references in the text: If it is an exact reference, the surname, the year of publication and the page should be written in brackets (Starc, 2013, str. 15). If it is a general reference, the page is omitted (Bobek, 2013).

For any further clarification and information not covered in these instructions with regard to the preparation and publication of papers, please contact the Editor-in-Chief. For general information and technical assistance in preparing the paper, please contact the editorial office or send your questions to our e-mail address: urednistvo@eb-nm.si.