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APPLICATION OF THE TOPSIS MULTI-CRITERIA DECISION-MAKING METHOD FOR THE ANALYSIS OF ECONOMIC SECTORS IN SERBIA

Abstract: The TOPSIS method represents an important tool in multi-criteria decision-making, enabling a systematic ranking and evaluation of alternatives based on their distance from the ideal and anti-ideal solutions. Its fundamental principle is the quantitative measurement of each alternative's deviation from the optimal values of the selected criteria, thereby providing a more precise and objective understanding of the observed phenomenon.
In order to ensure a higher level of objectivity in the evaluation process, the weights of the criteria were determined using the entropy method. This approach reduces subjectivity in weight assignment by relying on the informational content and variability of the data. The entropy-based weighting method was integrated into the TOPSIS procedure, thereby enhancing the reliability and robustness of the final ranking results.
The aim of this study was to rank 15 economic sectors in the Republic of Serbia using available economic and business data. The ranking procedure was carried out based on the number of business entities, total turnover, registered employment, average net wages, and gross value added. This approach enabled the identification of sectors with the greatest current development potential, as well as those requiring additional institutional support and investment.
The sectors of trade, manufacturing, and information and communication were identified as the three most promising and stable sectors according to the selected indicators. The conducted analysis provides insight into sectors with relatively lower competitiveness among the selected economic activities in Serbia and may serve as a useful basis for strategic planning and the direction of future investments.

Keywords: TOPSIS method, Serbia, development potential, entropy method

1. INTRODUCTION

Multi-criteria decision-making methods have developed out of the need to systematize scientific approaches in making high-quality decisions. In the modern era, where the flow and volume of available information are continuously increasing, the decision-making process becomes more complex. Given that many economic phenomena represent complex systems, decision-making, ranking alternatives, and the selection of appropriate options become more challenging methodological issues. It is precisely multi-criteria decision-making methods that are designed to provide a comprehensive analytical view of such problems. These methods compare alternatives and evaluate them based on predefined criteria. By integrating different types of information and quantifying them, a more objective picture is achieved, thereby facilitating the decision-making process.

In this paper, a multi-criteria decision-making method is applied in the economic and business analysis of economic sectors. Economic sectors represent an important indicator of the level of development of a country or region. The structure of the economy can provide answers to questions such as which areas of economic activity are dominant, as well as insights into the quality and intensity of business activities. It also encompasses the issue of employment levels as an indicator of interest in a particular sector on the one hand, and as a reflection of job availability on the other. The analysis of economic sectors aims to identify those that contribute the most to economic growth, as well as to detect those that lag behind in development.
The study of economic sectors can enhance the decision-making process related to budget allocation across activities, development planning, and the flow of investment funds. Based on such analysis, it is possible to identify the strengths and weaknesses of individual sectors and their overall contribution to economic activity.
For these reasons, the application of multi-criteria decision-making methods represents an appropriate approach in the analysis and ranking of economic sectors. By using predefined criteria, it is possible to more clearly assess their relative positions and identify differences in economic performance among sectors. In this way, a more comprehensive understanding of the structure and competitiveness of the economy is obtained, as well as the significance of individual sectors for its further development. The results of such analyses can be useful in identifying sectors that make the greatest contribution to economic trends, as well as those where there is room for further improvement and development.

2. THEORETICAL BACKGROUND

The field of multi-criteria decision-making (MCDM) has developed as a methodological framework to support rational decision-making in situations involving multiple, often conflicting criteria. In their seminal work Multiple Attribute Decision Making: Methods and Applications (Hwang & Yoon, 1981), the authors systematize the fundamental theoretical concepts of MCDM and outline its key areas of application. Among the methods presented, the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method stands out as a widely used approach, based on measuring the distance of each alternative from the ideal and negative-ideal solutions, thereby enabling a clear and structured ranking process. Its fundamental principle is the quantitative measurement of each alternative's deviation from the optimal values of the selected criteria, thereby providing a more precise and objective understanding of the observed phenomenon.

Recent studies further confirm the applicability and robustness of the TOPSIS method in empirical research, particularly within emerging economies and the Balkan region. For instance, Skrzyński and Wasiuta (2025) apply a composite TOPSIS index to evaluate the performance of municipalities in Serbia, highlighting the critical role of economic vitality and infrastructure in local development. Similarly, Petrović et al. (2023a) utilized the TOPSIS method to evaluate the annual operational efficiency of road transport in Serbia, demonstrating its utility in tracking performance trends over time. Further applications in the Serbian context include the evaluation of railway system performance (Petrović et al., 2023b), as well as various sectoral and infrastructure analyses based on the TOPSIS method, confirming its applicability in complex decision-making environments.

A critical step in the implementation of the TOPSIS method is the determination of criteria weights, which significantly influences the final ranking results. As highlighted by Žižović et al. (2021), the entropy weight method (EWM) offers an objective approach to weight determination. By relying on the informational content and variability of the data, this method reduces subjectivity and enhances the reliability and consistency of the evaluation process. The integration of entropy weights into the TOPSIS procedure is increasingly recognized as a "hybrid" gold standard for objective evaluation. Ozkaya et al. (2021) and Valaskova et al. (2025) demonstrate that this combination is highly effective for cross-country and cross-sectoral comparisons, such as digitalization levels or innovation policy indicators, where expert subjectivity might otherwise bias the results.

In the empirical part of this research, data from the Statistical Yearbook (Statistical Office of the Republic of Serbia, 2025) were utilized. This source provides comprehensive and up-to-date information on economic, business, and social indicators across different regions and sectors. Due to their accuracy and official nature, these data are considered highly reliable for rigorous scientific analysis, particularly when processed using objective weighting schemes such as the entropy method. To ensure a higher level of objectivity in the evaluation process, the weights of the criteria were determined using the entropy method. This approach reduces subjectivity in weight assignment by relying on the informational content and variability of the data, a rationale supported by recent regional studies that have successfully applied this hybrid approach to Serbian infrastructure and tourism potential (Nedeljković et al., 2025). The entropy-based weighting method was integrated into the TOPSIS procedure, enhancing the reliability and robustness of the final ranking results.

3. METODOLOGY

3.1. TOPSIS method

The TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) was originally proposed by Hwang and Yoon (1981). It is based on identifying the alternative that is closest, in terms of Euclidean distance, to the ideal solution and farthest from the negative ideal solution.
The ideal solution consists of the best performance values among all alternatives for each observed criterion, while the negative ideal solution represents the worst performance values. Whether a value is considered the best or the worst depends on the nature of the criterion, i.e., whether it is to be maximized or minimized.
Let the set of alternatives be defined as $A=\{A_k, k=1,\dots,n\}$, the set of criteria as $C=\{C_j, j=1,\dots,m\}$, the set of performance values of alternatives with respect to each criterion as $X=\{x_{kj}, k=1,\dots,n; j=1,\dots,m\}$, and the set of weight coefficients as $w=\{w_j, j=1,\dots,m\}$. The TOPSIS method employs a decision matrix in which n alternatives are evaluated based on m criteria. The element x_{ij} represents the performance of the i-th alternative with respect to the j-th criterion.
The following steps outline the procedure that precedes the ranking of the alternatives:

1. Normalization of the decision matrix to obtain the normalized matrix $R=[r_{ij}]_{mxn}$

Since the elements x_{ij} in the decision matrix are expressed in different units, the first step is to normalize the matrix $[x_{ij}]_{mxn}$ in order to obtain the normalized matrix $R=[r_{ij}]_{mxn}$, using the following relation:

$$r_{ij} = x_{ij} \,/ \sqrt{\sum_{i=1}^{m} x_{ij}^2}$$

$i=1,2, \dots , m; j=1,2, \dots , n$

The normalized matrix in this case contains only dimensionless values.

2. Multiplication of the normalized matrix by weight coefficients

The weighted normalized values v_{ij} are obtained using the following relation:

$v_{ij}= w_j \cdot r_{ij}; i = 1, \dots, m, j = 1, \dots, n.$

In this expression, w_j denotes the weight of the j-th criterion, which must be normalized so that the following condition is satisfied:

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

The weight of a criterion is a positive value that is independent of the measurement unit used for that criterion. A higher weight indicates greater importance assigned to that criterion by the decision-maker.

3. Determination of ideal solutions

The ideal solution and the anti-ideal solution are calculated using the following relations:

$A^+ = \{(\max v_{ij} \mid j \in J^{max}), (\min v_{ij} \mid j \in J^{min})\} = \{v_1^+, v_2^+, \dots, v_n^+\}$

$A^- = \{(\min v_{ij} \mid j \in J^{max}), (\max v_{ij} \mid j \in J^{min})\} = \{v_1^-, v_2^-, \dots, v_n^-\}$

$i=1,2, \dots , m.$

J^{max} is associated with revenue-related criteria that are maximized, while J^{min} corresponds to cost-related criteria that are minimized.
The best alternatives are those with the highest v_{ij} values for maximization criteria and the lowest v_{ij} values for minimization criteria.

4. Determining the distance of alternatives from ideal solutions

The next step involves calculating the distances of all alternatives from both the ideal and anti-ideal solutions. The distances S_i^+ from the ideal solution and S_i^- from the anti-ideal solution are computed using the following formulas:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2} \quad ;$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}$$

$i=1,2, \dots , m.$

5. Determining the relative closeness of alternatives to the ideal solution

For each alternative, the relative closeness to the ideal solution is calculated:

$$RC_1 = \frac{S_i^-}{S_i^+ + S_i^-} \ , 0 \le RC_1 \le 1, i = 1,2, \dots , m.$$

An alternative is considered closer to the ideal solution RC_1 if its value is closer to 1, or farther if it is S_i^+ closer to 0.

6. Ranking alternatives in descending order (Srđević B., Srđević Z., & Zoranović, 2002).

The five outlined steps represent the methodological structure of the TOPSIS method. One of the key issues in its application is the determination of weight coefficients w_j for each criterion. In this study, a method based on entropy was applied. In general, the determination of weight coefficients is a complex methodological issue that often involves experts from the relevant field in order to define the relationship between the importance of criteria and rational decision-making.

3.2. Entropy-Based Method for Determining Criteria Weights

The determination of criteria weights can significantly influence the ranking process of alternatives. In general, methods for determining weights can be classified into two groups: subjective and objective. Subjective methods are based on the judgments of the author or a team of experts in the observed field, while objective methods rely on predefined mathematical procedures for calculating weight coefficients. Among the latter, the entropy method is one of the most commonly used approaches.

The entropy method is based on the probabilistic nature of entropy and its role as a measure of uncertainty within a finite probability system (Žižović et al., 2021). By utilizing the variability and informational content of the data, this method enables the objective determination of criteria weights.

The following steps illustrate the procedure for determining the weight coefficients using the entropy method.

1. Normalization of the decision matrix

The initial decision matrix $[x_{ij}]_{mxn}$ is transformed into a normalized matrix $P=[p_{ij}]_{mxn}$, where the sum of all elements in each column equals 1:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad , x_{ij} > 0,$$

$i=1,2, \dots , m; j=1,2, \dots , n.$

2. Calculation of entropy for each criterion

$$e_j = -\frac{1}{log_b m} \sum_{i=1}^{m} p_{ij}\, log_b p_{ij}, \qquad b > 0,\ j = 1, \dots , n.$$

The logarithmic base b is often taken as e, i.e., $log_b m = ln m.$

3. Determination of deviation

$$d_j = 1 - e_j, \qquad j = 1, \dots , n.$$

4. Calculation of criteria weights

$$\mathrm{w_j} = \frac{\mathrm{d_j}}{\sum_{j=1}^{n} \mathrm{d_j}}, \qquad \mathrm{d_j} > 0, \quad \mathrm{j} = 1, \dots , \mathrm{n}.$$

4. RESULTS AND DISCUSSION

The TOPSIS method was applied in order to analyze and rank economic sectors in the Republic of Serbia, in accordance with the official classification of activities used by the Statistical Office of the Republic of Serbia (SORS). The main objective of the analysis was to assess the economic and business position of each sector based on available statistical indicators.

The study included 15 economic sectors, defined according to the official classification of activities, and the ranking was performed based on the following criteria: number of business entities, number of registered employees, total turnover, gross value added (GVA) by sector, and average net wages.

Each alternative represents one economic sector and is denoted by A_i, where i=1,2,…,15.

Table 1: Initial Data on Economic Sectors

Sector (A_i)	**Number of Business Entities**	**Registered Employment**	**Turnover (RSD)**	**GVA by Sector (RSD)**	**Average Net Wages (RSD)**
Mining (A_1)	375	30783	248292	285602.3	129 047
Manufacturing (A_2)	30156	497939	5222103	1236744.6	86372
Electricity Supply (A_3)	1047	24554	960473	157332.2	120155
Water Supply (A_4)	910	36001	168601	76726.7	84776
Construction (A_5)	16282	128453	1686846	492727.1	84843
Trade (A_6)	65183	359557	6826757	978907.1	82289
Transport and Storage (A_7)	14934	130316	1051391	373241.1	84059
Accommodation	19339	95937	296477	157751.2	59915

and Food Services (A_8)					
Information and Communication (A_9)	9961	111896	999580	826784.7	228493
Real Estate Activities (A_{10})	3612	9126	81890	679240.2	91038
Professional, Scientific and Technical Activities (A_{11})	24396	142825	662755	540194.7	125372
Administrative Services (A_{12})	6112	105401	333623	229490.4	89929
Education (A_{13})	2970	151376	39468	351174.2	90443
Health (A_{14})	3463	177653	86360	376351.4	97565
Arts and Recreation (A_{15})	2317	44492	136405	147000.3	80876

Source: Statistical Office of the Republic of Serbia, 2025.

The next step involves scaling the initial data and assigning integer values from 1 to 5. The scaling procedure consisted of determining the maximum and minimum values for each of the five criteria and defining the interval step as:

$$h = \frac{x_{max} - x_{min}}{5}$$

The following table presents the intervals based on which values from 1 to 5 are assigned.

Table 2: Intervals for Values on a 1–5 Scalenitial Data on Economic Sectors

Criteria	Value 1	Value 2	Value 3	Value 4	Value 5
C1 – Number of Business Entities	375 – 13336	13337 – 26298	26299 – 39260	39261 – 52222	52223 – 65183
C2 – Number of Employees	9126 – 106888	106889 – 204651	204652 – 302414	302415 – 400177	400178 – 497939
C3 – Turnover	39468 – 1396926	1396927 – 2754385	2754386 – 4111844	4111845 – 5469303	5469304 – 6826757
C4 – Gross Value Added (GVA)	76726 – 308730	308731 – 540734	540735 – 772738	772739 – 1004742	1004743 – 1236744
C5 – Average Net Wages	59915 – 93630	93631 – 127346	127347 – 161062	161063 – 194778	194779 – 228493

Source: Calculated by the author

The next table presents the data scaled on a 1 to 5 scale.

Table 3: Initial Data on Economic Sectors

Sector	C1	C2	C3	C4	C5
A_1	1	1	1	1	3
A_2	3	5	4	5	1
A_3	1	1	1	1	2
A_4	1	1	1	1	1
A_5	2	2	2	2	1
A_6	5	4	5	4	1
A_7	2	2	1	2	1
A_8	2	1	1	1	1
A_9	1	2	1	4	5
A_{10}	1	1	1	3	2
A_{11}	2	2	1	2	2
A_{12}	1	1	1	1	2
A_{13}	1	2	1	2	2
A_{14}	1	2	1	2	2
A_{15}	1	1	1	1	1

Source: Calculated by the author

The first step of the TOPSIS method is the normalization of the decision matrix, which is presented in Table 4.

Table 4: Normalized Decision Matrix

Sector	C1	C2	C3	C4	C5
A_1	0.1302	0.1179	0.1325	0.1043	0.3721
A_2	0.3906	0.5893	0.5298	0.5213	0.1240
A_3	0.1302	0.1179	0.1325	0.1043	0.2481
A_4	0.1302	0.1179	0.1325	0.1043	0.1240
A_5	0.2604	0.2357	0.2649	0.2085	0.1240
A_6	0.6509	0.4714	0.6623	0.4170	0.1240
A_7	0.2604	0.2357	0.1325	0.2085	0.1240
A_8	0.2604	0.1179	0.1325	0.1043	0.1240
A_9	0.1302	0.2357	0.1325	0.4170	0.6202
A_{10}	0.1302	0.1179	0.1325	0.3128	0.2481
A_{11}	0.2604	0.2357	0.1325	0.2085	0.2481
A_{12}	0.1302	0.1179	0.1325	0.1043	0.2481
A_{13}	0.1302	0.2357	0.1325	0.2085	0.2481
A_{14}	0.1302	0.2357	0.1325	0.2085	0.2481
A_{15}	0.1302	0.1179	0.1325	0.1043	0.1240

Source: Calculated by the author

The next step involves determining the weight coefficients, which in this study were calculated using the entropy method. In the expression $e_j = -\frac{1}{log_b m}\sum_{i=1}^{m} p_{ij}\, log_b p_{ij}$, the logarithmic base is taken as $b=e$, as commonly used in studies of this type, such as Skrzyński & Wasiuta (2025). Accordingly, the entropy values in this study are calculated as $e_j = -\frac{1}{ln(15)}\sum_{i=1}^{5} p_{ij}\, ln(p_{ij})$. The weight coefficients are presented in Table 5.

Table 5: Weight coefficients

Criteria	w_j
C1	0.1944
C2	0.1869
C3	0.2642
C4	0.1888
C5	0.1657

Source: Calculated by the author

The next step of the TOPSIS method is to calculate the values v_{ij} as the product of the weight coefficients w_j and the elements of the normalized decision matrix r_{ij}.

Table 6: Weighted Normalized Decision Matrix

Sector	C1	C2	C3	C4	C5
A_1	0.0253	0.0220	0.0350	0.0197	0.0617
A_2	0.0759	0.1101	0.1400	0.0984	0.0206
A_3	0.0253	0.0220	0.0350	0.0197	0.0411
A_4	0.0253	0.0220	0.0350	0.0197	0.0206
A_5	0.0506	0.0441	0.0700	0.0394	0.0206
A_6	0.1265	0.0881	0.1749	0.0787	0.0206
A_7	0.0506	0.0441	0.0350	0.0394	0.0206
A_8	0.0506	0.0220	0.0350	0.0197	0.0206
A_9	0.0253	0.0441	0.0350	0.0787	0.1028
A_{10}	0.0253	0.0220	0.0350	0.0591	0.0411
A_{11}	0.0506	0.0441	0.0350	0.0394	0.0411
A_{12}	0.0253	0.0220	0.0350	0.0197	0.0411
A_{13}	0.0253	0.0441	0.0350	0.0394	0.0411
A_{14}	0.0253	0.0441	0.0350	0.0394	0.0411
A_{15}	0.0253	0.0220	0.0350	0.0197	0.0206

Source: Calculated by the author

Once the values v_{ij} are calculated, it is possible to determine the ideal and negative ideal solutions for each criterion.

Table 7: Ideal and Negative Ideal Solutioneight coefficients

Criteria	A^+ (max)	A^- (min)
C1	0.1265	0.0253
C2	0.1101	0.0220
C3	0.1749	0.0350
C4	0.0984	0.0197
C5	0.1028	0.0206

Source: Calculated by the author

After determining the ideal and negative ideal solutions, the distances for each alternative were calculated.

Table 8: Distance from the Ideal and Negative Ideal Solutioneal and Negative Ideal Solutioneight coefficients

Sector	S^+	S^-
A_1	0.2133	0.0411
A_2	0.1027	0.1660
A_3	0.2182	0.0206
A_4	0.2249	0.0000
A_5	0.1772	0.0523
A_6	0.0874	0.1941
A_7	0.1999	0.0389
A_8	0.2147	0.0253
A_9	0.1860	0.1036
A_{10}	0.2072	0.0444
A_{11}	0.1924	0.0440
A_{12}	0.2182	0.0206
A_{13}	0.2037	0.0360
A_{14}	0.2037	0.0360
A_{15}	0.2249	0.0000

Source: Calculated by the author

Finally, Table 9 presents the ranked alternatives.

Table 9: Ranking of Alternatives

Sector	RC	Rank
A_1	0.1616	8
A_2	0.6178	2
A_3	0.0861	12/13
A_4	0.0000	14/15
A_5	0.2280	4
A_6	0.6897	1
A_7	0.1629	7
A_8	0.1055	11
A_9	0.3577	3
A_{10}	0.1765	6
A_{11}	0.1861	5
A_{12}	0.0861	12/13
A_{13}	0.1501	9/10
A_{14}	0.1501	9/10
A_{15}	0.0000	14/15

Source: Calculated by the author

The most developed economic sectors, according to the obtained results, are trade, manufacturing, and the information and communication sector. These sectors represent a key pillar of economic development, as they provide favorable conditions for business operations, the growth of entrepreneurship, and further industrial advancement in the country. Their high ranking indicates a significant contribution to overall economic activity and competitiveness.

On the other hand, the lowest-ranked sectors include electricity supply, water supply, as well as arts and recreation. Such a position may indicate a lower level of development in these sectors, as well as the need for greater investment and stronger systemic support—both financial and institutional—in order to enhance their capacities and enable further growth.

Particular attention is drawn to the position of the education and health sectors, which rank ninth and tenth, respectively. Considering their importance for society as a whole, these results may point to insufficient support and stimulation of these sectors.

5. CONCLUSION

The issue of selecting and ranking economic sectors in the Republic of Serbia is a complex and multidimensional problem that requires consideration of various aspects of each sector. The economic-business aspect represents only one possible perspective in the comparison, providing an evaluation based on quantitatively expressed performance indicators.

Based on the obtained results related to business efficiency indicators, a relatively unfavorable position of the education and health sectors can be observed in the ranking. Considering their importance for overall social and economic development, such results may indicate the need to improve relevant development policies aimed at enhancing service quality, ensuring more adequate valuation of employees, and increasing the attractiveness of these professions in the labor market.

On the other hand, the sectors of trade, manufacturing, and information and communication stand out as areas with more pronounced business potential. Their relatively high ranking suggests a more developed business environment, a higher level of economic activity, and favorable conditions for entrepreneurship and the development of new business initiatives.

The results obtained through the application of multi-criteria decision-making methods provide insight into the relative position of the analyzed sectors with respect to the selected criteria. Future research directions may include expanding the analysis by incorporating social, environmental, and regional development criteria, and comparing the results obtained from such multidimensional approaches. A comprehensive analysis would enable sectors to be observed from multiple perspectives, allowing for a clearer understanding of their overall position.

Beyond simple comparison, such an approach would provide a broader picture of how each sector is positioned. By integrating different dimensions, it would not only describe current conditions but also create a foundation for planning future business and investment strategies, as well as for improving the overall efficiency of the economy.

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