OPTIMISING INVESTMENT IN THE ENERGY SECTOR IN DEVELOPING COUNTRIES IN SOUTH EAST EUROPE

Vladan Vladisavljević[1], Dejan Ristić[2], Bojan Obrić[3], Saša Mičić [4], Snežana Lazić [5], Sanja Jakovljević [6], Spasenija Mirković [7], Nebojša Praća [8]

**Corresponding author E-mail: vlada91@gmail.com*

ARTICLE INFO

Review Article

Received: *21 November 2023*

Accepted: *06 December 2023*

doi:10.59267/ekoPolj2401263V

UDC 338.246.027:620.9(4-12)

Keywords:

energy sector, developing countries, optimization, multicriteria, AHP, TOPSIS

***JEL**: P28, Q39*

ABSTRACT

In this paper we are researching the optimality of developing counties for investing in their energy sector as a way of diversifying portfolio by applying the multicriteria decision making model There are multiple quantitative and qualitative criteria that can be considered when finding the adequate market for investment, other than its natural potential, such as the level that its energy sector is developed, legal framework that surrounds this sector, market openness of the observed economy, ease of investment and market liquidity. The four sources of the energy sector that are considered are oil, gas, coal and renewable energy sources. Even though the renewable energy sources aren't sufficiently exploited, the countries that have high potential could provide significant financial profits by exploiting them.

1 Vladan Vladisavljević, PhD, Qinshift d.o.o., Žorža Klemensoa no. 19, Belgrade, Serbia, Phone: +381631339317, E-mail: vlada91@gmail.com, ORCID ID (https://orcid.org/0009-0001-9475-7076)

2 Dejan Ristić PhD, Institute of Applied Sciences, Lomina no. 2, Belgrade, Serbia, Phone: +38162365076, E-mail: risticdejan712@gmail.com, ORCID ID (https://orcid.org/0009-0005-1918-7543)

3 Bojan Obrić PhD, Institute of Applied Sciences, Lomina no. 2, Belgrade, Serbia, Phone: +381113610906, E-mail: sef_ivan@yahoo.com, ORCID ID (https://orcid.org/0009-0005-0028-1054)

4 Saša Mičić PhD, PIM University, Despota Stefana Lazarevića nn, Banja Luka, Bosnia and Herzegovina, Phone: +38765637000, E-mail: aktuar.sasa.micic@gmail.com, ORCID ID (https://orcid.org/0009-0005-5672-7270)

5 Snežana Lazić, Institute of Applied Sciences, Lomina no. 2, Belgrade, Serbia, Phone: +381113610906, Email: snezanalazic222@gmail.com, ORCID ID (https://orcid.org/0009-0008-1306-7438)

6 Sanja Jakovljević PhD, Assistant Professor, University of Business Studies, Jovana Dučića 23a, Banja Luka, Bosnia and Herzegovina, Phone: +38765892075, Email: sanja.jakovljevic@ers.ba, ORCID ID (https://orcid.org/0009-0001-4075-7433)

7 Spasenija Mirković PhD, Assistant Professor, University Business Academy, Cvećarska 2, Novi Sad, SerbiaPhone: +38765764643, Email: spasenijam@hotmail.com, ORCID ID (https://orcid.org/0009-0009-5335-3655))

8 Nebojša Praća PhD, Resarch Associate, Institute of Applied Sciences, Lomina no. 2, Belgrade, Serbia, Phone: +381641129465, Email: prof.zoric@gmail.com, ORCID ID (https://orcid.org/0009-0009-5247-8130)

Through this study we are using the most significant and impacting criteria in order to explore and deduce the developing country that has the highest potential of the energy sector and represents the most optimal market to invest.

Introduction

There are numerous factors that can influence choosing the optimal country, to invest in its energy sector, that can be economical, political and legal. Even though certain countries may have the highest energy potential and based on only these factors could perhaps represent the best market to invest in, due to legal limitations or unstable political environment could present high risks to its investors and due to this could be less favorable for investment.

The subject of the paper that is going to be investigated in this research study is finding the adequate model for comparing the parameters of the energy sector, to reach the most objective results and choose the most appropriate economy to invest in. Choosing the best criteria to adequately compare best countries to invest is the aim of this problem. The concept of decision making is defined as choosing between possible multiple possibilities and that there must be at least two possible choices, it is appropriate to choose the decision making theory in this research subject to choose between the ten developing economies of South East Europe as the representative and comparable economies.

Each criterion is considered an attribute of the element that is compared between multiple alternative choices. First of all, it's necessary to define the criteria that will best provide the image of the factors that we want to consider as relevant to the subject in question. There are quantitative and qualitative criteria that need to be considered and they are separated based on the possibility to measure them. If a criterion can be shown through a unit of measurement then it is considered as a quantitative and if it can't then it's considered as qualitative. Qualitative criteria can either be described to a certain degree and compared or they don't possess any quantitative attribute that can be compared.

Research Methodology

In the paper we are going to use the AHP (Analytic Hierarchy Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) methods to calculate the optimal energy sector for investment. The AHP method is defined by Thomas Saaty (Saaty, 1980) as a multicriteria analysis when making group or single decisions. It is based on defining the problem hierarchy and determining the weights of all alternatives in relation to the given goal. AHP method is based on decomposing a complex problem into several levels of factors that have a defined hierarchy, making it the adequate method for the research subject.

TOPSIS method is based on choosing the option or alternative that is closest to the positive ideal result and furthest from a negative ideal result (Praščević, Praščević, 2014). This method is appropriate when deciding for investment opportunity as it focuses on criteria that are maximizing benefits and minimizing losses.

Defining the mathematical framework for Multicriteria decision-making

Mathematical expression of the multicriteria decision-making model is as follows (Čupić, Suknović, 2010):

$$\max [f_1(x), f_2(x),..., f_p(x)], p \geq 2$$

it contains these constraints

$$g_i(x) \leq 0,\ i=\overline{1,m}$$

$$x_j \geq 0,\ j=\overline{1,n}$$

The elements are:

n – variable quantity,

p – criteria functions quantity,

m – quantity of constraints,

X – Vector in an n-dimensional space representing variables $x_{j,}\ j=\overline{1,n}$,

f_k - Objective associated to the criteria $k=\overline{1,p}$,

$g_i(x)$ – set of constraints, $i=\overline{1,m}$.

We should highlight that maximizing target function vector occurs within the specified restrictions, as the minimization criteria can be equivalently expressed as maximization criteria as follows:

$$\max f_r(x) = -\min [-f_r(x)],\ r \subset (1,p)$$

The solution of this model provides a set of acceptable results denoted by vector X that is a part of a set of natural numbers $X \in R^n$ and it refers to:

$$X=[x \mid gi(x) \leq 0,\ i=\overline{1,m},\ xj \geq 0,\ j=\overline{1,n}]$$

The attained set of results for X, derived by using this formula is aligned with the values provided by vector f(x) which represents the values of the function for criteria, thus the set acceptable values for X can be associated to S:

$$f(x)=[\ f_1(x)\ f_2(x),\ ...,\ f_P(x)]$$

$$S=[f(x) \mid x \subset X\ ]$$

Combination of the AHP and TOPSIS methods for evaluating advantages of economies

Choosing the adequate structure of decision making to select the optimal economy for the portfolio investment is the research subject that is going to be addressed by combining AHP methods (Nikolic, Borovic, 1996) and TOPSIS (Lin MC, et all, 2008) Eligibility criteria, based on alternatives that will be evaluated in this case are (Đukić, 2011): K_1 - Energy Sector Liquidity; K_2 -Energy Sector Efficiency; K_3 - Legal framework and K_4 - Ease of investment.

These criteria are going to be analyzed based on information that indicates economy results for the observed counties, gathered in 2022, considering the values taken from developing counties in South-East Europe.

The data shown in the following table (Table 1) represents information that has been obtained for the first part of the decision matrix, which is the database:

Table 1. Decision matrix (database)

	Eligibility criteria			
Alternatives	K_1	K_2	K_3	K_4
Serbia	1.68	0.37	0.34	16.86
Bosnia and Herzegovina	1.55	0.27	0.34	24.93
Romania	2.91	0.43	0.45	17.25
North Macedonia	1.77	0.42	0.13	18.85
Montenegro	1.25	0.39	0.06	17.76
Bulgaria	2.39	0.41	0.06	17.47
Albania	1.47	0.42	0.15	26.61
Croatia	2.12	0.37	0.23	15.6
Moldova	1.81	0.33	0.13	24.36
Slovakia	2.3	0.32	0.12	26.47

Source: Data collected by the authors

First of all, we need to identify the relative weights of the criteria and their importance in our decision-making process. For the purpose of defining the relate weights we will use the AHP method and to estimate their relative weights we will use the Saaty scale (Saaty, 1980).

Table 2. Assessment of relative weights of the criteria

	Energy Sector Liquidity	Energy Sector Efficiency	Legal framework	Ease of investment
Energy Sector Liquidity	1	5	3	7
Energy Sector Efficiency	(5)	1	(3)	3
Legal framework	(3)	3	1	5
Ease of investment	(7)	(3)	(5)	1
Σ	1.675	9.333	4.533	16

Source: Data collected by the authors

Table 3. Eigenvector computation of the corresponding eigenvalues

	Energy Sector Liquidity	Energy Sector Efficiency	Legal framework	Ease of investment	Σ	W(Σ/4)
Energy Sector Liquidity	0.597	0.535	0.661	0.437	2.23	0.557
Energy Sector Efficiency	0.119	0.107	0.073	0.187	0.486	0.121
Legal framework	0.198	0.321	0.220	0.312	1.051	0.262
Ease of investment	0.085	0.035	0.044	0.062	0.226	0.056

Source: Data collected by the authors

In the second phase we will include the TOPSIS methods, as a way of identifying the most favorable answer of the analyzed subject matter.

Table 4. Decision matrix which should be normalized

Eligibility criteria	Energy Sector Liquidity	Energy Sector Efficiency	Legal framework	Ease of investment
Observed economies	w_1=0.6	w_2=0.1	w_3=0.2	w_4=0.1
Serbia	1.68	0.37	0.34	16.86
Bosnia and Herzegovina	1.55	0.27	0.34	24.93
Romania	2.91	0.43	0.45	17.25
North Macedonia	1.77	0.42	0.13	18.85
Montenegro	1.25	0.39	0.06	17.76
Bulgaria	2.39	0.41	0.06	17.47
Albania	1.47	0.42	0.15	26.61
Croatia	2.12	0.37	0.23	15.6
Moldova	1.81	0.33	0.13	24.36
Slovakia	2.3	0.32	0.12	26.47

Source: Data collected by the authors

Table 5. Normalized decision matrix

Eligibility criteria	Energy Sector Liquidity	Energy Sector Efficiency	Legal framework	Ease of investment
Observed economies	w_1=0.6	w_2=0.1	w_3=0.2	w_4=0.1
Serbia	0.268	0.311	0.453	0.253
Bosnia and Herzegovina	0.247	0.227	0.453	0.375
Romania	0.464	0.361	0.599	0.259
North Macedonia	0.282	0.353	0.173	0.283
Montenegro	0.199	0.328	0.079	0.267
Bulgaria	0.381	0.345	0.078	0.263
Albania	0.234	0.353	0.199	0.4
Croatia	0.338	0.311	0.306	0.234
Moldova	0.288	0.277	0.173	0.366
Slovakia	0.366	0.269	0.159	0.398

Source: Data collected by the authors

Table 6. Multiplication of normalized matrix values by criterion weights

Eligibility criteria	Energy Sector Liquidity	Energy Sector Efficiency	Legal framework	Ease of investment
Observed economies	w_1=0.6	w_2=0.1	w_3=0.2	w_4=0.1
Serbia	0.161	0.031	0.090	0.025
Bosnia and Herzegovina	0.148	0.023	0.090	0.037
Romania	0.278	0.036	0.119	0.025
North Macedonia	0.169	0.035	0.034	0.028
Montenegro	0.119	0.032	0.016	0.027
Bulgaria	0.228	0.034	0.015	0.026
Albania	0.140	0.035	0.039	0.04
Croatia	0.202	0.031	0.061	0.023
Moldova	0.173	0.027	0.034	0.036
Slovakia	0.219	0.027	0.031	0.039

Source: Created by the authors

Given that all criteria falls under the category of the maximization criteria, it can be defined that the ideal result is:

$$A^* = \{0.278, 0.036, 0.119, 0.04\}$$

Opposite to the ideal result:

$$A^- = \{0.119, 0.023, 0.015, 0.023\}$$

By marking the opposite ends of the ideal result with Si* for the ideal result and Si- for the negative result we can calculate the maximum and minimum distance from the ideal result and the values for the observed economies can be shown in the following table.

Table 7. Rankings of the observed economies

	Opposite ends of the ideal result	
Observed economies	S_i^*	S_i^-
Serbia	0.376	0.086
Bosnia and Herzegovina	0.134	0.081
Romania	0.015	0.187
North Macedonia	0.139	0.055
Montenegro	0.190	0.009
Bulgaria	0.118	0.105
Albania	0.159	0.038
Croatia	0.097	0.095
Moldova	0.135	0.058
Slovakia	0.106	0.195

Source: Created by the authors

After calculating opposite ends of the ideal result for the economies in question, we are going to calculate the vicinity to the ideal solution through the next formula:

$$Q_i^* = S_i^- / S_i^* + S_i^- , i=1,\ldots n$$

After calculating the results, the proximity shows the ranks of the observed economies and the order can be seen in Table 8.

Table 8. Ranking of alternatives

Observed economies	Relative proximity	Rank
Serbia	0,383	5.
Bosnia and Herzegovina	0,353	6.
Romania	0,933	1.
North Macedonia	0,249	8.
Montenegro	0,048	10.
Bulgaria	0,456	2.
Albania	0,171	9.
Croatia	0,444	4.
Moldova	0,266	7.
Slovakia	0,454	3.

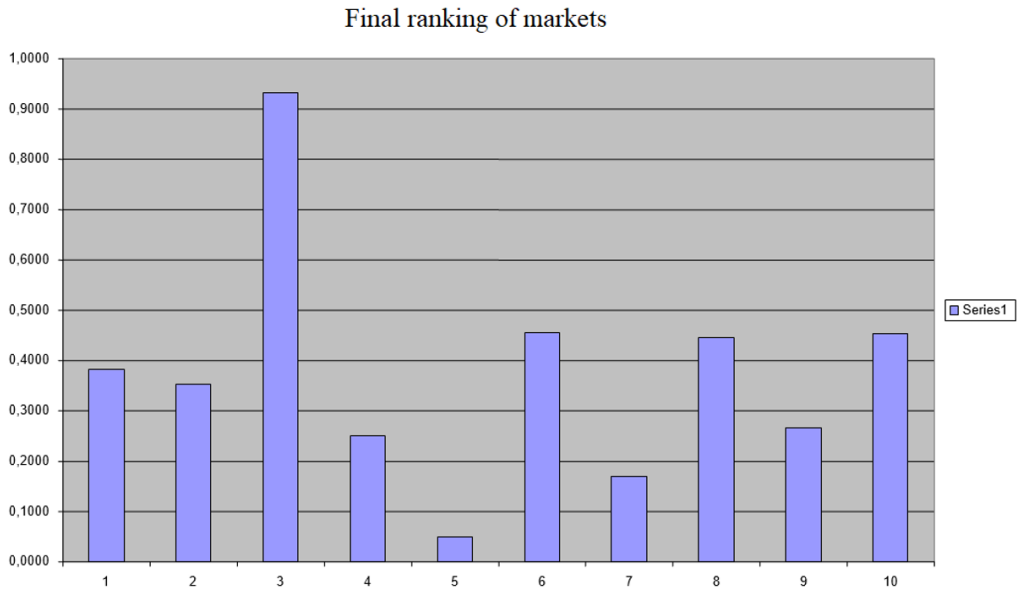
Source: Created by the authors

Based on the TOPSIS method implemented, a obtained solution is that the most suitable investment market is Romania, which has the highest ranking among all alternatives.

DISCUSSION OF RESULTS

The results indicate the market's ranking for the investor.

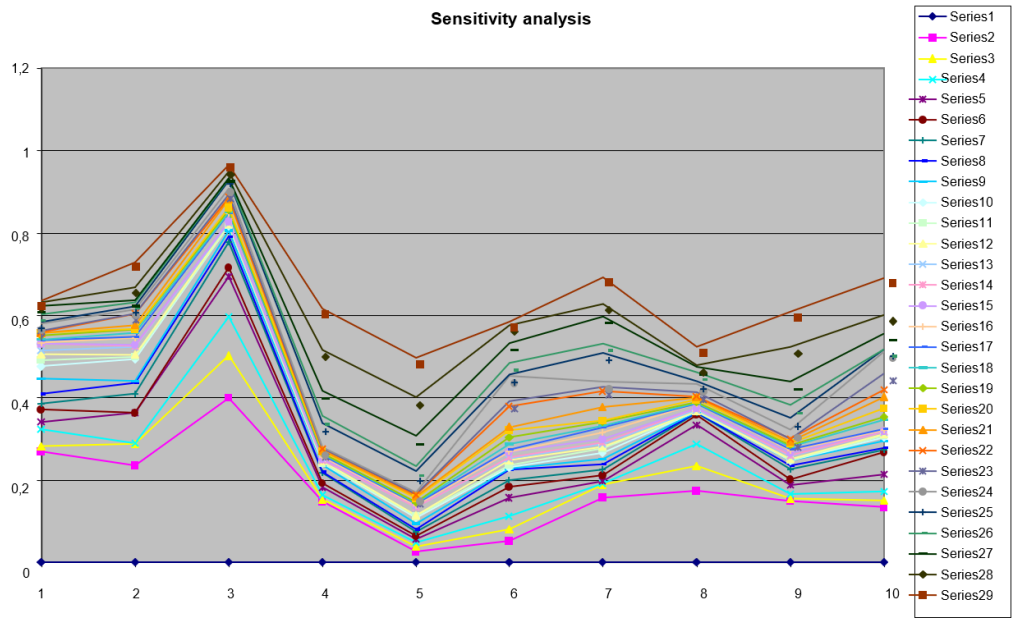
Figure 1. The final ranking of alternatives



Source: Created by the authors

The stability of the obtained solution in case of change of criteria can be performed by the sensitivity analysis procedure. Figure 1 shows the impact of the criteria on each market or alternative.

Figure 2. The impact of changing the weight of all criteria on alternatives



Source: Created by the authors

From the chart above, we can deduce that the optimal results are obtained by choosing Romania that is alternative 3, as the reduction in weight of K_1 - Energy Sector Liquidity, shows a rise for K_2 -Energy Sector Efficiency, K_3 - Legal framework and K_4 - Ease of investment criteria thus additionally concluding that Romania's energy sector shows most positive effects and least uncertainty of investment as a way of portfolio diversification. For the other observed economies that were taken into account, even though there is an increase in the weight of criteria K_2, K_3 and K_4 they showed an increase in relative proximity, but not sufficient to alter the results, still making option 3 the best alternative.

Conclusion

All participants of an economy make choices that have an effect on a small and a large scale that transcend the national borders. When there is a need to find a solution for a problem or make a decision, there are multiple viable options that can be chosen. The question that arises is which decision-making process to apply and how to decide on the best option. Depending on the problem type, the possible criteria, as well as comparable results from other market participants, we can decide on the most appropriate method to apply in the decision making process.

Thus, problem solving practices in the energy sector show that there are numerous methods to find a solution, adhering to the relevant criteria. In the past years, considering the energy sectors of the considered developing counties, there have been significant positive changes in Romania's exploitation method, causing efficient exploitation of its energy potential, which is confirmed by the parameters that indicates an increase in profits over stable production of its biggest producing energy sources, such as coal, natural gas, oil and nuclear power. Romania needs additional funding through foreign direct investment to additionally exploit the energy sector, which would bode well for both its economy and foreign investors. Additional fund would provide it with the possibility to modernize its equipment and reduce costs, thus increasing profits and provide higher return on investments for its investors.

By applying the multicriteria decision making methods we are combining the economic principles with its statistics to make the optimal decision. Main attributes of optimal energy sectors are visible in achieving long term positive results, maximization of profits, cost control and other. Various methods can be used to assess the performance of these attributes, all of which ultimately involve the application of specific ratios to a greater or lesser extent. By assessing these attributes through historical data and employing the adequate method, it's possible for a potential investor the calculate the efficiency of the energy sector, the impact it can have on further development of the energy sectors, as well as the possible return on investment. This historical data can be compared with other developing counties that are potential investment markets for the energy sector. For the purpose of statistical data, they could compare the data with other energy markets that had the same conditions, concluding the viability of the investment. It has the possibility to utilize numerous methods in the decision-making process which provide support in eliminating risk to investment, support the business and provide better understanding of the available alternatives. By using AHP and TOPSIS methods together, we are provided the methodology on how a decision-making process should work by combining relevant criteria and providing further evidence for application of the scientific method in the decision-making process.

Conflicts of interests

The authors declare no conflict of interest.

References

1. Algarin, C.R., Llanos, A. P., & Castro, A. O. (2017). An Analytic Hierarchy Proces Based Approach for Evaluating Renewable Energy Sources, *International Journal of Energy Economics and Policy, 7*(4), 38-47.
2. Ćirović, M., (2006). *Bankarstvo*, European Center For Peace and Development, Beograd. [in English: Ćirović, M., (2006). Banking, European Center For Peace and Development, Belgrade]

3. Čavlin, M., Vapa-Tankosić, J., Davidovac, Z., & Ivaniš, M. (2023). Analysis of risk factors of the financial and profit position with the objective of improving the vitality of the energy sector, Oditor, 9(2), 22-53.
4. Čupić, M., & Suknović M. (2010) *Odlučivanje*, Fakultet organizacionih nauka, Beograd. [in English: Čupić, M., & Suknović M. (2010) Decission-making, Fakultet organizacionih nauka, Belgrade]
5. Đukić, Đ. (2011). *Upravljanje rizicima i kapitalom u bankama* , drugo izdanje, Ekonomski fakultet, Beograd. [in English: Đukić, Đ. (2011). Managing risks and capital in banks, Second Edition, Faculty of Economics, Belgrade]
6. Đurković, V., Radosavljević, M., & Stanković, R. (2019). Application of the "AHP" method in determining the importance of the application of modern banking products to the performance of banks, *Oditor, 5*(1), 70-80.
7. Gojkov, D. (2023). Teorijski aspekti negocijabilnosti kao pravno-ekonomske kategorije, *Revija prava, 3*(1), 39-48. [in English: Gojkov, D. (2023). Theoretical aspects of negotiability as a legal-economic category, *Law review, 3*(1), 39-48]
8. Golubović, M., & Janković, G. (2023). FDI inflow in the function of improving economy competitiveness of the Republic of Serbia, *Održivi razvoj, 5*(1), 19-31.
9. Hemed, R. I. (2022). Normative arrangement of financial innovations in banking, *Finansijski savetnik, 27*(1), 25-64.
10. Jestrović, V., & Jovanović, V. (2022). The role of corporate governance in sustainable development, *Održivi razvoj, 4*(1), 43-53.
11. Ligus, M., & Peternek, P. (2018). Determination of most suitable low-emission energy technologies development in Poland using integrated fuzzy AHP-TOPSIS method, *5th International Conference on Energy and Environment Research, ICEER 2018, 153,* 101-106
12. Lin M. C., Wang, C. C., Chen, M. S., & Chang C. A. (2008). Using AHP and TOPSIS approaches in customer-driven product design process, *Computers in Industry, 59*(1) 18-31.
13. Madžarević, A., Ivezić, D., Tanasijević, M., & Živković, M. (2020). The Fuzzy–AHP Synthesis Model for Energy Security Assessment of the Serbian Natural Gas Sector, *Symmetry, 12*(6), 908
14. Mihajlović M., Burić T., & Krstić S. (2014). Menadžment operativnim rizikom u bankarskom poslovanju, *17th DQM International Conference, Dependability and Quality management ICDQM-2014*, 397-403. [in English: Mihajlović M., Burić T., & Krstić S. (2014). Operational risk management in the banking sector, *17th DQM International Conference, Dependability and Quality management ICDQM-2014*, 397-403.]

15. Milojević, I., Mihajlović, M., & Vukša S. (2018). Novčani tokovi privrednog subjekta kao predmet revizije, *Vojno delo, 70*(3), 361-371 [in English: Milojević, I., Mihajlović, M., & Vukša S. (2018). Cash flow of a business entity as a subject of audit, Vojno delo, 70(3), 361-371]
16. Milutinović, S., Mikić, M., & Stojanović, M. (2021). The use of multicriteria decision-making methods in determining the optimal solution in the form of selection the priority in exploitation the ore deposit in Eastern Serbia. *Mining and Metallurgy Engineering Bor*, *1-2*, 63-74
17. Mitić, N., Janjušić, D., & Beslać, M. (2022). Multikriteriumski metod odlučivanja-AHP u zelenim nabavkama. *Ekonomika*, *68*(3), 61-70. https://doi.org/10.5937/ekonomika2203061M [in English: Mitić, N., Janjušić, D., & Beslać, M. (2022). Multicriteria decision-making method-AHP in green procurement. Ekonomika, 68(3), 61-70.]
18. Nikolić, B., Tasić, V., & Petrović, M. (2022). Savremeni državni sistemi, *Revija prava, 2*(2), 6-22. [in English: Nikolić, B., Tasić, V., & Petrović, M. (2022). Contemporary state systems, *Law review, 2*(2), 6-22]
19. Nikolić, I., & Borović S. (1996). *Višekriterijumska optimizacija: metode, primena u logistici, softver,* Centar vojnih škola Vojske Jugoslavije, Beograd. [in English: Nikolić, I., & Borović S. (1996). Multi-criteria optimization: methods, application in logistics, software, Center of Military Schools of the Army of Yugoslavia, Belgrade]
20. Praščević, Ž., & Praščević, N. (2014). Application of modified fuzzy TOPSIS method for multicriteria decisions in civil engineering, *Building Materials and Structures 57*(3), 43-61.
21. Ristić, K., Živković, A., & Jemović, M. (2023). Political economy of money, *Oditor, 9*(1), 103-125.
22. Rstić, M. (2020). Kanali distribucije životnih i neživotnih osiguranja u sportu, *Management In Sport, 11*(1), 18-22. [in English: Rstić, M. (2020). Distribution channels of life and non-life insurances in sport, *Management In Sport, 11*(1), 18-22]
23. Pantić, N., Damnjanović, R., & Kostić, R. (2021). Method of economic analysis as a part of methods of social sciences, *Akcionarstvo, 27*(1), 7-26.
24. Saaty, T. (1980). *The Analytic Hierarchy Process*, McGraw-Hill, New York.
25. Savić, B. (2022). Importance of integrated reporting for functioning of capital markets, *Akcionarstvo, 28*(1), 7-20.
26. Savić, B., & Milojević, I. (2022). Challenges of targeted formation of financial reports in modern business conditions, *Oditor, 8*(2), 30-53.

27. Stanojević, A. (2020). Ponašanje i odluke potrošača, *Management In Sport, 11*(1), 7-11. [in English: Stanojević, A. (2020). Behavior and decisions of consumers, *Management In Sport, 11*(1), 7-11]

28. Suknović M., & Delibašić B. (2010). *Poslovna inteligencija i sistemi za podršku odlučivanju*, Fakultet organizacionih nauka u Beogradu, Beograd. [in English: Suknović M., & Delibašić B. (2010). Business Business intelligence and decision support systems, Faculty of Organizational Sciences, Belgrade]

29. Zekić, M., & Brajković, B. (2022). Uloga finansijskog menadžmenta u preduzeću, *Finansijski savetnik, 27*(1), 7-24. [in English: Zekić, M., & Brajković, B. (2022). The role of financial management in a company, *Financial advisor, 27*(1), 7-24]