The 56th International October Conference on Mining and Metallurgy
22-25 October 2025, Bor Lake, Bor, Serbia
www.ioc.tfbor.bg.ac.rs

DOI: 10.5937/IOC25695F *Original scientific paper*

IS MINING AND QUARRYING MOST EFFICIENT AND PROFITABLE EXPORT SECTOR IN SERBIA? INSIGHTS FROM A MULTI-CRITERIA PERFORMANCE ANALYSIS

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Abstract
The aim of this study is to compare the efficiency and profitability of companies in the mining and quarrying sector (Sector B) with those in other leading export sectors in Serbia, using a multi-criteria decision-making (MCDM) framework. The analysis is conducted using the Additive Ratio Assessment (ARAS) method, implemented under two distinct weighting scenarios: one assuming equal importance of all criteria, and other utilizing objective weights derived through the entropy method. The accounts receivable turnover ratio emerged as the most influential criterion, reflecting its critical role in indicating operational efficiency management, which is essential for sustaining competitiveness and profitability across export-oriented sectors. The findings reveal that the mining and quarrying sector demonstrates the most profitable and efficient export-oriented sector in Serbia, whereas the sector of professional, scientific, and technical activities is placed at the very bottom of the rankings. Additionally, a sensitivity analysis was conducted, which confirmed the robustness and consistency of the sectoral rankings across both scenarios.

***Keywords**: mining and quarrying sector, profitability, efficiency, Entropy method, ARAS method*

1. INTRODUCTION

The mining and quarrying sector holds a significant position within the Serbian economy, particularly due to its substantial contribution to export and GDP. Rich in mineral resources and strategically positioned in the regional market, Serbia has increasingly relied on the mining sector as a driver of economic growth, regional development, foreign direct investment, and infrastructure development, as well as solution for various social and demographic issues [1]. In recent years, the sector has attracted considerable attention due to major investments particularly in copper and gold extraction, underscoring its potential to strengthen Serbia' export competitiveness and economic resilience. Assessing the performance of this sector is therefore essential for understanding its current role and future trajectory within the national economy [2]. In broader perspective, evaluating the relative profitability and efficiency of different export sectors is crucial for accurately positioning each sector within the broader economic landscape. Such comparisons help highlight the competitive advantages and challenges of individual sectors, providing policymakers and investors with clearer guidance on where to focus support and resources in order to mitigate risks of business operations in these sectors [3]. However, comparative assessments that integrate multiple financial performance indicators using structured analytical frameworks remain scarce in the existing literature. The profitability and efficiency are especially important, since these companies operating in this sector are characterized by high investments and operating costs and significant oscillations of metals' prices in the global market [4, 5]. This study aims to fill that gap by applying multi-criteria decision-making (MCDM) approach to compare the efficiency and profitability of the mining and quarrying sector with nine other top-performing export sectors in Serbia. The evaluation is conducted using the Additive Ratio Assessment (ARAS) method under two weighting scenarios: one assuming equal importance of all criteria and the other employing objective weights derived from the entropy method. The

dual weighting approach enhances the objectivity and reliability of the results, while the inclusion of sensitivity analysis ensures the robustness of sectorial rankings.

2. RESEARCH METHODOLOGY

Multi-criteria decision-making methods (MCDM) are becoming more and more important in the assessment of sector performance, because they enable the simultaneous analysis of several criteria of different natures. The ARAS method enables the ranking of alternatives in relation to the optimal value [6, 7]. In contrast, the entropy method provides an objective way to determine the weights of the criteria, based on the variability of the information in the input data.

2.1. Selection of Criteria

The selection of evaluation criteria in this study was based on a review of relevant financial literature and previous empirical research on industrial performance assessment. Eight indicators were chosen, grouped into two main categories: efficiency ratios (accounts receivable turnover ratio - C1, average payment period - C2, total assets turnover ratio - C3, fixed assets turnover ratio - C4) and profitability ratios (operating profit margin – C5, net profit margin – C6, return on assets – C7, and return on equity – C8). The analysis is based on data provided by the Serbian Business Registers Agency, which annually publishes aggregated balance sheets and income statements at the sectoral level, incorporating summary data from all registered enterprises operating in each sector. Similar sets of indicators have been effectively used in previous studies focused on sectoral performance evaluation using MCDM techniques [8, 9].

2.2. Determination of weights

In order to determine the relative importance of each criterion in the evaluation model, two approaches were applied. In the first scenario, all criteria are assigned equal weights (0.125), assuming their equal importance in the evaluation process. In the second scenario, the weight coefficients are determined objectively (Table 1), using the Shannon entropy method, which uses the dispersion of the data to calculate the amount of information that each criterion contributes to the decision [10].

Table 1 - Caption of table

Criteria	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
Objective weight	0.159	0.123	0.121	0.108	0.136	0.121	0.119	0.112
Subjective weight	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125

2.3. ARAS method

The ARAS (Additive Ratio Assessment) method evaluates and ranks alternatives by comparing their performance against criteria. Its application involves several phases [6]. The decision-making process begins with creating a matrix of alternatives and criteria, followed by normalization, weighting (using Shannon's entropy method), and calculation of utility values that represent each alternative's closeness to the ideal solution. Finally, the alternatives are ranked based on their overall utility, with the highest value placed first. This method has numerous advantages, which make it suitable for this type of analysis [11].

3. RESULTS AND DISCUSSION

The decision table shown in Table 2 consists of ten alternatives: A1 - Mining and quarrying; A2 – Manufacturing; A3 - Electricity, gas, steam and air conditioning; A4 – Construction; A5 - Wholesale and retail trade, repair of motor vehicles and motorcycles; A6 - Transportation and storage; A7 - Accommodation and food service activities; A8 - Information and communication; A9 - Professional, scientific and technical activities; A10 - Administrative and support service activities.

Table 2 - Decision table

Criteria	*Efficiency ratios*				*Profitability ratios*			
	C1	C2	C3	C4	C5	C6	C7	C8
min/max	*max*	*min*	*max*	*max*	*max*	*max*	*max*	*max*
A1	11.13	32.33	1.0	0.70	22.81	15.74	16.06	19.10
A2	5.69	63.32	1.9	0.91	5.42	3.59	4.90	7.15
A3	5.46	65.98	0.5	0.41	7.28	2.44	3.02	1.85
A4	5.25	68.61	1.2	0.55	7.05	5.43	3.90	8.54
A5	6.97	51.63	4.6	1.49	4.47	3.35	6.65	12.19
A6	6.87	52.44	0.9	0.69	4.99	2.77	3.43	4.35
A7	13.77	26.15	0.9	0.65	6.49	4.46	4.23	6.82
A8	4.29	83.83	1.0	0.64	10.82	6.09	6.93	10.04
A9	4.38	82.15	0.9	0.55	4.28	1.86	2.37	2.79
A10	4.62	77.91	1.9	0.98	6.38	4.63	6.24	11.11
wj (Scenario S_1)	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
wj (Scenario S_2)	0.159	0.123	0.121	0.108	0.136	0.121	0.119	0.112

In scenario S_1, where all criteria are equally weighted, each has a weight of (w_j=0.125). Scenario S_2 uses an entropy-based method to determine criterion weights. In this case, C_1 is the most significant criterion with (w_j=0.159), whereas the C_4 has the lowest importance with (w_j=0.108). This result underscores the significant role of liquidity and short-term efficiency indicators in assessing the overall performance of industrial sectors. Specifically, the high weight assigned to accounts receivables turnover ratio suggests that the speed of receivables collection substantially impacts the financial stability and profitability of a sector. These findings align with previous research emphasizing the dominance of liquidity-related criteria in multi-criteria performance evaluations. Studies by [12] and [13] have shown that liquidity ratios, especially turnover-based indicators, often exhibit a high explanatory power when comparing firm or sectoral efficiency across various MCDM methods. Furthermore, [14] highlighted that criteria reflecting short-term operational agility, such as receivables turnover or cash conversion cycle, tend to dominate in dynamic and capital-sensitive industries. The ARAS method is utilized to calculate the results needed for ranking Serbia's industrial sectors in both scenarios Table 3.

Table 3 - Ranking results of using ARAS method for scenarios S_1 and S_2

Alternative	Scenario S_1 *(Equal wj)*			Scenario S_2 *(Objective wj)*		
	S	K	Rank	S	K	Rank
A1	0.16	0.79	1	0.16	0.79	1
A2	0.07	0.36	6	0.07	0.36	6
A3	0.05	0.23	9	0.05	0.24	9
A4	0.07	0.34	7	0.07	0.34	7
A5	0.11	0.55	2	0.11	0.53	2
A6	0.06	0.29	8	0.06	0.30	8
A7	0.09	0.44	3	0.09	0.46	3
A8	0.08	0.38	5	0.08	0.38	5
A9	0.04	0.22	10	0.04	0.22	10
A10	0.08	0.40	4	0.08	0.39	4

The alternative A1 is the best alternative in both scenarios, due to highly efficient turnover and profitability indicators. The mining of precious metals and minerals is often shown to be stable and profitable when the processes are optimally organized [15]. On the other hand, the A9 achieves the weakest performance in both scenarios. Given that this sector often has high fixed asset costs and perhaps slower monetization, it ranks lower on criteria such as ROE or operating profit margin.

In order to verify the stability and robustness of the sector ranking, a sensitivity analysis was carried out using COCOSO, CODAS, COPRAS, EDAS, MABAC, VIKOR and TOPSIS methods. The obtained results are present in Figure 1.

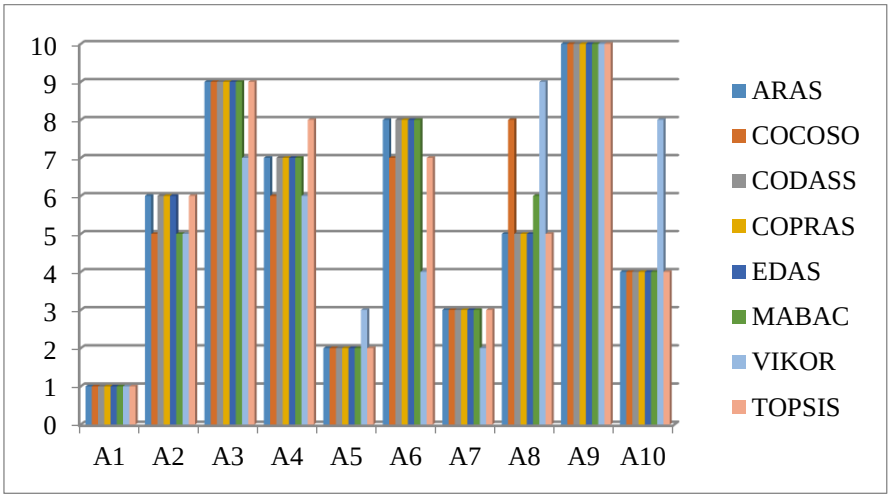

Figure 1 - Sensitive analysis

As shown in the Figure 1, the ranking positions of certain alternatives (A1–A10) remain relatively stable across different methods. Alternative A1 consistently ranks first in all methods, demonstrating a high level of robustness and consistency in the assessment.

4. CONCLUSION

The mining and quarrying sector has been gaining increasing importance in the Serbian economy, particularly over the past decade, due to its contribution to export competitiveness of national economy, regional development, and investment attractiveness. A precise assessment of the sector's efficiency and profitability is therefore essential for guiding strategic decisions made by investors and policymakers. This study employed a combined Entropy-ARAS methodology to evaluate and rank ten leading export-oriented sectors in Serbia. The results indicate that the mining and quarrying sector achieves the highest overall performance, demonstrating superior financial efficiency and profitability compared to other major export-oriented sectors. On the other end of the spectrum, the sector of professional, scientific, and technical activities are ranked at last position. Among the evaluated indicators, the accounts receivable turnover ratio was identified as the most influential, emphasizing the critical role of operational efficiency in shaping overall sector performance. Sensitivity analysis further confirmed the consistency and robustness of the rankings across both weighting scenarios. Although the findings provide useful insights, they are limited by the use of aggregated financial data, and excluding dimensions such as innovation, environmental impact, and workforce productivity. Future research should broaden the scope by including non-financial and sustainability criteria, applying additional MCDM techniques, and using multi-year data to capture sectoral dynamics more comprehensively.

ACKNOWLEDGEMENTS

The research presented in this paper was carried out with the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia within the framework of financing scientific research work at the University of Belgrade, Technical Faculty in Bor, in accordance with the contract with registration number 451-03-137/2025-03/200131.

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