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SELECTING A MINING WAREHOUSE LOCATION

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Abstract: Choosing the optimal location for building a new or renovating an existing mining warehouse is of great importance, especially when it comes to a company that has multiple mines in different locations and needs to build one main mining warehouse. Multi-criteria decision-making finds wide application in solving many problems in mining, such as selecting the location of a main mining warehouse. When multi-criteria decision-making is applied to solve a problem, a larger number of criteria are taken into account that affect the alternatives differently, and the optimal alternative is chosen based on them. In this paper, a methodology for optimal selection of the location of the main mining warehouse will be developed using seven multi-criteria decision-making methods. After the problem has been solved using all seven methods, the resulting rankings will be compared and the optimal location of the main mining warehouse will be selected.

Keywords*: *location, warehouse, multi-criteria decision-making methods

1. INTRODUCTION

Large mining companies that have multiple mines in different locations need to build one main mining warehouse that will serve the auxiliary warehouses located within each mine individually. One of the very important decisions that a mining company, or rather the mining engineers and designers employed by that company, must make is the choice of the location of the main mining warehouse. The main mining warehouse may contain various spare parts for machines in use, explosives, oil, lubricants, and more. Choosing the optimal location of the main mining warehouse is of great importance for

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the smooth functioning of the enterprise itself. When choosing the location of the main mining warehouse, it is necessary to take into account as many influential parameters as possible. Usually, in all cases, some parameters have a greater impact and others have a lesser impact on the choice of location. In some cases, the current location decision is optimal, but over a period of time expressed in years it may become suboptimal. The optimal choice of location for the main mining warehouse has a direct impact on the costs of transportation, production, consumption and finance, i.e., the economic operations of the company itself. This part is not directly related to mining production, i.e., it represents the application of logistics in mining with the aim of minimizing the costs of purchasing, storing and delivering necessary spare parts and raw materials for the smooth operation of the mine. Essentially, this issue covers logistics for servicing large companies, whether it's mining, construction, engineering, power generation, military industry, etc.

The parameters, or criteria, by which potential locations for the construction of a main mining warehouse are compared can be quantitative and qualitative. Essentially, decision-making is the selection of one of several possible alternatives for a given problem. In order to apply decision-making, it is necessary to have two or more possible alternatives for a given problem (Mijalkovski et al. 2021). The application of decision-making to solve a given problem can be single-criteria or multi-criteria. In single-criteria decision-making, only one criterion is applied, while in multi-criteria decision-making, multiple criteria are applied to make the final decision. Single-criteria decision-making uses only one criterion during optimization, thereby reducing the actual solution to a given problem. Multi-criteria decision-making uses multiple criteria, so that the resulting solution is the most optimal for a given problem. There are a large number of methods for multi-criteria decision-making, such as: TOPSIS, AHP, VPM, ANP, VIKOR, ELECTRE, PROMETHEE, EDAS, AHP-PROMETHEE and others. All of the previously mentioned multi-criteria decision-making methods can be successfully applied to solving mining problems, such as selecting a location for a main mining warehouse.

There are many authors who have conducted research related to the selection of a warehouse location for any purpose, where they have applied one of the multi-criteria decision-making methods (MCDM) for this purpose. Some of the more significant research conducted at the direction of location selection is: In 2024, Mijalkovski et al. applied the TOPSIS method to the selection of a main storage location for a large water utility (Mijalkovski et al. 2024a). In 2024, Mijalkovski et al. applied the EDAS method to the selection of the main warehouse location for a large industrial company with 14 subsidiaries in different locations (Mijalkovski et al. 2024b). In 2024, Mijalkovski et al. applied the VIKOR method to solve a logistics problem, namely the selection of a warehouse location for a company with 4 main branches distributed in different locations (Mijalkovski et al. 2024c). Mijalkovski et al. in 2023 applied several multi-criteria decision-making methods for underground mining method selection (Mijalkovski et al. 2023a). Mijalkovski et al. in 2023 used the Fuzzy TOPSIS method for underground mining method selection (Mijalkovski et al. 2023b). In 2022, Yousefi et al., using a geographic information system (GIS), implemented a multi-criteria decision-making system for wind farm location selection (Yousefi et al. 2022). In 2022, Wang et al. applied a multi-criteria decision-making method, where they performed a geographic information system-based analysis for location selection and evaluation in urban integrated power plants (Wang et al. 2022). In 2022, Mijalkovski and colleagues applied the TOPSIS method to underground mining method selection (Mijalkovski et al. 2022). In 2021, Sahin applied multi-criteria decision-making methods for location selection, using objective and subjective weights (Sahin 2021). In 2021, Shaikh et al. applied multi-criteria decision-making methods to identify the ideal business location (Shaikh et al. 2021). In 2021, Arunianart et al. investigated international site selection for production fragmentation (Arunianart et al. 2021). In 2021, Margana et al. applied the center of gravity method to select the location of a distribution center in a small and medium-sized enterprise (Margana et al. 2021). In 2020, Alkaradaghi et al. conducted a landfill site selection using GIS and AHP and SAW methods, using a larger number of criteria (Alkaradaghi et al. 2020). In 2020, Efe and colleagues selected mobile phones based on a new quality feature approach (Efe et al. 2020a). In 2020, Efe implemented hybrid multi-criteria models: Joint selection of health and safety units to hybrid multi-criteria decision-making (Efe 2020b). In 2020, Mijalkovski et al. applied the Fuzzy TOPSIS method to assess workplace risks in underground lead and zinc mines (Mijalkovski et al. 2020). Yap et al. in 2019 provided a systematic review on the application of multi-criteria decision-making methods for site selection (Yap et al. 2019). In 2018, Mulia investigated the choice of company location in the era of digital technology and whether it still has great importance (Mulia 2018). Siam et al. in 2018 applied multi-criteria decision-making methods to select the optimal location of a central spare parts warehouse for a given taxi company in Indonesia (Siam et al. 2018). In 2017, Efe et al. applied an integrated intuitionistic fuzzy set and mathematical programming approach to occupational health and safety policy (Efe et al. 2017). Chakraborty et al. in 2013 applied multi-criteria decision-making methods for selecting the location of a distribution center (Chakraborty et al. 2013). In 2004, Cheng and Li conducted a study on the application of quantitative methods for site selection in certain projects (Cheng and Li 2004). In 1997, Yang and Lee applied the ANR decision model to the selection of the location of a particular facility (Yang and Lee 1997). In 2024, while working on his master's thesis, Stefanov applied by several multi-criteria decision-making methods to select the location of the main warehouse in an enterprise with dispersed centers (Stefanov 2024). In 2016, while working on his doctoral thesis, Rangelović defined optimization models for selecting the location of production facilities as a function of local economic development (Rangelović 2016). So far, no one has investigated the selection of a location for a main mining warehouse facility using multi-criteria decision-making.

This paper will present a methodology for selecting the optimal location of the main mining warehouse. The methodology consists of one main phase and one sub-phase:

- optimal selection of the location of the main mining warehouse using multi-criteria decision-making methods;
  – comparing the results obtained by different multi-criteria decision-making methods.

2. METHODOLOGY

The methodology for selecting a location for the construction of the main mining warehouse is shown in Fig. 1. First, we define the problem, and then we list possible locations for building the main mining warehouse. The next step represents the main

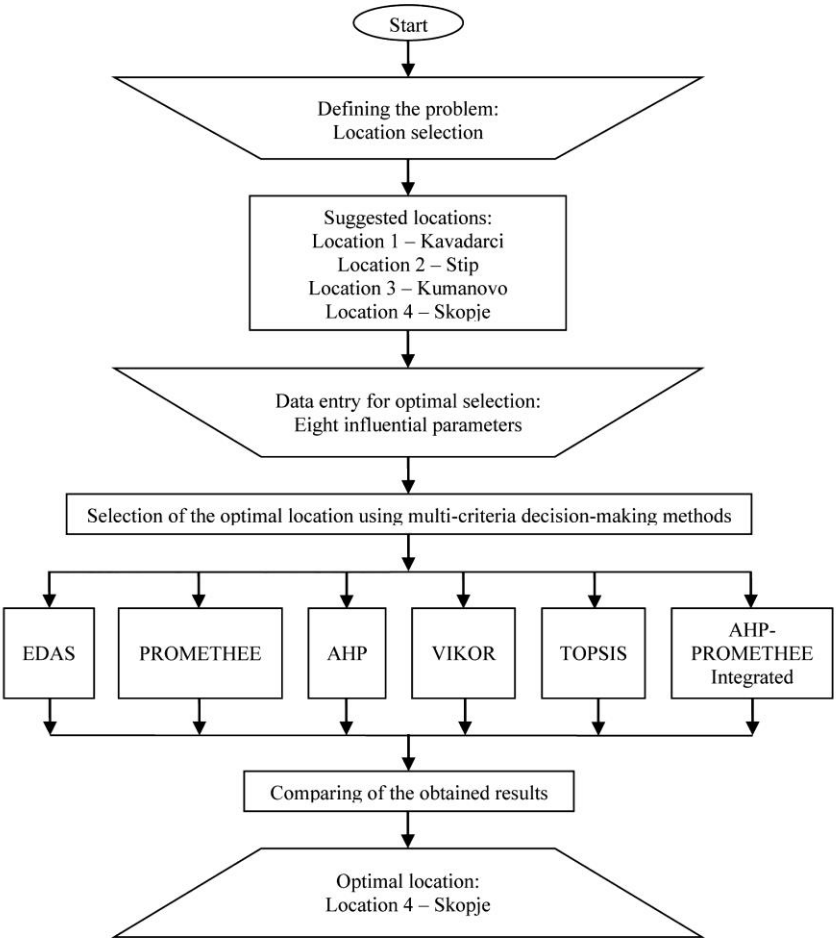

Fig. 1. Methodology for selecting a mining warehouse

phase of this methodology, namely the optimal selection of the location of the main mining warehouse by applying multi-criteria decision-making methods (TOPSIS, AHP, VIKOR, EDAS, PROMETHEE, AHP-PROMETHEE Integrated). After ranking the proposed locations according to different multi-criteria decision-making methods, the resulting rankings from each multi-criteria method will then be compared and an average ranking for the proposed locations will be calculated, which is a sub-phase of this methodology. The proposed location, which will have the highest ranking, will actually represent the optimal location for the construction of the main mining warehouse. If only one or two multi-criteria decision-making methods are applied to solve a given problem, then there is a possibility of obtaining a location that is not optimal. By applying multiple multi-criteria decision-making methods, in this case six methods, different rankings of alternatives are obtained and the average ranking represents the optimal location.

3. CASE STUDY

We will apply the proposed methodology to the selection of the location of the main mining warehouse, for a mining company engaged in the exploitation of non-metallic mineral raw materials with multiple surface mines in different locations (Fig. 2).

Fig. 2. Map with mines location and transportation routes

The main purpose of this mining company is to provide non-metallic mineral raw materials for its own needs, as well as for sale to other mining or construction companies.

3.1. MULTI-CRITERIA DECISION-MAKING METHODS

The optimal choice for the location of the main mining warehouse will be made from the four most significant locations, which will actually represent alternatives (Table 1). These four locations are the most significant open pit mines, which are actively operating and are part of the mining company. All these locations are interconnected by excellent road infrastructure. For this purpose, we will use a multi-criteria decision-making method, i.e., TOPSIS, AHP, VIKOR, EDAS, PROMETHEE, AHP-PROMETHEE Integrated. For the optimal selection of the location of the main mining warehouse, we will use eight criteria against which we will compare alternatives (Table 2). Each criterion has a different impact on alternative solutions, that is, it has a different weight. The authors of this paper consulted with a group of 10 experts in the field of mining and logistics and defined the weights of the criteria by voting (Nourali et al., 2012), as well as by applying the AHP method, in order to minimize subjectivity in the optimization. The definition of weights was adopted in consultation with experts in such a way that each expert gave their opinion on the weights of the criteria, and the average value was taken for further calculations (Table 2). These weights will be used in calculations using multi-criteria decision-making methods. Also, Table 2 provides the classification categories of the criteria (quantitative or qualitative) and the goal they aim at (max or min). Some criteria are classified as quantitative (can be measured or calculated), and some criteria are classified as qualitative (cannot be measured). Qualitative criteria are defined by descriptive ratings, so in order to be used for further calculations, they need to be transformed into numerical values. This transformation can be performed in several ways, using a linear transformation scale, a qualitative scale, an interval scale, a bipolar scale, etc. In this paper, an interval scale was used to transform qualitative into quantitative values. The weights obtained by the AHP method (Table 10) will be used in calculations integrated with the AHP and AHP-PROMETHEE methods.

Table 1. Alternatives for choosing the location of the main mining warehouse

Alternatives	Symbol
Location 1 – Kavadarci	A_1
Location 2 – Stip	A_2
Location 3 – Kumanovo	A_3
Location 4 – Skopje	A_4

Table 2. Criteria for selecting the location of the main mining warehouse

Criteria	Symbol	Weights of criteria	Definition
1	**2**	**3**	**4**
Average size for covering and servicing open-pit mines [number of open-pit mines]	C_1	0.10	This criterion is quantitative and tends to the maximum. The average size for covering and servicing open-pit mines includes the total number of surface mines that will use a given main mining warehouse. The values for criterion C_1 were obtained by counting separately for each alternative.
Average annual revenues of open-pit mines [million dollars]	C_2	0.15	This criterion is quantitative and tends to the maximum. Average annual revenues of open-pit mines include the total average annual revenues for each location. The values for criterion C_2 were obtained by separate calculations for each alternative.
Average distance to all consumers [kilometers]	C_3	0.13	This criterion is quantitative and tends to the minimum. The average distance to all consumers represents the average distance from the location to regular customers who pick up mineral raw materials from open-pit mines at a given location. The values for criterion C_3 were obtained by separate calculations for each alternative.
The strategic importance of open-pit mining at the state level	C_4	0.14	This criterion is qualitative and tends to the maximum. The strategic importance of an open-pit mine at the state level implies the location of the site in relation to the state strategy for the construction of roads, facilities, regional development, etc. Criterion C_4 is assigned qualitative values for each alternative.
Average cost of warehouse service	C_5	0.11	This criterion is qualitative and tends to the minimum. Average warehouse servicing costs indicate what the average costs would be for servicing and maintaining the main mining warehouse. This refers to a rough estimate of what the average costs would be if there were new hiring, construction of new facilities, etc. Criterion C_5 is assigned qualitative values for each alternative.

1	2	3	4
Need for new employment [number of workers]	C_6	0.09	This criterion is quantitative and tends to the minimum. The total number of employees in open-pit mines for each location is known. The construction of a main mining warehouse at a specific location will create various needs for new employment. There are more employees at one location, and fewer employees at the other, who can be hired at the main mining warehouse. The values for criterion C_6 were obtained by counting separately for each alternative.
Average delivery of spare parts and consumables [number of deliveries]	C_7	0.16	This criterion is quantitative and tends to the maximum. The average delivery of spare parts and consumables covers the average number of deliveries for surface mines at a specific location. The values for criterion C_7 were obtained by separate calculations for each alternative.
Need for new facilities [number of months]	C_8	0.12	This criterion is quantitative and tends to the minimum. The need for new facilities implies the time required to build new facilities or adapt the existing facilities to the needs of the main mining warehouse. At each location, there are already built facilities, some of which can be adapted to meet needs for a certain period of time, or new facilities need to be built for that purpose. The values for criterion C_8 were obtained by separate calculations for each alternative.

After an analysis was performed to evaluate individual criteria for each alternative solution, a multi-criteria model was defined (Table 3).

Table 3. Input model of multi-criteria decision-making methods

Alternatives	Criteria							
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Goal	max	max	min	max	min	min	max	min
A_1	3.00	84.00	105.00	9.00	9.00	3.00	74.00	6.00
A_2	2.00	81.00	110.00	5.00	9.00	2.00	52.00	11.00
A_3	4.00	82.00	115.00	7.00	5.00	4.00	91.00	8.00
A_4	5.00	79.00	100.00	9.00	7.00	2.00	93.00	7.00
Weights	0.10	0.15	0.13	0.14	0.11	0.09	0.16	0.12

3.1.1. DECISION-MAKING ANALYSIS USING EDAS MODEL

The EDAS method was proposed by Ghorabaee et al. in 2016 and further developed by Aggarwal et al. in 2018. This method is an estimation based on the distance from the average solution or simply EDAS for short. The distance is calculated in the positive and negative directions relative to the average solution, individually and respectively for the selected useful or useless criteria (Ghorabaee et al. 2016). In this method, the largest values of positive distance from the average solution and the smallest values of negative distance from the average solution give the best solution from the average solution (Aggarwal et al. 2018). The result obtained from the average solution normalizes the data, thereby minimizing the possibility of deviation from the best solution.

The input model for the EDAS method is shown in Table 3.

By solving the given task, a complete ranking of alternatives was obtained according to the EDAS method (Table 4).

Table 4. The ranking of the alternatives by EDAS method

Alternatives	Score	Rank
A_1	0.5853	3
A_2	0.0773	4
A_3	0.6119	2
A_4	0.9892	1

3.1.2. DECISION-MAKING ANALYSIS USING PROMETHEE MODEL

The PROMETHEE method was proposed by Brans (1982), which serves to overcome the finite set of alternatives to be ranked and selected. The original method was supplemented and expanded by Brans and Vincke (Brans and Vincke, 1985). The final set of predetermined alternatives is evaluated according to several criteria. Each independent criterion is weighted, and the appropriate preference function should be chosen. The preference function describes the difference between the evaluations of an alternative relative to another in terms of degree of preference (Brans et al., 1986). Since the introduction of this method, six methods have been developed within the PROMETHEE family, namely: PROMETHEE I, II, PROSA (continuation of the PROMETHEE II method), III, IV, V and VI. Each method from the PROMETHEE family of the methods has a specific role in relation to the type of problem being solved. In this paper, the PROMETHEE II method will be applied to select a location for the construction of the main mining warehouse.

The PROMETHEE method uses six generalized criteria to show decision makers' preferences for specific criteria. Based on the theory, the equations for the method, and our assessment, types of generalized criteria were adopted for a specific case (Table 5).

The input model for the PROMETHEE II method is shown in Table 3.

Table 5. Adopted type of generalized criteria

Criteria features	Criteria							
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Type	linear	level	linear	quasi	level	level	linear	level
q	–	2	–	5	4	2	–	2
p	4.3	4	6.09	–	6	4	5	6

By solving the given task, a complete ranking of alternatives was obtained according to the PROMETHEE II method (Table 6).

Table 6. Complete ranking of alternatives according to the PROMETHEE II method

Alternatives	Positive flow	Negative flow	Net flow	Rank
A_1	0.1280	–0.0605	0.1885	2
A_2	–0.1647	0.2762	–0.4409	4
A_3	–0.0033	0.0435	–0.0469	3
A_4	0.1123	–0.1870	0.2993	1

3.1.3. DECISION-MAKING ANALYSIS USING AHP MODEL

The AHP method was developed by Saaty (1980), and this method provides the opportunity for a systematic process to include factors such as experience or knowledge, logic, emotions, and a sense of optimization in the decision-making methodology. This method simplifies a complex problem by using multiple criteria in a hierarchical structure (Saaty and Vargas 2001). The representational structure of a complex problem is done at multiple levels, where the first level represents the goal, followed by sublevels, criteria, and subcriteria, up to the last level of alternatives. Using this approach, a complex problem can be deconstructed into parts and then arranged in the form of a hierarchy, so that the problem appears more structured and systematized. This method consists of four main stages, which must be performed in sequence.

The ANP method is a generalization of the AHP method and deals with dependencies (Saaty 2008). This method allows modeling of interactions, dependencies, and feedback between different criteria and subcriteria in the form of internal and external dependencies or in the form of feedback from alternative criteria.

The input model for the AHP method is shown in Table 3.

The Consistency Ratio of the pairwise comparison matrix is calculated as $0.0957 < 0.1$. So, the weights are shown to be consistent, and they can be used in the decision making process (Table 7).

Table 7. Results obtained by comparing first level criteria

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Weights	0.3190	0.1186	0.0795	0.1339	0.0363	0.2408	0.0466	0.0253
Rank	1	4	5	3	7	2	6	8
λ_{max} = 8,9443		CI = 0.1349		RI = 1.41		CR = 0.0957 < 0.1		

By further solving the given task, the final ranking of alternatives was obtained using the AHP method (Table 8).

Table 8. The ranking of the alternatives by AHP method

Alternatives	Score	Rank
A_1	0.3765	2
A_2	0.1118	4
A_3	0.1221	3
A_4	0.3896	1

3.1.4. DECISION-MAKING ANALYSIS USING VIKOR MODEL

The VIKOR method was proposed by Opricovic in 1998, where the final decision is made as a compromise solution by selecting one alternative from a group of available alternatives and based on multiple criteria (Opricovic and Tzeng 2004). A multi-criteria ranking index was introduced based on a certain measure of proximity to the ideal solution, i.e., distance from the goal (Gao et al. 2019). According to this method, the ranking of alternatives is done in several steps and according to three scalar values, which are independently evaluated according to the criteria.

The input model for the VIKOR method is shown in Table 3.

By solving the given task, the order of the alternatives was obtained using the VIKOR method (Table 9).

Table 9. The ranking of the alternatives by VIKOR method

Alternatives	S_j	R_j	Q_j	Rank
A_1	0.34	0,11	0,10	1
A_2	0.81	0,16	1,00	4
A_3	0.44	0,13	0,38	2
A_4	0.23	0,15	0,40	3

According to the ranking of the minimum values for Q, a proposed compromise solution is obtained that meets the first condition.

Condition 1: Acceptable advantage:

$$Q(A'') - Q(A') \geq DQ$$

$$0.38 - 0.10 = 0.28 < 0.33$$

$$DQ = 1/(4-1) = 1/3 = 0.33$$

3.1.5. DECISION-MAKING ANALYSIS USING TOPSIS MODEL

The TOPSIS method was proposed and developed by Hwang and Yoon (1981) and later expanded and refined by Chen (2000). According to this method, the best ranked alternative is the one that is furthest from the negative ideal solution (NIS) and is also closest to the positive ideal solution (PIS). A negative ideal solution (NIS) is a hypothetical alternative that maximizes the cost criterion (CC) and simultaneously minimizes the benefit criterion (BC). A positive ideal solution (PIS) is the opposite of a negative ideal solution (NIS). According to this method, calculations are carried out in several steps, and the best alternative is the one that has the greatest distance from the NIS and the smallest Euclidean distance from the PIS (Parida, 2019), i.e., the TOPSIS method simultaneously takes into account the distance to the NIS and to the PIS. The optimal or ideal solution is the solution that is furthest from the NIS and closest to the PIS.

The input model for the TOPSIS method is shown in Table 3.

By solving the given task, the order of the alternatives was obtained according to the TOPSIS method (Table 10).

Table 10. The ranking of the alternatives by TOPSIS method

Alternatives	Score	Rank
A_1	0.5637	3
A_2	0.2751	4
A_3	0.5963	2
A_4	0.8317	1

3.1.6. DECISION-MAKING ANALYSIS USING AHP-PROMETHEE INTEGRATED MODEL

Macharis et al. (2004) analyzed the advantages and disadvantages of the AHP and PROMETHEE methods, making a comparative analysis of the following elements: problem structuring, key decision values, weighting, inconsistency treatment, ranking problem management, evaluation extraction, group decision support, problem visualization capability, and software package available. Based on this comparative analysis, it was concluded that a number of favorable features of the AHP method could improve the PROMETHEE method, when structuring decision problems and determining weights. The criterion weights obtained using the AHP method have a higher level of consistency, correlation, coherence and accuracy than weights defined based on intuition or specialist domain knowledge, which is usually used in the PROMETHEE method (Bogdanovic et al. 2012; Turcksin et al. 2011).

According to this combined decision-making method, the weights of the criteria are first calculated using the AHP method, which are given in Table 7, and further calculations are performed using the PROMETHEE II method.

The input model for the AHP-PROMETHEE integrated method is shown in Table 3, and the adopted types of generalized criteria are shown in Table 5.

By further solving the given task, a ranking of alternatives was obtained according to the AHP-PROMETHEE integrated method (Table 11).

Table 11. The ranking of the alternatives AHP-PROMETHEE integrated method

Alternatives	Positive flow	Negative flow	Net flow	Rank
A_1	0.2345	0.1918	0.0427	2
A_2	0.1096	0.4240	–0.3144	4
A_3	0.2144	0.3554	–0.1410	3
A_4	0.4970	0.0844	0.4127	1

3.1.7. COMPARING THE RESULTS OBTAINED FROM MULTI-CRITERIA DECISION-MAKING METHODS

After the alternatives have been ranked according to the previously mentioned multi--criteria decision-making methods, the results obtained are compared. When comparing the results, an average value is calculated for ranking the alternatives, thus determining the optimal alternative for a given problem. Table 12 shows the rankings of alternatives according to multi-criteria decision-making methods, as well as the average ranking value. According to this table, it can be concluded that the most acceptable alternative is "A_4", i.e., Location 4 – Skopje (Fig. 3). Alternative "A4" is in first place according to five multi-criteria decision-making methods, and in third place according to one method. The average ranking of this alternative across all multi-criteria decision-making methods indicates that this alternative is ranked first. Alternative "A_1" is ranked second, then alternative "A_3", and the last ranked alternative is "A_2" ($A_4 \rightarrow A_1 \rightarrow A_3 \rightarrow A_2$).

Table 12. Ranking alternatives according to different multi-criteria decision-making methods

Multi-criteria decision-making methods	Alternatives			
	A_1	A_2	A_3	A_4
EDAS	3	4	2	1
PROMETHEE II	2	4	3	1
AHP	2	4	3	1
VIKOR	1	4	2	3
TOPSIS	3	4	2	1
AHP-PROMETHEE INTEGRATED	2	4	3	1

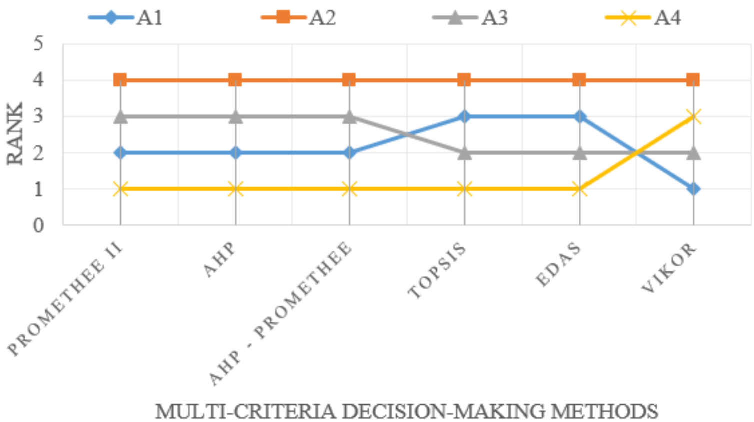

Fig. 3. Ranking of alternatives according to different multi-criteria decision-making methods

4. CONCLUSION

Every large company, when choosing a location for a main warehouse, such as the case of choosing a location for a main mining warehouse, must take into account as many influential parameters as possible. The decision to select the location of the main mining warehouse is a very complex process, influenced by many parameters, which have different weights. Some of these influential parameters are qualitative and very difficult to measure, so they are estimated descriptively and then transformed into numerical values.

The company's management has the greatest influence in choosing the location of the main warehouse. When the final decision on location is made, representatives from production, engineering, logistics, finance, and planning (if such a department exists in the company) must be involved.

Multi-criteria decision-making methods enable optimal location selection, taking into account a large number of influential parameters. The selection of a location for the main warehouse can be carried out using several multi-criteria decision-making methods, such as: AHP, ELECTRE, PROMETHEE, TOPSIS, VIKOR, EDAS, AHP-PROMETHEE and others. This paper uses the previously mentioned six methods for selecting the location of the main mining warehouse, considering several possible locations (alternatives) and comparing them based on several influential parameters (criteria). After ranking the alternatives according to various multi-criteria decision-making methods, the results were compared and thus the optimal location for the construction of the main mining warehouse was selected, which is of great importance for solving this very complex issue. According to this method, i.e., the methodology for selecting the location of the main mining warehouse, it was concluded that the optimal location is Location 4 – Skopje.

The next step in investigating this problem is to apply various FUZZY methods for multi-criteria decision-making, and then compare the results obtained.

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