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CHOICE OF EXCAVATION METHOD OF THE ORE DEPOSITS

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ABSTRACT

The paper defines choice of the optimal excavation method for ore deposits, which are characterized by general irregularity due to their origin, occurrence and different content of the usable minerals. In such complex conditions, the choice of the excavation method is defined according to: the natural characteristics of the deposit and according to the techno - economic parameters of the comparison methods and the methods of multi-criteria optimization.

Keywords: *excavation method, natural characteristics, multicriteria optimization, AHP method*

INTRODUCTION

The choice of the optimal manner of excavating ore deposits is the most important phase when designing the future of underground mine. From the selected manner of excavation (methods of excavation) depend on [1]:

- the economic indicators of mine operation, (the cost of deposit exploitation is 60% of the total costs of the underground mine)
- work safety of employees and equipment
- use of certain mining mechanization

The choice of the excavation method of ore deposits is a complex and very responsible procedure when designing the underground exploitation of a deposit, and the selection process itself is done in two basic manners:

- the choice of the excavation method according to the natural characteristics of the deposit is a rational manner of choosing the excavation method
- optimal manner of choosing the method of excavation, which is done on the basis of technical and economic parameters by economic comparison of variants of excavation methods, i.e. by the method of multi-criteria optimization

CHOICE OF EXCAVATION METHOD ACCORDING TO THE NATURAL CHARACTERISTICS OF DEPOSIT

The choice of the excavation method for a certain non-layered (ore) mineral deposit is made according to certain mining and geological characteristics of that deposit, whereby these characteristics can be divided into two groups:

1. The basic or constant factors:
   - stability of the ore and the surrounding rock
   - capacity (thickness) of the ore body (deposits)
   - dip angle
2. The variable factors:
   - deposit size per strike and dip
   - ore body morphology
   - value of ore
   - the character of the useful minerals distribution in the ore body
   - tendency of ore to compaction (hardening), oxidation or self-ignition
   - the hydrogeological characteristics
   - the need to preserve the surface of the terrain above deposit

The basic or constant factors are taken into account in each case, while variable factors are taken as limitations in certain cases [2].

The stability of ores and surrounding rocks defines the possibility of applying excavation methods with gape excavated areas, methods with support or methods with caving [3]. Depending on the stability of the ore and surrounding rocks, the excavation method is chosen (Table 1), as well as the parameters of the roof control system that provide safe working conditions [4,5,6].

Table 1. Mining methods according to the stability of the ore and the surrounding rock

Stability combination of cases ores and surrounding rocks	The possible groups or subgroups of excavation methods.
Stable ore and surrounding rocks	All groups of excavation methods are acceptable, except for excavation methods with caving.
Stable ore and unstable surrounding rocks	From the group of excavation methods with backfilling, a subgroup of methods with the horizontal levels is acceptable, it is also possible to use the subgroups of excavation methods in sloped levels. Acceptable group of excavation methods with caving, except for block caving methods.
Unstable ore and stable surrounding rocks	Subgroups of excavation methods with support of excavation, then with support and backfilling of stopes are acceptable.
Unstable ore and souronding rocks	Subgroups of excavation methods with stope support are acceptable.

Table 2 gives the choice of the excavation method depending on the dip angle and the thickness (capacity) of the deposit.

Table 2. Excavation methods according to the capacity and dip angle

Possibility and dip angle of deposits	Methods with natural maintenance of open stope (open stope methods)	Methods with ore and surrounding rock caving	Methods with artificial support of stope (methods with support)
The deposits are steep	The chamber excavation system - at any thinkness. Shrinkage stoping where the thickness must not be less than 1 - 1.3 m to avoid ore bind.	Block caving methods for thick deposits. Sublevel caving methods at deposit thickness less than 3 m.	Excavation methods with backfilling in horizontal and inclined levels - at any deposit thickness. Self-filling methods of narrow deposit. Methods with support and backfilling at every deposit thickness.
The deposits with slightly slope	Frontal and room- pillar excavation methods at medium and low thickness. Chamber methods with ore shrinkage in more thick deposits.	Block caving methods in thick deposits. Methods with caving of thick deposits.	Methods of excavation horizontally and inclined with backfilling. Support methods. Methods with support and backfilling of stopes.

Table 3. presents systematized basic or constant factors and their influence for certain groups and subgroups of ore mining methods.

Table 3. Influential natural parameters on the choice of excavation method

Group	Subgroup		Layer thickness (m)	Dip angle (^{0})	Ore stability	Stability of hanging wall / floor
I AND OPEN EXCAVATION METHODS	1. Frontal excavation methods		1,5 – 4	≤ 30^0	stable	stable / stable
	2. Room and pillar methods		2 – 30	≤ 45^0	stable	stable / stable
	3. Sublevel caving methods		≥30	≥ 60^0	stable	stable / stable
	4. Shrinkage stope methods		0,6 – 5	≥ 60^0	stable	stable / stable
II EXCAVATION METHODS WITH BUILDING	1. Excavation methods with backfilling of stopes	1.1. Roof excavations in horizontal levels	≥ 1	≥ 60^0	stable	any/ any
		1.2. Roof excavations in sloping levels	0,7 – 4	≥ 60^0	stable	stable / stable
		1.3. Self-backfilling excavation methods	0,1- 0,8	≥ 60^0	stable	any/ any
	2. Excavation method with substructure and backfilling of excavated areas	2.1. Excavation methods in horizontal levels	> 4	≥ 50^0	unstable	any/ any
		2.2. Excavation methods by square set	> 4	0 - 90^0	unstable	any/ any
	3. Excavation methods with subdivision of excavated areas	3.1. Excavation methods in horizontal levels	> 4	0 - 90^0	unstable	any
		3.2. Frontal excavation methods	> 3	≤ 30^0	unstable	moderately firm
		3.3. Excavation methods per dip of deposit	< 3	≤ 45^0	unstable	moderately firm
III METHODS OF EXCAVATION WITH CAVING	1. Excavation methods by the immediate roof caving		< 4	< 40^0	stable	moderately firm
	2. Excavation method by roof caving in the levels		> 3	≥ 45	stable	unstable/ unstable
	3. Sublevel caving methods		> 15	≥ 45	any	unstable/ unstable
	4. Excavation methods with block cutting		> 25	≥ 75	unstable	moderately firm

On the example of one deposit of irregular contours, with stable ore and unstable sides. The deposit has an average capacity of about 2 m, with dip angle of about 50° and a depth of about 300 m. The value of the ore in the deposit is average, and the distribution of useful minerals is uneven in such a way that the rich parts of the ore are mixed with the poor parts. Based on the known characteristics, Table 4. is compiled with a list of factors and their characteristics.

Table 4. Choice of the excavation method based on the natural characteristics of the deposit (Example)

Characteristic	Value	Possible method of excavation
Dip angle	50^0	I-3,4; II-1.1.,1.2.,1.3.,1.4. ,2,1.,2.2.,3.1, III-2,3,4
Deposit thickness	2 m	I-1,2,4;II-1.1,1.2,1.3,3.1,3.2;III-1,2
Strength 1. Ore 2. Surrounding rocks	Stable Unstable	II-1.1,1.3;III-2,3
Deposit contours Contact of ore and surrounding rocks	Incorrect contour Clear contact	I - III
Metal distribution in the deposit	Rich ore alternates with poor ore and waste	I – III with selective excavation
Disturbance of the terrain surface	No limit	I - III
Depth of exploitation	300 m	I - III

Table 4. shows that the following excavation methods are suitable for a specific ore deposit:

- Method of roof directional excavation with backfilling in horizontal levels
- Sub-level caving method
- Excavation methods with backfilling and backfilling in horizontal levels
- Excavation methods with supporting in the horizontal levels

The final decision on the choice of excavation method will be made by optimizing of the selected excavation methods, which can be done on the basis of technical and economic parameters by economic comparison of variants of the excavation methods or by the method of multi-criteria optimization [7,8,9].

CHOICE OF EXCAVATION METHOD BY MULTICRITERIA ANALYSIS

The method of analytical hierarchical processes (AHP) was developed by Thomas Saaty in the early 1970s and it represents one tool in decision analysis. The area of method application is multi-criteria decision, where based on the defined set of criteria and attribute values for each alternative, the most acceptable solution is selected, i.e. the complete schedule of the importance of the alternative in the model is shown. Four phases of application of the method can be distinguished [10]:

1) structuring the problem
2) data collection
3) estimation of the relative weights
4) determining the solution to the problem

Problem structuring consists of decomposing a certain complex decision problem into a series of hierarchies, where each level represents a smaller number of the managed attributes. A graphical representation of the structuring of the problem is presented in Figure 1.

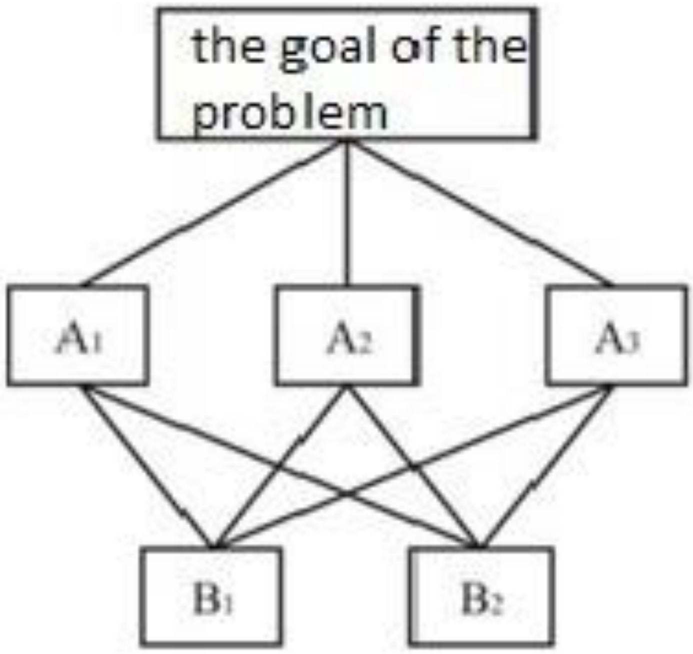

Figure 1. Structuring of the problem

By collecting data and measuring them, the second phase of the AHP method begins. The decision maker assigns the relative ratings to pairs of attributes of one hierarchical level, for all levels of the entire hierarchy. The Saaty scale of nine points, presented in Table 5, is used.

Table 5. Saaty scale

Impotance intensity	Definition	Explanation
1	Equally important	It is used when both factors act equally on the final result.
3	Somewhat more important	It is used when there is a small difference on the side of one factor in relation to another.
5	Much more important	It is used when one factor is much more important than another factor.
7	Significantly more important	It is used where one factor is significantly more important than another.
9	Absolutely more important	It is used in the case when one instance is absolutely more important than another instance, without any doubt.
2,4,6,8	Intermediate values	They are used when a compromise between two values is needed. That is, when it is difficult to decide between two odd intensities of importance.

At the end of this phase, an appropriate matrix of comparisons by pairs corresponding to each level of the hierarchy is obtained.

Estimation of relative weights is the third phase of application of the AHP method. The comparison matrix will be "translated" in pairs into problems of determining of own values, in order to obtain normalized and unique own vectors, as well as weights for all attributes at each level of the hierarchy A_1 $_2$, ,..., A A_n, with the weight vector m m m m = ( ) $_{1\,2}$, ,..., $_n$., [10].

Determining the solution of the problem is the last phase of the AHP method, and it involves finding the so-called composite normalized vector. Once the vector of the sequence of activity of the criteria in the model is determined, in the next round it is necessary, within each observed criterion, to determine the sequence of importance of the alternative in the model [11].

Finally, the overall synthesis of the problem is performed as follows: the participation of each alternative is multiplied by the weight of the certain criterion, and then these values are summed for each alternative separately. The obtained data represents the weight of the certain alternative in the model. In the same way, the weight is determined for all other alternatives, after which the final sequence of alternatives in the model can be determined.

The AHP method belongs to the group of popular methods, because it has the possibility of identifying and analyzing the consistency of the decision maker in the process of comparing elements from the hierarchy. Since the comparison of the alternative is based on a subjective assessment by the decision maker, it is necessary to constantly monitor it, in order to ensure the necessary accuracy [12]. The AHP method makes it possible to monitor the consistency of estimates at any time in the process of comparing the alternative pairs.

Using the consistency index:

$$C.I. = (\lambda_{max} - n)/(n-1)$$

the consistency ratio is calculated: $C.R. = \frac{C.I.}{R.I.}$

R.I.- random index (matrix consistency index of size *n* randomly generated pair comparisons).

Table 6. Random index value R.I.

n	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0,52	0,89	1,11	1,25	1,35	1,40	1,45	1,49

The coefficient λ_{Max} is the maximum and main characteristic of the value of the comparison matrix, while *n* is the size of the comparison matrix. In this case, it is valid that $\lambda \geq n$, and the difference $\lambda_{Max} - n$ is used in measuring the consistency of the estimation. In case of inconsistency, if λ_{Max} is closer to *n*, the estimate is more consistent. If the comparison matrix is $C.R. \leq 0{,}10$, estimates of the relative importance of the criteria (alternative priorities) are considered as acceptable. Otherwise, the reasons why the inconsistency of the assessment is unacceptably high need to be found.

The choice of the excavation method according to the natural characteristics of the deposit always precedes to the final choice, which means that in this way the variants of the excavation method are defined which according to the natural characteristics meet the set conditions [13]. For example, for the appropriate deposit the following excavation methods are selected that could be applied in Table 7.

Table 7. The variants of excavation methods selected according to the natural characteristics of the deposit

Serial number	Excavation method
1	Roof directional excavation method with backfilling in horizontal levels
2	Sublevel caving method
3	Methods of excavation with support and backfilling in horizontal levels
4	Excavation methods with support in horizontal levels

Attributes at the second level (decision criteria) are marked as follows (Table 8):

Table 8. Criteria for choice of excavation method

S.N.	Criterion	Mark
1	Value of excavated ore	$K_1 \rightarrow max$
2	Safety of excavation work	$K_2 \rightarrow max$
3	Processing coefficient (k_p)	$K_3 \rightarrow min$
4	Recovery of deposit (i)	$K_4 \rightarrow max$
5	Dilution of the obtained ore (r)	$K_5 \rightarrow min$
6	Production price of 1 t of ore (C_{pr})	$K_6 \rightarrow min$
7	Excavation effect (U_o)	$K_7 \rightarrow max$
8	Surface impact and other environmental impacts	$K_8 \rightarrow min$

Criteria such as coefficient of processing, recovery, dilution of ore, excavation effect for individual groups and subgroups of excavation methods of non-layered (ore) deposits are given in Table 9.

Table 9. Influential techno-economic parameters for the choice of the excavation method

Group	Subgroup		U_o t/shift	k_p m/1000 t	i %	r (%)	C_{pr} (€/t)
I OPEN STOPE METHODS	1. Frontal excavation methods		30 - 70	0,5 - 3	70 - 90	5 - 15	17,5 – 25
	2. Chamber-pillar methods		30 - 70	2- 14	60- 80	5 - 15	20 - 30
	3. Sublevel caving methods		60 - 90	3 - 16	80 - 95	5 - 15	18 - 25
	4. Shrinkage methods		25 - 40	2 - 17	75 - 90	3 - 15	25 - 32
II EXCAVATION METHODS WITH BUILDING	1. Excavation methods with backfilling of stopes	1.1. Roof excavations in horizontal levels	10 - 25	3 - 9	95 - 99	1 - 5	27 - 40
		1.2. Roof excavations in sloping levels	9 - 18	4 - 14	94 - 98	2 - 8	25 - 40
		1.3. Self-backfilling excavation methods	2 - 8	5 - 20	88 - 98	5 - 20	15 - 30
	2. Excavation method with support and backfilling of stopes	2.1. Methods of excavation in horizontal levels	5 - 20	2 - 12	85 - 95	5 - 15	20 - 40
		2.2. Methods of excavation by square set support	2 - 15	5 - 12	90 - 95	5 - 15	34 - 45
		3.1. Excavation methods in horizontal levels	2 - 15	5 - 12	95 - 98	2 - 10	28 - 35

	3. Excavation methods with subdivision of excavated areas	3.2. Frontal excavation methods	4 - 15	5 - 12	90 - 95	5 - 15	25 - 35
		3.3. Excavation methods per dip of deposit	2 - 15	7 - 12	90 - 95	2 - 13	25 - 32
III METHODS WITH CAVING	1. Excavation methods by caving of the immediate hanging wall		10 - 20	3 - 8	85 - 95	2 - 15	15 - 28
	2. Excavation method by roof caving		15 - 35	4 - 6	95 - 98	1 - 8	12 - 30
	3. Sublevel caving methods		40 - 90	3 - 15	80 - 95	5 - 25	15 - 25
	4. Excavation methods with block cutting		5 - 130	2 - 10	75 - 95	10 - 25	15 - 30

The next step of the AHP method is pairwise comparison, Saaty's scale of relative importance is used when comparing in pairs.

Table 10. Comparison of attributes at the level of decision criteria

	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	Weights
K_1	1,000	3,000	4,000	3,000	5,000	2,000	7,000	8,000	0,2792
K_2	0,333	1,000	2,000	0,333	4,000	0,200	3,000	5,000	0,0967
K_3	0,250	0,500	1,000	0,333	4,000	0,166	3,000	5,000	0,0799
K_4	0,333	3,000	3,000	1,000	5,000	0,166	4,000	6,000	0,1417
K_5	0,200	0,250	0,250	0,200	1,000	0,143	0,500	3,000	0,0359
K_6	0,500	5,000	6,000	6,000	7,000	1,000	7,000	8,000	0,3016
K_7	0,143	0,333	0,333	0,250	2,000	0,143	1,000	4,000	0,0454
K_8	0,125	0,200	0,200	0,166	0,133	0,125	0,250	1,000	0,0195
Total	2,884	13,283	16,783	11,282	28,130	3,943	25,750	40,00	

$$\lambda = 8{,}77 \; ; \; C.I. = \frac{\lambda_{max} - n}{n-1} = \frac{8{,}77 - 8}{7} = 0{,}11 \; ; \; C.R. = \frac{C.I.}{R.I.} = \frac{0{,}11}{1{,}4} = 0{,}079 < 0{,}10$$

Analogous to the previous one, the attributes of the alternative level can be marked as follows (Table 11):

Table 11. Alternative level attributes

Roof directional excavation method with backfilling in horizontal levels	A_1
Excavation method with roof caving	A_2
Methods of excavation with support and backfilling in horizontal levels	A_3
Excavation methods with support in horizontal levels	A_4

The corresponding alternative comparison matrices for each criterion attribute and their priorities are shown in the following tables (12 – 19.).

Table 12. Matrices of relevant importance of the alternative in relation to attribute K_1 (Value of exc. ore)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	5,000	3,000	3,000	0,5050
A_2	0,200	1,000	0,500	0,333	0,0868
A_3	0,333	2,000	1,000	3,000	0,2441
A_4	0,333	3,000	0,333	1,000	0,1641
Σ	1,866	11,000	4,833	7,333	

$$\lambda = 4{,}25\ ;\ C.I. = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}25-4}{3} = 0{,}084\ ;\ C.R. = \frac{C.I.}{R.I.} = \frac{0{,}084}{0{,}89} = 0{,}094 < 0{,}10$$

Table 13. Matrices of relevant importance of the alternative in relation to attribute K_2 (Work safety)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	7,000	3,000	5,000	0,5769
A_2	0,143	1,000	0,333	0,500	0,0716
A_3	0,333	3,000	1,000	3,000	0,2399
A_4	0,200	2,000	0,333	1,000	0,1125
Σ	1,676	13,000	4,666	9,500	

$$\lambda = 4{,}06\ ;\ C.I. = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}06-4}{3} = 0{,}02\ ;\ C.R. = \frac{C.I.}{R.I.} = \frac{0{,}02}{0{,}89} = 0{,}022 < 0{,}10$$

Table 14. Matrices of relevant importance of the alternative in relation to attribute K_3 (Processing coefficient)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	5,000	3,000	2,000	0,4658
A_2	0,200	1,000	0,333	0,200	0,0691
A_3	0,333	3,000	1,000	0,500	0,1679
A_4	0,500	5,000	2,000	1,000	0,2973
Σ	2,033	14,000	6,333	3,700	

$$\lambda = 4{,}058\ ;\ C.I. = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}058-4}{3} = 0{,}019\ ;\ C.R. = \frac{C.I.}{R.I.} = \frac{0{,}019}{0{,}89} = 0{,}022 < 0{,}10$$

Table 15. Matrices of relevant importance of the alternative in relation to attribute K_4 (Recovery of deposit)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	7,000	5,000	4,000	0,6256
A_2	0,143	1,000	0,200	0,333	0,0614
A_3	0,200	5,000	1,000	0,500	0,1659
A_4	0,250	3,000	2,000	1,000	0,1988
Σ	1,593	16,000	8,200	4,833	

$$\lambda = 4{,}236\ ;\ C.I. = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}236-4}{3} = 0{,}079\ ;\ C.R. = \frac{C.I.}{R.I.} = \frac{0{,}079}{0{,}89} = 0{,}088 < 0{,}10$$

Table 16. Matrices of relevant importance of the alternative in relation to the attribute K_5
(Dilution of the obtained ore)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	0,143	0,333	0,200	0,0568
A_2	7,000	1,000	5,000	4,000	0,5917
A_3	3,000	0,200	1,000	0,500	0,1302
A_4	5,000	0,250	2,000	1,000	0,2212
Σ	16,000	1,593	8,333	5,700	

$$\lambda = 4{,}124\ ;\ C.I. = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}124-4}{3} = 0{,}041;\ C.R. = \frac{C.I.}{R.I.} = \frac{0{,}041}{0{,}89} = 0{,}045 < 0{,}10$$

Table 17. Matrices of relevant importance of the alternative in relation to attribute K_6
(Production price of 1t of ore)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	5,000	3,000	2,000	0,4583
A_2	0,200	1,000	0,333	0,200	0,0691
A_3	0,333	3,000	1,000	2,000	0,2372
A_4	0,500	5,000	0,500	1,000	0,2247
Σ	2,033	14,000	4,833	5,200	

$$\lambda = 4{,}225 \text{ ; C.I.} = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}429-4}{3} = 0{,}074; \text{ C.R.} = \frac{\text{C.I.}}{\text{R.I.}} = \frac{0{,}075}{0{,}89} = 0{,}081 < 0{,}10$$

Table 18. Matrices of relevant importance of the alternative in relation to attribute K_7 (Mining performance)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	0,200	3,000	3,000	0,2211
A_2	5,000	1,000	4,000	3,000	0,5479
A_3	0,333	0,250	1,000	2,000	0,1308
A_4	0,333	0,333	0,500	1,000	0,1004
Σ	6,666	1,783	8,500	9,000	

$$\lambda = 4{,}165 \text{ ; C.I.} = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}165-4}{3} = 0{,}055; \text{ C.R.} = \frac{\text{C.I.}}{\text{R.I.}} = \frac{0{,}055}{0{,}89} = 0{,}062 < 0{,}10$$

Table 19. Matrices of relevant importance of the alternative in relation to the attribute K_8 (Impact to surface)

	A_1	A_2	A_3	A_4	Weights
A_1	1,000	0,250	2,000	3,000	0,2292
A_2	4,000	1,000	4,000	3,000	0,5101
A_3	0,500	0,250	1,000	0,333	0,0919
A_4	0,333	0,333	3,000	1,000	0,6752
Σ	5,833	1,833	10,000	7,333	

$$\lambda = 4{,}225 \text{ ; C.I.} = \frac{\lambda_{max} - n}{n-1} = \frac{4{,}225-4}{3} = 0{,}075; \text{ C.R.} = \frac{\text{C.I.}}{\text{R.I.}} = \frac{0{,}075}{0{,}89} = 0{,}084 < 0{,}10$$

At the end of the procedure, a synthesis of the problem of choosing the excavation method is performed, so that all alternatives are multiplied by the weights of individual decision criteria, and the obtained results are added, as shown in Table 20.

Table 20. Choice of the optimal alternative of the excavation method

Criterion	Weight criteria	A_1	Weight x A_1	A_2	Weight x A_2	A_3	Weight x A_3	A_4	Weight x A_4
K_1	0,2792	0,5050	0,1409	0,0868	0,0242	0,2441	0,0682	0,1641	0,0458
K_2	0,0967	0,5769	0,0558	0,0716	0,0069	0,2399	0,0232	0,1125	0,0109
K_3	0,0799	0,4658	0,0372	0,0691	0,0055	0,1679	0,0134	0,2973	0,0237
K_4	0,1417	0,6256	0,0886	0,0614	0,0087	0,1659	0,0235	0,1988	0,0282
K_5	0,0359	0,0568	0,0200	0,5917	0,0212	0,1302	0,0047	0,2212	0,0079
K_6	0,3016	0,4583	0,1382	0,0691	0,0208	0,2372	0,0715	0,2247	0,0678
K_7	0,0454	0,2211	0,0100	0,5479	0,0249	0,1308	0,0059	0,1004	0,0046
K_8	0,0195	0,2292	0,0044	0,5101	0,0099	0,0919	0,0018	0,6752	0,0132
			0,4774		0,1223		0,2122		0,2021

The alternative with the highest value is the most acceptable or optimal method of excavation for a specific ore deposit, which means that alternatives A1 - Method of roof directional excavation with backfilling in horizontal levels will be selected for exploitation of this deposit.

CONCLUSION

The paper presents the procedure for choice of the optimal excavation method of ore deposit through two basic phase:

1. The choice of the excavation method according to the natural characteristics of the deposit.
2. The choice of the excavation method by the procedure of multicriteria analysis from the group of possible excavation methods selected on the basis of natural characteristics.

The choice of the excavation method by the procedure of multicriteria analysis was performed by applying the AHP method in specific conditions of the ore deposit. One of the leading problems in the application of this method is the definition of decision-making attributes at the second level (decision-making criteria) and the assessment of their relevant weights. The authors defined the criteria and estimated the values of their relative weight based on their own experiences in previous scientific research.

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